An Acoustic Sociophonetic Study of Three London Vowels

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Abstract

The thesis presents an empirical socio-phonetic investigation of the acoustics of the three short vowels in the DRESS, TRAP and STRUT lexical sets (Wells 1982) in London. The vowels have been reported by a number of phoneticians and variationists to have shifted in particular directions in Received Pronunciatioin (RP) and London English during the course of the 20th century; the directions of the movements, however, seem to be rather complicated. Moreover, there have been relatively fewer instrumental studies for these vowels in London. The main purpose of this research, therefore, is to provide detailed patterns of recent vowel shifts involving these three vowels in London English in relation to internal and external factors.

Acknowledging RP and Cockney as referential accents on a multidimensional accent continuum in London, it is presumed that Londoners closer to the upper and lower ends of social continuum are distinguished as 'London Upper Middle Class (UMC)' speakers and 'London Working Class (WC)' speakers respectively. Social class classification is made on the basis of speakers' occupational information.

The application of the vowel formant normalisation technique called *S-procedure* (Watt & Fabricius 2002) allows direct visual and statistical comparisons for multiple speakers regardless of their physical differences. Investigations are made not only by traditional descriptions of relative placements of vowels in a visual two-dimensional F1/F2 vowel space but also by a recent innovative 'angle and Euclidean distance calculations' procedure (Fabricius 2007) with thorough statistical analyses.

Results show complicated but interesting correlations between the movements of these vowels and the social and phonological characteristics. One of the most interesting findings is an ongoing vowel change process called 'TRAP/STRUT rotation' (Fabricius 2006: 3, 2007: 310) among (female) London UMC speakers who show a well-progressed anticlockwise chain shift involving DRESS, TRAP and STRUT, whereas there is no evidence for this process among London WC speakers who show a rather moderate vowel shift involving only TRAP and DRESS. In this respect, the most innovative group is discussed to be the female young London UMC speakers, followed by the male young London UMC speakers as far as the data in the current study are concerned. The finding of a clear difference between two different accent groups in the realisations of the vowels is discussed to suggest a correlation between social class and accent variation in London, as well as to enhance the validity of occupation as a single indicator for people's social class. Observing a great number of general and minute patterns from the statistical results, the thesis attempts to provide possible explanations for the vowel changes in London, as well as extends its discussions for possible implications with regard to internal and external factors.

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1 Introduction

London, as the capital of England, is considered to have historically played an important leading part in the phonetic development of Received Pronunciation (RP). This seems especially true in the case of 'mainstream RP' (Wells 1982: 279, see §2.1.2 below); it has been greatly influenced by trends and features spreading from working class urban speech, particularly that of London (Wells 1982: 106). Wells also comments as follows:

> With the loosening of social stratification and the recent trend for people of working-class or lower middle class origins to set the fashion in many areas of life, it may be that RP is on the way out. By the end of the [20th] century everyone growing up in Britain may have some degree of local accent. Or, instead, some new non-localizable but more democratic standard may have arisen from the ashes of RP; if so, it seems likely to be based on popular London English. (Wells 1982: 118)

> Not only did its [London's] courtly and upper-class speech lay the historical basis for Standard English and – in many respects – for RP, but its working-class accent is today the most influential source of phonological innovation in England and perhaps in the whole English- speaking world. (Wells 1982: 301)

These speculations have already been supported by a number of recent empirical studies in various places in Britain (cf. Foulkes & Docherty 1999) as will be shown below (§2.3.2).

London has often been claimed to have different accents on a continuum, with Received Pronunciation (RP) and Cockney being its extremes as two socially differentiated accents, an acrolect and a basilect. There are several mesolectal varieties referred to by a number of possibly overlapping terms such as 'London (or, more generally, south-eastern) Regional Standard' and 'Popular London' speech (Wells 1982: 302-3), 'Estuary English' (Rosewarne 1984), 'Post-Modern English' (Maidment 1994), 'New London Voice' (McArthur 1994) and 'South East London Regional Standard' and 'South East London English' (Tollfree 1999).

The phonological variables selected in the current study are the vowels of the DRESS, TRAP and STRUT lexical sets[1]. These three short vowels were chosen because they have been reported by a number of phoneticians and variationists to shift in particular directions in RP, southeast English English and London English during the course of the 20th century, with a certain degree of interrelatedness. As we will see below, however, the reported and proposed directions of the

[1] 'Standard lexical sets' proposed by Wells (1982) are used throughout the current thesis, and written in capitals.

shifts are not always consistent. Moreover, although a number of studies of RP vowels provide more objective acoustic measurements, many of the studies conducted for London English are based on impressionistic auditory analysis which is more subjective. The only recent acoustic analysis carried out for London short vowels is the study of Torgersen, Kerswill & Fox (2006). Moreover many acoustic studies for the RP short vowels (e.g. Wells 1962, Hawkins & Midgley 2005, Fabricius 2006, 2007) predominantly or exclusively investigate the speech of male speakers, which could possibly obscure the actual innovative changes on account of a well-known sociolinguistic tendency that female speakers often lead those innovative changes (Labov 2001: 292). Furthermore, to the best of my knowledge, there have been so far no studies which have thoroughly investigated correlations between these vowel changes and social, and/or phonological factors in London.

A pilot study (Kamata 2006) which investigated nine male speakers indicated particular vowel changes which were very much in line with findings in recent studies such as Torgersen *et al.* (2006) and Fabricius (2007). What was particularly interesting from the early findings was that the data indicated the configurational change of TRAP and STRUT vowels especially among the socially upper (but not extreme) end of speakers (who are categorised as 'London UMC' speakers here) compared to among the socially lower (but not extreme) end of speakers (who are categorised as 'London WC' speakers here); this finding is very much in accordance with the recent (male) RP phenomenon involving TRAP and STRUT vowels – named 'TRAP/STRUT rotation' (Fabricius 2006: 3, 2007: 310) – found by an innovative sociolinguistic method, angle and Euclidean distance calculations (Fabricius 2007). For this reason, the current study was motivated to apply this newly developed method to the data in order to explore more the configurational change in these two vowels not only for the male speakers, but also for the female speakers.

This study pays particular attention to the acoustic characteristics of these three short vowels in London in relation to speakers' social characteristics, and stylistic and phonological variations of their speech. The data analysed were elicited from 32 males and females, older and younger Londoners from two socially well distinct groups. The thesis explores the following research questions:

Q1. Are the three short vowels (DRESS, TRAP and STRUT) in London English shifting?
Q2. If the vowels are shifting, in which directions are they shifting in London WC and London UMC respectively?
Q3. Is there any indication of social effects on the movements of these vowels? Is there any particular social group of people who seem to lead a particular change?
Q4. Is there any consistent stylistic variation for the movements of these vowels?

Q5. Is there any tendency for shifting with regard to the following segment?
Q6. Is there a significant configurational change between TRAP and STRUT in London English? If so, is there any correlation with social and/or phonological characteristics?

In order to find out the answers to these questions, the following three main investigations were conducted: investigation for the relative positions (Chapter 6), apparent-time investigation (Chapter 7) and configurational analysis of TRAP and STRUT (Chapter 8). While observing the results from these investigations, the thesis also attempts to consider possible explanations for the vowel changes in London as well as possible implications with regard to internal and external factors.

The body of the thesis consists of nine chapters together with appendices and bibliography.

Chapter 2 starts with describing the current situations of accent variation in and around London. The chapter discusses not only two traditionally well-known accents – RP and Cockney – but also their middle ground accent especially under the name of Estuary English (Rosewarne 1984).

Chapter 3 presents both internal and external factors which have been proposed to potentially contribute to general language variation and change. As the key internal factors for the short vowel change, Labov's (1994) General Principles of Short Vowel Change are briefly reviewed before general phonetic influences of the following segments are discussed. It should be noted that the social factors, as external factors, discussed here are confined to sex, age, social class, and speech style – the former three of which are said to be 'three overriding social categories in modern industrialized societies' (Chambers 2002: 349) – in the nature of the current data. The chapter also attempts to discuss the concept of social class as well as the sociolinguistic way of social class classification to verify the importance of occupation as an indicator of social class.

Chapter 4 describes historical and current situations of DRESS, TRAP and STRUT vowels in RP and London English from various studies. The chapter also reviews the methodological procedure of Fabricius's (2007) angle and Euclidean distance calculations, followed by the findings from her real-time study of TRAP and STRUT configurations of RP speakers.

Chapter 5 begins with proposing the research questions, and discusses the methodological procedures employed. The chapter also reviews a methodology of vowel normalisation technique called *S-procedure* (Watt & Fabricius 2002) in which vowel formant frequencies in Hertz are transformed into *S-units* which allow me to directly compare multiple speakers both visually and statistically regardless of their physical differences.

Chapter 6 presents results from the investigation of relative positions of DRESS, TRAP and STRUT for social and phonological correlations in London English. The chapter provides statistical results in great detail as well as general but detailed observations from the results, by which minute correlations between the vowel shifts and social and phonological factors are revealed.

Chapter 7 presents results from the apparent-time investigation of DRESS, TRAP and STRUT for generational comparisons in London UMC and London WC respectively. The investigation reveals clear patterns of generational changes in these three vowels according to their age, sex, and social (or accent) group. Possible explanations for the observed changes across generations as well as possible implications with regard to internal and external factors are considered.

Chapter 8 conducts angle and Euclidean distance calculations to investigate the configurational change in TRAP and STRUT in relation to social and phonological aspects in London English. The investigation reveals detailed correlations between different configurations and social and phonological factors.

Chapter 9 finally presents the conclusions of the thesis by providing final remarks with regard to the proposed research questions in Chapter 5.

2 Accent variation in London

2.1 Bipolar accent variation in London – RP and Cockney

It is traditionally said that there are in London, two distinct accents[2]: Cockney and Received Pronunciation (hereafter RP). These two accents are generally distinguished from each other not only by their linguistic – particularly phonetic and phonological – characteristics but also by their regional and social characteristics. This section, however, mainly focuses on the latter two characteristics.

2.1.1 Cockney

Cockney[3] is used to describe a basilectal London English, which is related to both the social class and the geographical area the speaker belongs to. Socially, it is often stigmatised as a vulgar accent; it is presumed to be used by people of the lowest social strata of the city, i.e. the working class. Geographically, it is only heard in the London area. To be more accurate, this variety is particularly associated with the innermost areas of east London – the East End – such as Bethnal Green, Stepney, Mile End, Hackney, Whitechapel, Shoreditch, Poplar, and Bow (Wells 1982: 302).

Although a well-known traditional regional criterion for a 'true Cockney' being someone who was born within the sound of Bow Bells (i.e. the bells of St Mary-le-Bow, Cheapside) (Barltrop & Wolveridge 1980: 2, Coggle 1993: 23, Crowther 1999: 118, Wells 1982: 302) seems to be 'nostalgic' rather than 'realistic' (Altendorf 2003: 36), Cockney can be described in a rather narrow sense of the term. Wells (1982: 302), for instance, describes that Cockney 'constitutes the basilectal end of the London accent continuum, the broadest form of London local accent'. He, furthermore, identifies another type of working class Londoners south of River Thames who do not qualify as 'true Cockneys' and sound 'very slightly closer to RP than the broadest Cockney', and terms it 'popular London' (Wells 1982: 302). Although the original definition of this term is attributed to its speakers' regional characteristics (i.e. south of the Thames), the term is used in

[2] The term 'accent' is used to distinguish from the term 'dialect' here. 'Accent' means the way of pronouncing English, while 'dialect' refers not only to pronunciation but also to the words and grammar that people use (Trudgill 1999a: 2). In this respect the term 'accent' will mainly be considered in this thesis.

[3] Cockney is generally considered not only as an accent but as a dialect in that it possesses many of its own special vocabulary and usages, including rhyming slang (Wells 1982: 302, Cruttenden 2001: 87); however, its phonetic and phonological aspect will only be considered here.

more general sense as Wells describes it as 'an ordinary working-class London accent' (1982: 302).

Sivertsen (1960: 2) defines Cockney in a wider sense of the term as 'speech forms found in the London area', arguing that '[t]here is no homogeneous speech form which might be so labelled: there are regional and local variants, and there are social and stylistic differences.' She goes on to comment that some forms of Cockney are presumably more 'genuine' than others, referring to Franklyn (1953)'s distinction between the 'light' Cockney of the Cockney clerk and the 'deep' Cockney of the coster (Sivertsen 1960: 2-3). A similar observation is made by McArthur (1992: 226-8) who distinguishes between 'Core Cockney' and 'fringe Cockney', the latter of which refers to 'a widely diffused variety of working-class speech in south-eastern England' 'centred on the East End of London'.

What seems to be shared as the concept of the term Cockney in general is that (1) it serves as the broadest accent which originated from (the East End of) London, (2) it is strongly associated with the area, London, and its working class people (3) it has a certain degree of variation in itself, and (4) it is considered to be socially and linguistically located on an extreme end of an accent continuum within London.

2.1.2 RP

RP, which is located on the other end of the continuum, is a standard accent of English in England. It has gained such a status as the standard accent, according to Altendorf (2003: 28), by having gone through a series of 'standardisation' processes based on a 16th century London upper-class variety (Smith 1996: 93): that is, codification at the beginning of the 20th century by Daniel Jones (1917), and propagation through private boarding schools (Mugglestone 2003) and the BBC (Leitner 1982).

RP has, on the one hand, socially been regarded as the most prestigious accent and perceived as being spoken by upper class or upper-middle class people in general. Geographically, on the other hand, RP has often been claimed to have no relation to the region where the speaker comes from. In fact, however, it was originally based on the speech of educated speakers of southern British English, particularly on that of the London region as a place for the centre of politics, commerce, and the presence of the Court (Cruttenden 2001: 78). It also typologically has origins in the southeast of England in a sense that unlike accents from the southwest of England, for example, it is a non-rhotic accent, and unlike the accents of the north of England, it has /ɑː/[4] rather than /æ/ in the lexical sets of *bath* and *dance* (Trudgill 2002: 172). This originally regional-based accent has become so widespread, due to the influence of the BBC, and has discarded some of its regional characteristics while undergoing modification (Przedlacka 2002: 8). For these reasons, its speakers nowadays do not solely come from a particular region (i.e. the south(east) of England). Therefore, one of its unique definitions is non-localisability within England (Wells 1982: 117, Przedlacka 2002: 8-9).

As in the case of Cockney, RP has been considered to have a certain degree of variations in itself. Gimson (1980), Wells (1982) and Cruttenden (2001), for examples, have proposed different sets of distinctions for those variations within RP, which are summarised in Table 1 below:

Table 1 Variations in/around RP proposed by Gimson (1980), Cruttenden (2001) and Wells (1982)

<table>
<tr><th></th><th>Gimson
(1980)</th><th>Cruttenden
(2001)</th><th>Wells
(1982)</th></tr>
<tr><td>(1)-a</td><td>Conservative RP</td><td rowspan="2">Refined RP</td><td rowspan="2">U-RP
(upper-crust RP)</td></tr>
<tr><td>(1)-b</td><td>Advanced RP</td></tr>
<tr><td>(2)-a</td><td rowspan="2">General RP</td><td rowspan="2">General RP</td><td>Mainstream RP</td></tr>
<tr><td>(2)-b</td><td>Adoptive RP</td></tr>
<tr><td>(3)</td><td></td><td>Regional RP</td><td>Near-RP</td></tr>
</table>

(1) is considered to be the type of RP spoken commonly by upper class speakers as indicated by the Wells's term 'upper-crust RP' or simply 'U-RP', and is further distinguished by Gimson into 'Conservative RP' and 'Advanced RP' particularly for the types of RP used by the older and younger generations respectively (Wells 1982: 279-80). The division between 'Advanced RP' and 'General RP' is indicated by a dotted line in the table since Gimson hints at the possibility that some of the trends in the former type of RP might be retained and become characteristics of the latter type of RP (cited in Altendorf 2003: 31). (2) is considered to be spoken mainly by upper middle class speakers (Wells 1982: 280), used as the teaching model (Schmid 1999: 5) and typically as the pronunciation of the BBC (Gimson 1980). It is distinguished by Wells (1982) into two types: 'Adoptive RP' as a variety of RP spoken by adults who did not speak RP as children, and 'Mainstream RP' as a variety of RP spoken by other (native) RP speakers. As indicated by a dotted line, the distinction between these two accents could be obscured particularly when an 'Adoptive RP' speaker perfectly learns to speak exactly like a native RP speaker, though Wells

[4] Trudgill (2002) describes as /aː/.

comments that this often does not happen (1982: 284). As for (3), Wells (1982: 279, 297) acknowledges 'Near-RP' which does not fall within the definition of RP but is not very different from it. The 'Near-RP' is also said to include regional characteristics which enable us to localise the speaker within England. This is presumably considered to be equivalent to the concept of 'Regional RP' introduced by Cruttenden who, whilst being aware of its possible contradiction to its peculiar characteristic as non-localisability, does not exclude it from the category of RP but describes it as 'the type of speech which is basically RP except for the presence of a few regional characteristics which go unnoticed even by other speakers of RP' (2001: 80).

Despite a number of different regions existing in England, London has exclusively been given special terms for the last type of accent. Wells (1982: 303) recognises a type of speech which is closer to RP than 'popular London' (1982: 302, also §2.1.1) and spoken by the vast majority of middle class speakers, and especially labels it as 'London (or more generally, south-eastern) Regional Standard'. Cruttenden (2001: 81) also makes special mention of what he calls 'London Regional RP' – a modified version of RP towards Cockney – among many other 'Regional RPs' (2001: 80). It is interesting to note that the term, London Regional Standard, is used by Cruttenden as a synonym of 'Estuary English' (Rosewarne 1984) – a term for a hybrid between RP and Cockney – which has been controversial amongst linguists in the last few decades. More will be discussed for the term, Estuary English, below (§2.3).

In short, RP is closely related to the social status of the speakers, therefore it is an extremely significant marker of higher class groups in all parts of England including London. Despite its prestige, the number of RP speakers has been estimated to make up only about 3 to 5 percent of the whole population (Wales 1994: 4, Trudgill 2002: 171-2, Hughes, Trudgill & Watt 2005: 3), or less than 10 percent of the population even with the more generous definitions (Wells 1982: 117-8); it is, therefore, conceivable that relatively fewer people speak RP in London.

2.2 Accent continuum from RP to Cockney and its middle ground

RP and Cockney, thus, seem to constitute two extremes of an accent continuum in London as an acrolect and a basilect respectively. They, therefore, fit readily into a traditional accent pyramid model representing social and regional accent variations in England[5] (see Fig. 2 in Wells 1982: 14 or Figure 1.1 in Hughes *et al.* 2005: 10) with RP at the top of the pyramid and with various broadest local accents (one of which is Cockney in the case of London) on the bottom of the

[5] This model is sometimes called differently; Trim (1961/62: 31) calls this a 'pronunciation cone' and Hughes *et al.* (2005: 9) a 'triangle'.

pyramid. According to Wells (1982: 14), it has long been pointed out that in England the distribution of accents can be compared to this pyramid model, in which the horizontal dimension represents geographical variation (regionality) and the vertical variation the social variation (from the highest to the lowest). The pyramid is broad at the base since working class accents exhibit a great deal of regional variation. It is narrower at the apex since upper class accents (i.e. RP) are generally considered to exhibit no regional variation within England[6].

Though the top and the bottom of the social spectrum have thus been referred to by way of explanation of the pyramid model, the middle has been given little information from this model. In fact, it is not uncommon that the middle has been explained in a rather vague way since it actually is a gradual change along an accent continuum in a given locality. Wells consistently sees a range of accent variations in any particular locality as a continuum (or 'the gamut' that he also calls) ranging from the broadest local accent up to Near-RP and RP (1982: 336). In this view, his intermediate accent labels such as 'popular London' and 'London Regional Standard' must be considered not to 'refer to entities we can reify but to areas along a continuum stretching from broad Cockney (itself something of an abstraction) to RP' (Wells 1982: 303) which itself is also an abstraction (Wells 1982: 280). This accent continuum may be likened to a series of change from one colour to another, as Wells likens the existence of RP to that of the colour 'red' (1982: 301). To explain it simply, supposing that RP is more like the colour 'white', and it can gradually change to the other colour, depending on the region it is spoken, as it goes down the accent continuum to the direction of the broadest local accent. In this way, any accent closer to the RP-end of the continuum can be 'yellowish-white' or 'pale yellow', 'pinkish-white' or 'pale pink', 'bluish-white' or 'pale blue' etc, whereas any accent closer to the broadest local accent can be just 'yellow', 'red', 'blue' etc. Thus, London is not the only one region but everywhere in England which has an accent continuum from RP to the broadest accent.

There is, however, one clear difference between London and any other localities in England in terms of their accent variations. That is, as in the case of subcategories of RP such as 'London Regional Standard' or 'London Regional RP' (cf. §2.1.2), London, or a wider area centred on London, has exclusively been given special terms for its mesolectal accent variations within their accent continuum between RP and Cockney. They have been referred to by a number of different terms. The terms named by linguists include: 'popular London' and 'London Regional Standard'

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[6] Although RP contains no regionality in England, it is of course regarded as a variety that is associated with England, and to a certain extent also with the rest of the United Kingdom (Trudgill 2002: 172). Considering the fact that it is generally regarded as a standard throughout southern British which includes England and probably Wales, but excludes Scotland, an alternative term 'Southern British Standard (Wells & Colson 1971: 6, Wells 1982: 117) may be more appropriate.

(Wells 1982: 302-3, see §2.1.1 and §2.1.2 above), 'Estuary English' (Rosewarne 1984), 'London English', 'General London' or 'Tebbitt-Livingstone-speak' (Wells 1994), 'Post-Modern English' (Maidment 1994), 'New London Voice' (McArthur 1994), 'South East London Regional Standard (SELRS)' and 'South East London English (SELE)' (Tollfree 1999), and 'London Regional RP' (Cruttenden 2001: 81, see §2.1.2 above), each of which may refer to a slightly different region of the continuum but all of which presumably refer to somewhere in the middle of the continuum between RP and Cockney. Not only the existence of these terms but also an increasing number of journalistic articles and academic studies referring to and focusing on the mesolectal accent variations on the continuum over the last few decades are considered to reflect the growing interest in the middle ground accent variations on the accent continuum between RP and Cockney, and suggest their significant importance in England.

2.3 London English in the light of 'Estuary English'

2.3.1 General remarks on the term 'Estuary English'

Above all, the term Estuary English, which is occasionally referred to by its acronym 'EE', has certainly achieved some degree of public recognition, having drawn more and more attention firstly from the British media and eventually also from expert linguists. EE is first introduced in 1984 by David Rosewarne who has sensed 'a particularly important gap in the descriptions of accents varieties in London and the South-East of England' (Rosewarne 1994a: 3). Based on his database composed of recordings from radio and television of speakers whose pronunciation was central on a continuum from RP to Cockney, Rosewarne (1984) defines it as follows:

> "Estuary English" is a variety of modified regional speech. It is a mixture of non-regional and local southeastern English pronunciation and intonation. If one imagines a continuum with RP and London speech[7] at either end, "Estuary English" speakers are to be found grouped in the middle ground.
>
> The heartland of this variety lies by the banks of the Thames and its estuary, but it seems to be the most influential accent in the south-east of England.
>
> On the level of individual sounds, or phonemes, "Estuary English" is a mixture of "London" and General RP forms. Although there are individual differences resulting

[7] 'London Speech' in Rosewarne's definition in 1984 seems to stand for the broadest London working-class variety (Wells 1994) called 'Cockney' in this thesis. Rosewarne, moreover, seems to be inconsistent with labelling this variety in that he means this variety by using some kinds of terms: 'London speech' (1984), 'popular London speech' (1994a: 3), and 'Cockney' (1994b:3).

> from the speech background and choices of pronunciation made by the speaker, there is a general pattern.
>
> Sociolinguistically it gives a middle ground between all types of RP on one side and regional varieties on the other. "Estuary English" speakers can cause their original accents to converge until they meet in the middle ground.

The term was named after the Thames estuary since it was claimed that his initial research had suggested that 'this type of accent was most in evidence in suburban areas of Greater London and the counties of Essex and Kent lying to the north and south of the Thames Estuary' (Rosewarne 1994a: 3).

Despite the currency of the term itself, EE has had no clear consensus about its properties, or even its existence. A number of detailed empirical studies centring on and around EE, most of which are accessible at an informative Estuary English website maintained by Professor John Wells at University College London (http://www.phon.ucl.ac.uk/home/estuary/home.htm), have attempted to find what EE actually is. Haenni (1999) who studies the perception of EE for the general public finds 'no convincing way to describe (let alone to define) the concept conclusively' so that he comes to the view that '[i]t is thus very difficult to uphold the notion of EE as a distinct variety in its own right' acknowledging extremely fuzzy boundaries between Cockney and EE and between EE and RP in terms of phonological variables combined with the possibility of style/register variation (cf. Maidment 1994). Schmid (1999: 155) who attempts to describe EE with reference to RP and Cockney concludes that 'Estuary English is only a new name' for a continuation of a long-lasting trend in which features of popular London speech has spread out geographically and socially since 'London became the capital city and the centre of political and cultural, and hence linguistic, importance'. Przedlacka (2002) examines the phonetic make-up of the teenage speech in four Home Counties – Buckinghamshire, Kent, Essex and Surrey – and finds no linguistic homogeneity in the accents spoken in the areas. Altendorf (2003: 162, 167) aims to provide an empirically based approach to the description and explanation of the concept of EE, and concludes that it is 'less likely that EE can be established as a variety', noting different perceptions of EE for linguistic laymen (i.e. EE as 'a new phenomenon which requires a new name') and for expert linguists (i.e. EE as 'just another phase within a longer historical trend' which therefore 'does not deserve a new name').

The term has thus been much discussed and argued, often critically, over the last few decades. As suggested by Watt & Milroy (1999: 43) and Foulkes & Docherty (1999: 11), the current perspective of many linguists to this EE is that it is probably a levelled form, rather than a variety as has initially been described by Rosewarne (1984). The present thesis will also see it as such.

Since the supposed geographical area of EE, whether or not it exists as a variety, is not confined to London – which is the main and only area of interest here – but involves the southeast, or even the whole south, of England, it is outside of the scope of this study to go into detail. However, considering the fact that the speech in London – i.e. the central topic of this thesis – seems not only to be the regional and linguistic origin of EE but also to comprise the heart of EE in many respects, it should deserve special mention particularly to the general issues related to the speech in London. Above all, its geographical and social characteristics in terms of geographical diffusion of London-based phonetic features, social convergence, and accent levelling in the southeast of England are considered to be of particular interest in this study, so that the following sections will focus on them.

2.3.2 Geographical diffusion of London features and regional levelling in the light of EE

While the view for the heartland of EE being in the southeast of England centred on London seems to be generally agreed among most of linguists, its concrete geographical boundary has never been made clear. Rosewarne (1994a: 4) reported that EE has spread northwards to Norwich and westwards to Cornwall, whereas Coggle (1993: 26, 28) shows an impressionistic map for the heartland of EE and its spread in future, describing that it extends northwards to Norfolk coast, southwestward to the Dorset coast, and southeastward to the south Kent coast. Following his division of 'Modern Dialect areas' (see Map 18 in Trudgill 1999a: 65), Trudgill defines the area of EE as 'the Home Counties Modern Dialect area', supposing that it will continue to spread until it covers all of Hampshire, Bedfordshire, Cambridgeshire, Suffolk, and parts of Northamptonshire (1999a: 65-6, 81). Furthermore he adds, mapping possible dialect divisions (see Map 19 in Trudgill 1999a: 83), that the East Anglia dialect area will probably also contract and the South Midlands dialect area will disappear in the face of continuing expansion of the London-centred Home Counties (Trudgill 1999a: 83-4). Interestingly, the boundary of the EE shown in Coggle's impressionistic map (see map in Coggle 1993: 28) appears to be similar to that presented in Trudgill's 'possible future dialect areas' (see Map 19 in Trudgill 1999a: 83).

Moreover, several sociophonetic variationist studies in Foulkes & Docherty (1999) identified a number of empirical evidence for the signs of London features not only in various places within England, but also in Scotland and Wales, which suggests the geographical spread of EE (or Cockney) to a wider area. In England, for example, the evidence for TH-fronting (i.e. the use of /f/ and /v/ for /θ/ and /ð/) – which is typically known as a Cockney feature rather than an EE feature – has been reported for the speech of mainly younger and/or working class speakers in Milton Keynes, Reading and Hull (Williams & Kerswill 1999: 147), Newcastle and Derby (Watt & Milroy 1999: 30, Docherty & Foulkes 1999: 51), Sandwell in West Midlands (Mathisen 1999: 111), and Norwich (Trudgill 1999b: 132, 137-8). In Scotland, Stuart-Smith (1999: 209-10) also found that her WC younger speakers (aged 13-14) from inner Glasgow frequently used TH-fronting – especially /f/ for /θ/, but also /v/ for /ð/ in e.g. *smooth* – and showed evidence for another southern English feature, L-vocalisation (i.e. the vocalisation of [ɫ] as [ʊ]), which is originally a feature in London Cockney (Jones 1956: §298, cited in Wells 1982: 259) and which has started being considered as a recent innovation on the verge of General RP (Cruttenden 2001: 83, see below).

There are several possible causes of the geographical spread of some features in London. The first possible cause, according to Crystal (1995: 327), has to do with movements of population after World War II from London to elsewhere such as new towns[8]. The second cause is, as Schmid (1999: 81) describes, the increase of geographical mobility in recent years. People have become regionally mobile due to the highly developed transport system which enable them to commute daily from one region to another, which allows them to have regular contact with speakers from different regional varieties, which therefore increase chance for people to encounter 'dialect contact' (cf. Trudgill 1986). The third possible cause is, as suggested by Crystal (1995: 327), the influence of radio, television and English media personalities who use a modified form of Cockney. Much of radio and television is broadcast by the BBC, in which from its foundation in 1922 its head demanded that its announcers speak RP (Abercrombie 1992: 6, cited in Schmid 1999: 56-7) until the early 1970s (Wells 1982: 117). Nowadays, however, it is no longer true that many of the announcers or the presenters on BBC speak traditional RP; instead, although they may still reduce the number of regional features in their speech, they no longer remove such features altogether (Trudgill 1999a: 81, Cruttenden 2001: 79). The presence of some media programmes in which people's accents are clearly based on accents in London, such as a long-running English popular soap opera, *EastEnders* – which is about the lives of the people who live in an imaginary area in the East End of London and which is known as one of the most popular soap operas in Britain[9] (Crowther 1999: 164, 499) – may possibly contribute to this spread (cf. Stuart-Smith 2006: 140-8).

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[8] New towns were established by the government to encourage people, businesses and industries to move out of the crowded cities. Thirty-two towns were planned and built in Britain in the second half of the 20th century, and ten of them are located within the Home Counties. (cf. Crowther 1999: 378)

[9] *EastEnders* has won the 'Best British Soap' awards most often between 1999 and 2007 with more total awards than their main rival soap opera on ITV, *Coronation Street*, which is about the lives of people in a

The geographical diffusion of London features may be seen as a hard evidence for the view of London as a 'linguistic centre of gravity' (Wells 1982: 301). London has long been the political and cultural capital of England. The speech in London not only served a basis of RP in the past, but has been traditionally causing most changes within RP for a long time (Altendorf 2003: 31). What seems to have changed with regard to this traditional trend is, according to Altendorf (2003: 31), the social position of those whose accent is the source of innovation. As quoted from Wells (1982: 301) at the beginning of the thesis, while the speech of Londoners at the upper end of social spectrum provided the historical basis for Standard English, that of Londoners at the other end – i.e. working class accent – is said to be 'the most influential source of phonological innovation' in England and possibly in the whole English-speaking world. For example, Cruttenden (2001: 83) describes two phonetic features which were originally heard in the London working-class accent (i.e. Cockney) and which are now standard in the mesolectal accent variety ('London Regional RP' that he calls synonymously with EE) as recent innovations on the verge of 'General RP' which is the second category of the RP in the Table 1. Those two features are (1) L-vocalisation in a wide rage of pre-consonantal positions and finally as in *fill* [fɪʊ] and *middle* [mɪdʊ], and (2) T-Glottalling (i.e. the use of [ʔ] for /t/) before an accented vowel or before pause as in *not even* [nɒʔ iːvn] and *need it* [niːd ɪʔ] (Cruttenden 2001: 83).

Hence, although a regionally levelled form of RP and Cockney, which may be represented by the term EE, seems to be still firmly considered to be mainly heard in the southeast of England, there are some signs that it has influenced on other parts in the south as well as further north and west. Due to its geographical spread, it may be possible to speculate that EE, which is ultimately a modified version of Cockney, will heavily influence RP, or at least on the Regional RPs as inferred by Cruttenden (2001: 81). One thing to be borne in mind in this respect, however, is that this phenomenon of EE in which features of London speech spread out geographically to other parts of the country is not new, but a continuation of a trend that has been going on for five hundred years or more (Wells 1997). Importantly, the trend has also involved tendency for those London features (i.e. Cockney) to spread out socially to higher social classes (Wells 1997). This is presumably due to the long-lasting notion that the pronunciation of the southeast of England, or more particularly that of London, is socially preferable (Cruttenden 2001: 78). With regard to this point, the next section will especially consider some selected notable social characteristics related to the speech in and around London.

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typical working-class area of Manchester (The British Soap Awards official website at http://www.british soapawards.tv, Crowther 1999: 129, 499).

2.3.3 Social convergence and social levelling in the light of EE

With regard to the above-mentioned pyramid model, acknowledging its validity to place RP at the top and Cockney at the bottom of the social hierarchy, Schmid (1999: 6) stresses the need to consider the middle of the pyramid in further detail in a changing society. One's social position is not always stable throughout one's life. It is particularly true in a society in which people are socially mobile. It has been said that England has seen a relatively blurring of the once sharply stratified social classes over the past century (Schmid 1999: 6). One of the consequences from such a change in society may well reflect on change in people's (attitudes to) accents. It has been reported, for example, some regional accents have gradually become accepted by people in the higher public societies such as BBC speakers (Cruttenden 2001: 79) and politicians (Schmid 1999: 6).

Such a blurring of the social class divisions in England seems to be promoted particularly by the social movement from both ends of the social spectrum between RP and Cockney in and around London. EE as a levelled form of RP and Cockney accents, therefore, is regarded as the result of a social convergence of two trends: an upward-oriented movement from Cockney-end of working class speakers who discard some of the features of Cockney, and a downward-oriented movement of (upper) middle class speakers who keep/acquire some of the Cockney features (cf. Coggle 1993: 26, Crystal 1995: 327). Although there are still those who aspire to move upward or remain with their social status by modifying their native speech styles strongly in the direction of RP, the majority of the middle class speakers are said to prefer a mesolectal variety (Schmid 1999: 7). The social movement from both ends of the spectrum has thus affected the accent situation in Britain; in fact, according to Trim (1961/62: 31), the base of the pyramid model mentioned earlier was already much eroded at the time of his writing, i.e. nearly half a century ago.

What, then, could be a possible driving force for these social movements into the middle ground? Among others, one of the keys to find answers to this question may have something to do with the understanding for the notions of 'prestige', 'standard', and 'local' in relation to the accent variations in and around London.

The notion of 'prestige' may well deserve special mention in relation to the notion of 'standard'. As we saw earlier (§2.1), in general, a non-standard accent (such as Cockney) is described as a vulgar and stigmatised accent whereas a standard accent (such as RP) as a prestigious accent. First of all, prestige is understood as a subjectively positive view of a language variety (Przedlacka 2002: 5). Therefore a variety which is considered prestigious for one group of a society may not be regarded prestigious for another. Secondly, there are two different types of prestige recognised; namely, overt and covert prestige. As Przedlacka (2002: 5) explains, the former is the one with which the variety in question is openly admired. It is generally the standard variety which carries this type of prestige, and RP is no exception (Wells 1982: 104, 117, Trudgill 2000: 74). The latter, on the other hand, refers to positive attitudes towards lower-class, non-standard varieties, with which the variety in question is covertly favoured, and with which male speakers are said to be particularly associated (Trudgill 2000: 74). Interestingly, the existence of this type of prestige is indirectly supported by the comment of Trudgill (2000: 74) that '[w]e can assume that this is the case: otherwise there would be far more RP and Standard English speakers than there in fact are'. In London, Cockney or some features of Cockney have been considered to have this type of prestige. Przedlacka (2002: 6) summarises the link between standard and prestige as follows:

> [...] a standard accent is not regarded as prestigious by the entire society. The relationship between standard and prestige is not a straightforward one. It is not reduced to the presence or absence of positive evaluation, but it also refers to who holds it prestigious, whatever reasons and consequences. Thus, while for some speakers the current standard is also their own speech and they value it as such, speakers of other varieties might wish to modify their pronunciation towards the standard or keep it distinct. On the other hand, speakers of the overtly prestigious standard may want to tone it down, too.

People's evaluation to RP has in fact been gradually changing over the course of 20th century; that is, RP was predominantly interpreted in a positive way in the first half of the 20th century, whereas it started encountering more negative evaluation than positive one in the second half (cf. Altendorf 2003: 34-6). Along with change in people's evaluation to RP, RP accent itself has been reported to be 'diluted' (see Gimson below) or even 'downgraded' (Wells 1998) under the influence of non-standard accent. Gimson (1989: 86) remarks the tendency of this type of change in RP among its speakers, particularly its young speakers, which possibly indicates the apparent-time difference at the time of his observation:

> [...] some members of the present younger generation reject RP because of its association with the 'Establishment' in the same way that they question the validity of other forms of traditional authority. For them a real or assumed regional or popular accent has a greater (and less committed) prestige. It is too early to predict whether such attitudes will have any lasting effect upon the future development of the pronunciation of English. But, if this tendency were to become more widespread and permanent, the result could be that, within the next century, RP might be so diluted that it could lose its historic identity and that a new standard with a wider popular and regional base would emerge.

Similar, but more specific, speculation has been made by Wells (1982: 106, 118):

> Over the last quarter-century all the signs are that the covert prestige of working-class speech is acting as a more potent source of innovation than the overt prestige of advanced RP. Mainstream RP is now the subject of imminent invasion by trends spreading from working-class urban speech, particularly that of London [...]. (Wells 1982: 106)
>
> With the loosening of social stratification and the recent trend for people of working-class or lower-middle-class origins to set the fashion in many areas of life, it may be that RP is on the way out. By the end of the [20th] century everyone growing up in Britain may have some degree of local accent. Or, instead, some new non-localizable but more democratic standard may have arisen from the ashes of RP: if so, it seems likely to be based on popular London English. (Wells 1982: 118)

Now we are in the first decade of a new century. It seems that we are facing to a type of accent based on London-based pronunciation – whether it is called EE or not – which Gimson and Wells have speculated[10].

The notion of 'standard', moreover, should be noted in relation to a term 'local'. Since a localised feature tends to be often described non-standard, the notion of 'standard' is often considered to be opposed to the term 'local' in sociolinguistic study. Observing this tendency, Milroy, Milroy & Hartley (1994: 1-33) raise questions about the view in which 'standard' (e.g. RP) is directly opposed to 'dialects' without any intermediate category between these extremes. They, instead, argue for the importance of gradations in terms of 'local' and 'non-local' as possible intermediate stages between 'dialect' and 'standard'; in this view, according to them, the standard is presumably 'the ultimate in a non-localised variety of language' (Milroy *et al.* 1994: 2). From this standpoint, the mesolectal pronunciation between RP and Cockney which has been spreading to other geographical areas and possibly losing its 'local' (i.e. London) association in a way may well be considered as a gradation between non-localised and localised forms.

A few other sociolinguistic characteristics within the continuum between RP and Cockney should briefly be noted. It was already seen that there is a tendency that both extremes on the social spectrum have been drifting towards the centre of this mesolectal type of pronunciation, i.e. EE. There also seems to be a tendency which is based on a speaker's sex. According to Coggle (1993: 86), male EE speakers tend to have more of the Cockney end of the spectrum features in their speech than their female counterparts do. Coggle believes that this could be explained by a

[10] There is a piece of evidence that the speech in and around London is preferred in a particular sector. ntl:Telewest Business, a supplier of communications services to the public and private sectors, finds in their survey to 1,300 business professionals across the UK in June 2006 that London and southeast accent in England was seen by most of the UK business community as the ideal professional accent for financial, sales and customer service careers. (ntl:Telewest Business 2006) This may in fact be in accordance with Rosewarne's (1984) statement that EE is well established in business circles.

persistent image which many male speakers have of RP being somewhat 'effeminate', while perhaps Cockney is seen as more 'masculine'. Moreover, it is often said that EE is becoming more popular among the young in particular, and for social reasons they positively cultivate it. In brief, EE provides an urban rather than a rural image of the speaker, and is characterised among them as having 'street credibility' or 'street-cred', i.e. as being fashionable (Coggle 1993: 24-6, Cruttenden 2001: 81).

2.4 Summary of accents in London

Following Wells (1999b), RP can be defined sociolinguistically as the pronunciation of people at the upper end of the social scale – whatever that is at any given time. From this perspective, RP gradually changes as times, and social boundaries move to admit other accents to RP. As suggested by Well (1997), RP will not remain the same as in the form codified by Daniel Jones nearly a century ago; instead, it will be gradually modernised, possibly adapting some key EE elements which originally come from London, i.e. Cockney features. It should, therefore, be very interesting to see how the accents centred in London are currently changing.

As far as accent variation in London is concerned, what is for sure is that there exists a continuum like accent variation ranging between two extreme accents, RP and Cockney. In this view, the whole continuum consists of a gradation, just like change from one colour to the other, so that it is almost impossible to make a clear line from one accent to another in the middle. This, however, does not mean to object to any labelling for a certain type of pronunciation in the middle ground variation especially when such a pronunciation becomes considerably noticeable in the speech of people from wider social spectrum and/or from regionally wider area as in the case of EE which should ultimately be considered as a consequence of social and regional levelling in and around London.

The present thesis, however, rather takes a cautious stance by not attempting to demark any additional discrete accent variety in the middle of the continuum between RP and Cockney. Instead, acknowledging RP and Cockney as two extreme referential accents on a 'multidimensional continuum' (Wells 1982: 280) in London, it is presumed that the middle of the accent continuum can be abstractly categorised at least into two types of speech; a more RP-type of speech mainly spoken by (upper) middle class speakers, and a more Cockney/London-type of speech mainly spoken by working class speakers. In this view, it is assumed that this accent continuum is generally relative to the social spectrum as encapsulated in the above-mentioned pyramid model. Although speakers are in fact classified into three social classes – i.e. upper middle class (UMC), lower middle class (LMC) and working class (WC) – as will be discussed later (§5.2.2.4.1), the speech of the UMC and WC speakers will only be investigated in the current research. This is because (1) since they are socially well distinct from each other, their speech is also expected to be reasonably distinct – i.e. more RP-type of speech for the UMC speakers and more Cockney-type of speech for the WC speakers – on the ground of the traditional pyramid model, (2) the change in their speech may show evidence for social convergence as is claimed to be happening under the name of EE, (3) their speech is considered to be particularly important in that the speech of Londoners from upper-end of social spectrum (i.e. UMC speech) is said to have historically formed a basis of RP, whereas WC speech seems to have not only influenced RP but also been regionally diffusing in all over the southeast of England as being a main linguistic resource for a levelled form of speech which may be known as EE. As a matter of convenience, I decide to call the speech of the UMC Londoners 'London UMC', the speech of the WC Londoners 'London WC', and any accent spoken in London or by Londoners as 'London English' as a cover term. Wells emphasises that 'no accent is a homogeneous invariant monolith' (1982: 279), so that RP and Cockney themselves as well as their sub-varieties are 'not objectifiable entities' but 'abstractions' (1982: 280, 303). With regard to this point, the categorised accent groups in this thesis are no exception.

2.5 Demography of Greater London

Greater London, generally known as London, is a metropolitan county of southeastern England (see map in Appendix 1). It is not only the capital of but also the largest urban area of England and the United Kingdom. It is nationally the centre of economy, politics, transportation and culture, while it is internationally one of the top four 'World Cities' alongside New York, Paris and Tokyo (Beaverstock, Smith & Taylor 1999). The administrative structure of Greater London includes 32 separate boroughs, 12 of which constitute Inner London along with the City of London and the others Outer London, surrounded by adjacent Home Counties: Kent, Surrey, Berkshire, Buckinghamshire, Hertfordshire and Essex (see Figure 5 in §5.2.2.2, and Appendix 1).

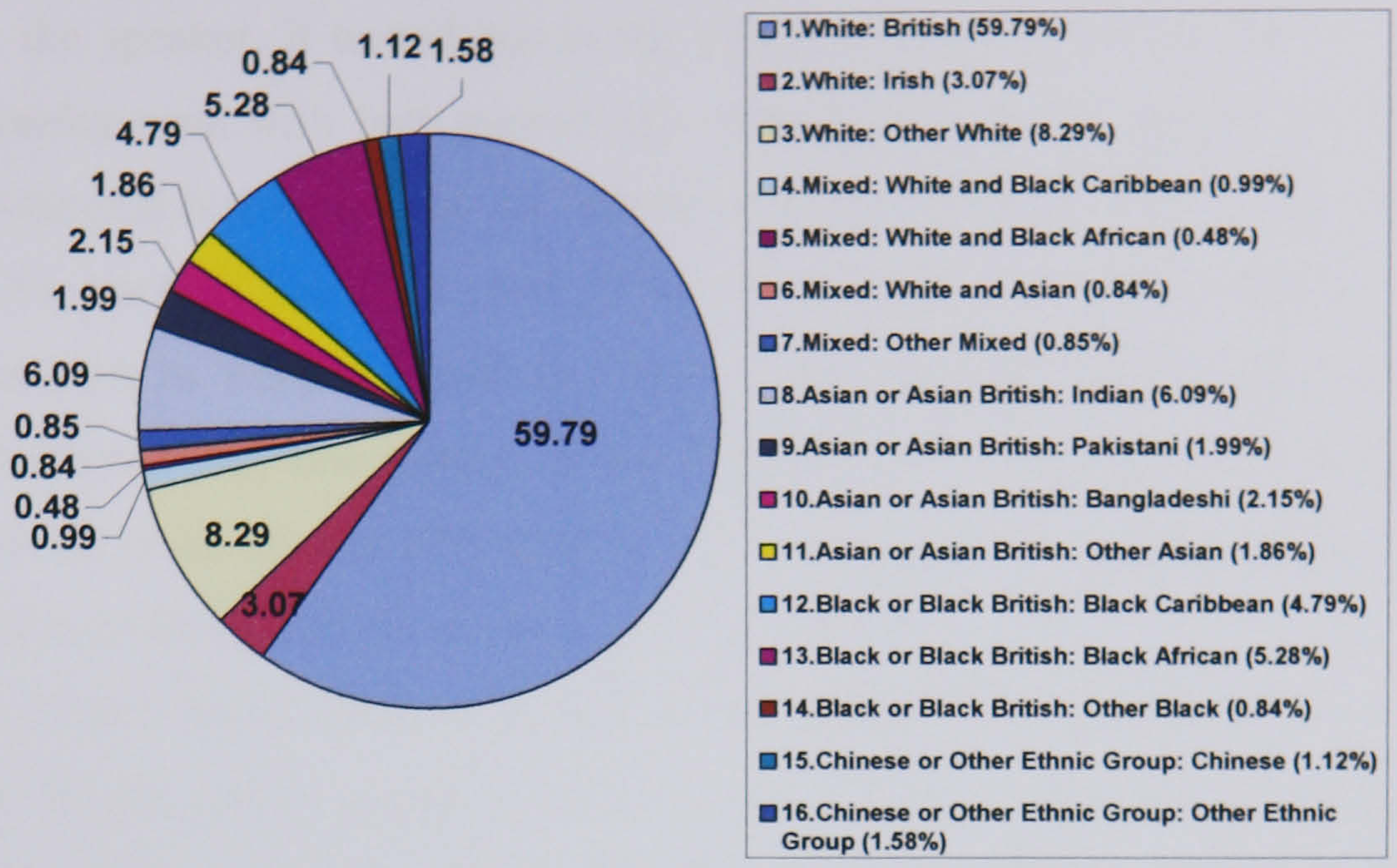
London has experienced large scale immigration and emigration since World War II. Particularly relevant for the purpose of this study is its immigration. London is a melting pot of races, having been receiving a large number of immigrants. The general historical background of immigration to Britain in the last half a century is found in Crowther (1999: 268) as follows:

> [...] After World War II, Britain needed more workers and admitted citizens of Commonwealth countries without restriction. Many came from the Caribbean and from India, Pakistan and Bangladesh. They found work in hospitals, in the textile industry and in the public transport system, though most jobs were poorly paid. Nearly 500 000 Commonwealth citizens came to Britain before 1952, many of whom were later joined by their wives and children. People from other countries were allowed in provided they had a work permit for a specific job.
>
> When there were no longer enough jobs the Commonwealth Immigrants Act (1962) was passed to restrict the numbers entering Britain. The country was put under more pressure when many Asians arrived from East Africa in the late 1960s. Many had kept British citizenship after Kenya and Uganda became independent and were not subject to the restrictions of the 1962 Act. In the following years several more Acts were passed, further restricting the right to live in Britain.
>
> Immigration is now strictly controlled. Normally only people from the European Union and certain Commonwealth citizens can get permission to live in Britain. The right to stay may also be given to people from other countries who have special skills and to asylum seekers and refugees. Britain now accepts about 50 000 immigrants every year.

The area most influenced by this was undoubtedly the capital of the country, London. This post-war period saw heavy immigration from countries of the old British Empire change the character of the city. The official population within the boundaries of Greater London is around 7.2 million in Census 2001 (Office for National Statistics 2007), and it was reported that London had a population of 7.5 million as the mid-point population estimate in 2005[11]. Figure 1 shows the number and percentage of each ethnic group in Greater London reported in Census 2001 (Office for National Statistics 2007). What is clear from the figure is that about 40% of the total population in Greater London now consists of Londoners from ethnic minorities. Importantly, it seems that they have had an influence not only on the culture in London but also on its accent variation and change (e.g. Torgersen *et al.* 2006). It is, therefore, hardly sensible to completely ignore their speech in the study of London English. At the same time, however, it is very difficult to capture an accurate picture of their direct influence on accent variation in London without sufficient speech samples from those ethnic minorities.

Table 2 shows ethnic information of all the speakers in the current study:

[11] This is according to Office for National Statistics website http://www.statistics.gov.uk (accessed on 8th January 2008).



Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
7,172,091	4,287,861	220,488	594,854	70,928	34,182	59,944	61,057	436,993	142,749	153,893	133,058	343,567	378,933	60,349	80,201	113,034

Figure 1 Ethnic groups in Greater London: number (in data table) and percentage (in pie graph) (Based on Census 2001, Office for National Statistics 2008)

Table 2 Ethnic background for all 32 speakers

ID	Father's origin	Mother's origin	ID	Father's origin	Mother's origin
F01	British(Essex)	British(London)	**M01**	***Jamaican***	British(London)
F02	British(Lincs)	British(London)	**M02**	British(London)	British(London)
F03	British(Lincs)	British(London)	**M03**	British(London)	British(London)
F04	British(London)	***Irish***	**M04**	***Italian***	British(London)
F05	***Ghanaian***	***Ghanaian***	**M05**	British(Yorks)	***Venezuelan***
F06	British(London)	British(Hants)	**M06**	British(London)	British
F07	British(South)	British(Herts)	**M07**	British(Sussex)	British(London)
F08	British(London)	British(WestMids)	**M08**	British(London)	British(WestMids)
F09	British(Welsh)	British(English)	**M09**	British(London)	British(Sussex)
F10	British(London)	British(London)	**M10**	British(London)	British(Lancs)
F11	British(London)	British(London)	**M11**	British(London)	British(London)
F12	British(London)	British(London)	**M12**	British(London)	British(London)
F13	British(London)	British(Herts)	**M13**	British(London)	***Belgium***
F14	British(London)	British(London)	**M14**	British(London)	British(London)
F15	British(Essex)	British(Essex)	**M15**	British(London)	British(London)
F16	***Lithuanian***	British(London)	**M16**	British(London)	British

In the Census terms, the 32 speakers can possibly be categorised in several ways. For convenience's sake, however, they are roughly categorised into three groups. Firstly, the majority of the speakers (25 out of 32) are from white Anglo British background as indicated by no-shading in the table. They account for 78% of all the speakers. It is noteworthy that many of their parents are also from London. Secondly, six speakers indicated by lighter grey shading in the table are from mixed background with at least one parent from white Anglo British background.

One possible exception in this group is the case for M05. Although his mother was claimed to be Venezuelan by the speaker, it turned out in the interview section that she had in fact a white Anglo British background with both parents (i.e. grandparents of the speaker) from Yorkshire. Her detailed residential history told by the speaker was that she had been born in Venezuela and had lived there for the first five or so years of her life followed by 3-year residence in Indonesia before she came back to Yorkshire with her family. The last category indicated by darker grey shading in the table has only one speaker in our data, F05, whose parents were both from a non-British background. In the case of F05, both of her parents came from Ghana so that she should be considered to have Black African origin in the Census terms.

The majority of the speech samples in the current study are thus from white Anglo British speakers whose families have settled in the UK, particularly in London, for generations. This exclusiveness, however, does not necessarily bring about a distorted picture of the accent situation in London, as long as it is appreciated that the study mainly focuses on the speech of white Anglo Londoners who have settled in the region for a long time. It may well be possible to think that their speech reflects some effects from the speech of people from ethnic minorities if there is any as being reported in a recent empirical study in London by Torgersen *et al.* (2006: 262, cf. §4.5 below). However, the degree of such effects should depend on networks and social position of the individuals, on how much/less contact they actually have with which ethnic origin speakers, on how tight/loose their relationship is, and so on. Since none of these is systematically investigated in this study, it is beyond the scope either to speculate any effect of the speech of ethnic minorities or to discuss their own speech purely based on the current data. It is, therefore, very important to emphasise that results obtained in this study are mainly from the white Anglo Londoners.

3 Language Variation and Change

It has been established that there are a number of principles and factors involved in language variation and change. As will be seen shortly, they are broadly distinguished into two kinds: internal and external factors. The internal factors are also called linguistic or system-driven factors. The external factors indicate non-linguistic factors, particularly social factors. In this chapter, we will particularly review selected internal and external factors which are related to our project research in the later chapters. First of all, the General Principles of Vowel Shifting introduced by Labov (1994) will be briefly reviewed with his speculation on the change of London short front vowels (§3.1). Secondly, possible effects of phonetic conditions on vowel shift, particularly of following segments, are considered (§3.2). Lastly, selected sociolinguistic factors – sex, age, social class, and speech style – are discussed (§3.3).

3.1 General Principles of Short Vowel Change – internal factors 1

Labov (1994: 116-21) introduces his General Principles of Vowel Shifting based on various historical and synchronic evidence from different languages. Before attempting to specify those general principles on change in vowel systems, Labov (1994: 30) argues difference between independent simple movements and chain shifts of vowels with regard to their fewer and greater constraints as follows:

> The simplest kinds of vowel shifts involve movement of a vowel to an empty position in the vowel system, in turn leaving behind an empty position. There are very few constraints on such simple movements: it is not difficult to find examples of vowels becoming higher or lower, backer or fronter, rounded or unrounded, nasalized or unnasalised. But when these simple movements are combined in interlocking sets – chain shifts – the situation is quite different. The systematic character of sound change appears most clearly in chain shifts, and a number of unidirectional patterns appear.

Chain shift is a type of sound change whereby changes in a vowel's phonetic quality cause changes in one or more of the other vowels in the system without affecting the number of phonetic contrasts the system expresses (Docherty & Watt 2001: 303). Labov defines it in terms of its subtypes, minimal chain shift and extended chain shift, making a clear distinction from its opposite phenomenon, merger, as below (1994: 118-9):

> A *minimal chain shift* is a change in the position of two phonemes in which one moves away from an original position that is then occupied by the other. (Thus a chain shift is distinguished from its opposite – a *merger* – in that a merger is a change in the relations of two vowels in which one assumes or approximates the position held by the other.) The two phonemes of a minimal chain shift may be referred to more briefly as the *entering* and *leaving* elements. An *extended* chain shift, then. is any combination of minimal chain shifts in which the entering element of one minimal chain shift replaces the leaving element of a second.

Chain shift is also often distinguished into push chain and drag chain. The former is a type of chain shift in which the entering element moves first and initiates the move of the leaving elements, while the latter is a type of chain shift in which the leaving element moves first and initiates the move of the entering elements (Labov 1994: 119, 199). Although Labov's Principles which will be reviewed below are stated in terms of chain shifts, Labov implies their applicability for description and classification of individual movements (Labov 1994: 117).

He firstly introduces the following three Principles:

PRINCIPLE I : In chain shift, long vowels rise
PRINCIPLE II : In chain shift, short vowels fall
PRINCIPLE IIA : In chain shift, the nuclei of upgliding diphthongs fall
PRINCIPLE III : In chain shift, back vowels move to the front

He then takes up new conceptions of English phonological space and the feature 'peripherality' based on instrumental measurements of vowel systems in a variety of American and British dialects in order to explain various data from chain shifts in progress (Labov 1994: 155-221). The outlines of the phonological space are defined based on the typical results of measurements. The top limit of the triangle is defined by the lowest F1 values for [i] and [u]. The bottom of the triangle is defined by the F1 values of the most open vowel of the system. The two diagonals of the triangle in front and back are defined as follows: $F1 = -1/2*F2 + \text{Constant}$ (where the constant ranges from about 2800 for men to 3400 for women) for the front diagonal, and $F1 = F2$ for the back diagonal by definition (Labov 1994: 159-60). The phonological space is then extended to two distinct tracks, peripheral and nonperipheral tracks, which occupy two layers of space in parallel from the outer limit of phonological space; the remaining space is central (Labov 1994: 177). Figure 2 is a reconstructed triangular acoustic diagram in which peripheral and nonperipheral tracks are indicated, based on two diagrams in Labov (1994: 159, 177):

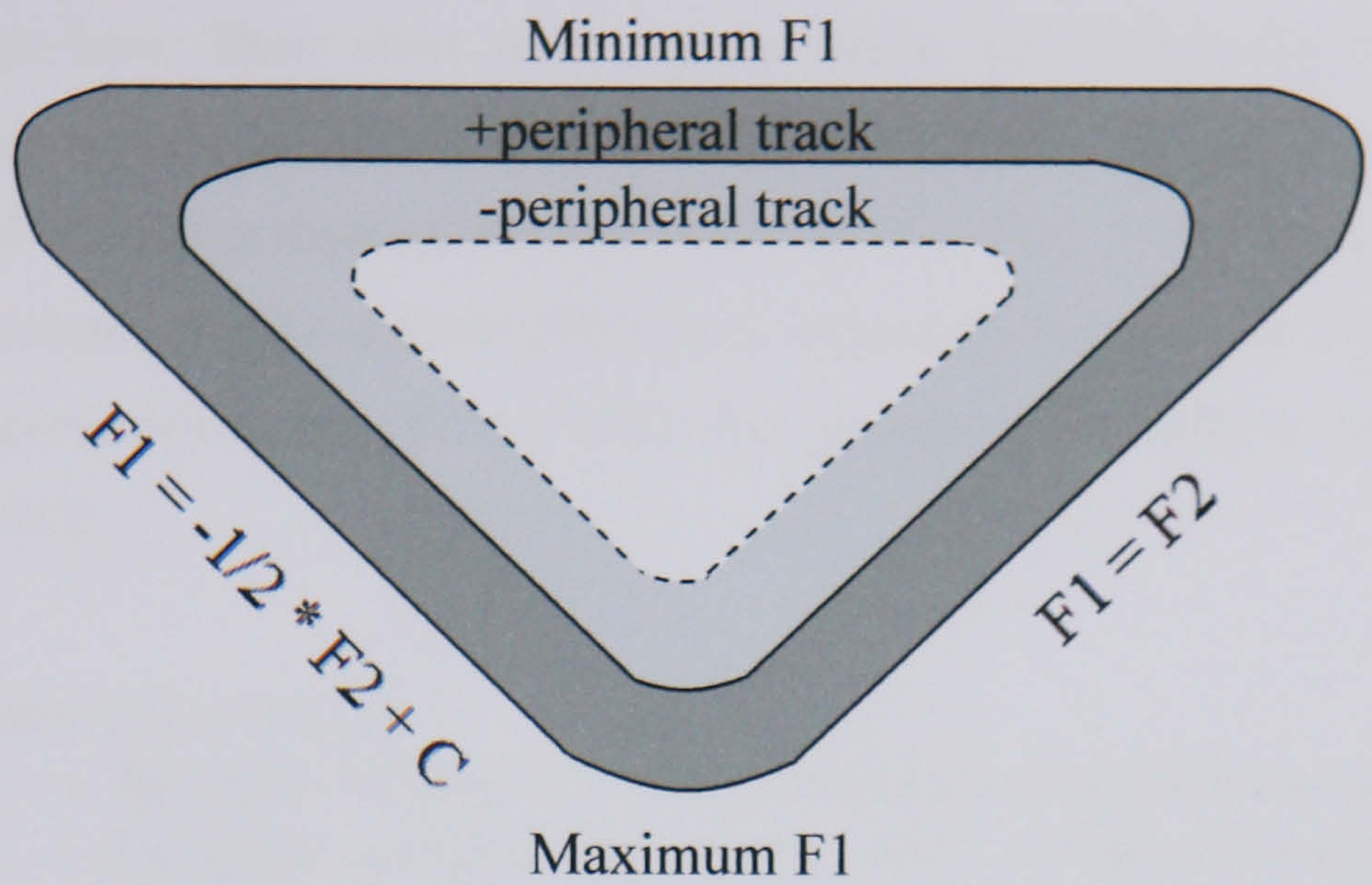


Figure 2 Labov's acoustic vowel triangle and peripheral/nonperipheral tracks (based on Labov 1994: 159, 177)

With regard to this peripherality, the above-mentioned principles are then restated by Labov (1994: 176, 200) as follows:

PRINCIPLE I	:	**In chain shifts, tense nuclei rise along a peripheral track**
PRINCIPLE II	:	**In chain shifts, lax nuclei fall along a nonperipheral track**
PRINCIPLE III'	:	**In chain shifts, tense vowels move to the front along peripheral paths, and lax vowels move to the back along nonperipheral paths**

Although it is stated that these principles of chain shifting are independent, they are not free to combine in every possible way; instead, there are certain ways of combining them that allow us to explain various vowel changes functionally. Combining these principles, Labov proposes four different major patterns to describe sound changes both in the past and in progress (1994: 123-37, 167-218). Above all, Pattern 4 (Labov 1994: 208-18) is of great interest in this thesis, since it involves short front vowels in London as a part of what he calls 'Southern Shift' (Labov 1994: 202) which governs the vowel systems of southern England as well as of Australia, New Zealand, South Africa, and certain regions in the U.S. (such as the southeastern Middle Atlantic states, the Upper and Lower South, the South Midland, the Gulf states, and Texas). For this pattern, Labov (1994) observes the vowel systems of two Londoners, a 39-year old female Cockney speaker from Hackney and a 23 year old male Londoner from Chelsea both of whom were interviewed in 1968. While the laxing (= following a 'nonperipheral track') and lowering of the onset of FACE and FLEECE are less relevant to the current study, the tensing (= following a 'peripheral track') and rising of front vowels – KIT, DRESS and TRAP – observed in the two London speakers are particularly relevant here. Their short front vowels which were originally short, lax vowels become (short) tense vowels being relocated into the 'peripheral track' where he argues that the short vowels would rise rather than fall (Labov 1994: 209-11, 285). This raising of London short front vowels is explainable by the restated Principle I, together with Principle VII, which is one of five additional general principles (IV to VIII) that govern chain shifting across subsystems (Labov 1994: 271-91):

PERIPHERALITY PRINCIPLES

PRINCIPLE IV	:	**In chain shifting, low nonperipheral vowels become peripheral**
PRINCIPLE V	:	**In chain shifting, one of two high peripheral morae becomes nonperipheral**
(REVISED)	:	**In chain shifting, the first of two high morae may change peripherality and the second may become nonperipheral**
PRINCIPLE VI	:	**In chain shifts, peripheral vowels rising from mid to high position develop inglides**
PRINCIPLE VII	:	**Peripherality is defined relative to the vowel system as a whole**
PRINCIPLE VIII	:	**In chain shifts, elements of the marked system are unmarked**

It is said that this peripherality of short front vowels is 'a tendency of the greatest importance in the dynamics of the Southern Shift' (Labov 1994: 210). With regard to the concept of phonological space that is organised by the feature of peripherality, the original three General Principles I-III are eventually refined to a single General Vowel Shift Principle (Labov 1994: 262) as follows:

GENERAL VOWEL SHIFT PRINCIPLE
In chain shifts, peripheral vowels become less open and nonperipheral vowels become more open

As we will see in the later chapters, however, this raising of short front vowels (of which we only consider DRESS and TRAP here) proves to be untrue in London, in southeast England, or in RP.

3.2 Phonetic environments – internal factors 2

There are a number of phonetically motivated factors which could possibly cause and accelerate/restrain a sound change. As far as sound changes for vowels are concerned, phonetic environments, particularly of following segments, seem to exert a powerful influence. These are considered as part of a Neogrammarian position on 'regularity of sound change' (Labov 1994), as opposed to a change based on 'lexical diffusion' (Wang 1977)[12]. In the following section, some of the possible effects of phonetic environments on vowel changes are picked up and discussed.

One general phenomenon related to vowel changes in different phonetic contexts is the one known as pre-fortis clipping (Wells 1990) by which vowels shorten before phonologically voiceless consonants (e.g. Jones 1972: 233-6, Chen 1970, Roach 1991: 34, Ladefoged 1993: 250, Kent & Read 1992: 94-5, Cruttenden 2001: 94-6, 152-3). The phenomenon is explained as a signal to the listener that the following obstruent is phonetically long; that is, [+voice] obstruents tend to be shorter than [-voice] obstruents because of difficulty to maintain the transglottal pressure difference creating the air flow driving vocal fold vibration (Kingston and Diehl 1994, cited by Gussenhoven 2007).

Cruttenden (2001: 152-3) describes it as follows:

> It is a feature of English (and to varying extents universally in languages) that syllables closed by voiceless consonants are considerably shorter than those which are open, or closed by a voiced consonant. (...) [t]his variation of length is particularly noticeable when the syllable contains a 'long' vowel or diphthong, cf. the fully long vowels or diphthongs in *robe, heard, league* (closed by voiced /b, d, ɡ/) with the reduced values in *rope, hurt, leak* (closed by voiceless /p, t, k/).

Jones (1972: 325) describes this phenomenon for the English short vowels as being less in degree compared to that for the English long vowels. According to him, although the variations in the length of short vowels are not sufficiently noticeable in general, there are certain cases in which the lengthening of particular short vowels is remarkable. Above all, the related cases for the current topic are the paragraphs 874-876 in Jones (1972: 235). Followings are the partial extracts:

> The most important is a lengthening of æ in certain words. In the South of England a fully long æ: is generally used in the adjectives ending in *-ad* (*bad* bæ:d, *sad* sæ:d), and is quite common in some nouns, e.g. *man* mæ:n or mæn, *bag* bæ:g or bæg, *jam* dʒæ:m or dʒæm. Curiously enough the æ appears to be more usually short in *nouns* ending in *-ad* (*lad* læd, *pad* pæd, etc.).
>
> Long æ: is most frequently found before voiced consonants but not confined to these situations. Thus the words *back, that* (meaning 'that thing') at the end of a sentence are often pronounced with long æ: by some Southern English people.
>
> Some English people, and especially Londoners, make a similar lengthening of e in some words, e.g. *bed, dead* (but apparently not in *fed, tread*).

[12] See Labov (1994) for a detailed discussion on a long term controversy between these two positions.

Thus, the length of short vowels, particularly of TRAP, seems to be very much subject to the phonetic environment or the grammatical class of words in which they appear. That aside. Cruttenden (2001: 96) shows as a reference the actual duration of English vowels in different phonetic contexts measured in csec in accented monosyllables in the study of Wiik (1965). Following is an extract for the measured values of the short vowels only[13]:

	_voiced C		*_nasal C*	*_voiceless C*	
	_VF	***_VS***	***_N***	***_LF***	***_LS***
Short vowels	17.2		13.3	10.3	
TRAP[14]	25.2	21.6	19.6	16.5	15.0

Short vowels, thus, are generally longer in the order of: before voiced consonants, before nasals, and before voiceless consonants. In the case of TRAP, the vowel is also longer before fricatives than before stops in the same voicing condition.

What do these different vowel lengths in different phonetic environments possibly have to do with sound change? It has, briefly speaking, something to do with vowel peripherality. It usually takes longer for vowels to reach peripheral realisations so that longer vowels would have theoretically more chance to achieve more peripheral realisations than shorter ones. Moreover, the opposition between long and short vowels of English is sometimes referred to as a distinction between tense and lax vowels (Cruttenden 2001: 96). In the phonological sense of 'tense' and 'lax', all DRESS, TRAP and STRUT are categorised as lax vowels in that they never appear in open syllables (Ladefoged 1993: 86-7). In the phonetic sense, however, the distinction should occur even among short vowels. According to Ball & Rahilly (1999: 47), tense vowels are claimed to be articulated with greater muscular effort and consequently to be longer in duration and nearer the periphery of the vowel area, while lax vowels are shorter in duration and more likely to be centralised. Therefore, lengthening is likely to be a consequence of tensing, while shortening is likely to be a consequence of laxing. All these concepts – peripherality, tensing, laxing – should recall the General Principles of Vowel Shifts of Labov who remarks that '[t]he [...] terms *tense* and *lax* must [...] be related to the terms *long* and *short* that are generally found

[13] _VF, _VS, _N, _LF and _LS denote different phonetic environments: before voiced fricative, before voiced stop, before nasal, before voiceless fricative and before voiceless stop respectively. These are also used throughout the thesis, especially in the later chapters.

[14] According to Cruttenden (2001: 92, 111), TRAP vowel is here treated separately from short vowels in general because of its special characteristics for length. The relative length of TRAP is said to be dependent upon the context or is characteristic of the pronunciation of particular words. The traditionally short TRAP vowel is now generally longer in RP than other short vowels, and such lengthening is particularly remarkable before voiced consonants. It is also remarkably long in the case of 'bad'. The length of these longer TRAP vowels is almost as long as long vowels.

in the historical record' (Labov 1994: 31, with his original emphases). Therefore, the phonetic environments which affect the vowel length may potentially be among the factors for sound change. Provided that the long and short distinction is more or less similar to the tense and lax distinction, the above-cited values of durations for the vowels in different phonetic environments may lead us to assume that the vowels are more tense and peripheral in the following order of phonetic environments – before voiced consonants, before nasals, and before voiceless consonants – and that TRAP is more tense and peripheral before fricatives compared to before stops in the same voicing condition.

In real sound changes, however, the relation between length and peripherality does not seem to be as simple as this assumption. For example, this is not exactly the case of changes in the short **a** word class in the Northern Cities Shift in Detroit which is reported by Labov (1994: 99-100). In observing tensing/fronting and raising of the short **a**, Labov finds that the advancement of a particular token depends primarily on its phonetic environment, arguing that the following segment exerts the most powerful influence (Labov 1994: 99-100). He further identifies its detailed effects as follows:

> [t]he relative degree of advancement is influenced by the manner of articulation of the following segment, in the order nasals > voiceless fricatives > voiced stops > voiced fricatives > voiceless stops. Point of articulation follows the ordering palatal > apical > labial, velar. (Labov 1994: 100)

In other words, the short **a** is found to be more peripheral to more centralised in the order from before nasals, before voiceless fricatives, before voiced stops, before voiced fricatives, and voiceless stops in terms of the manner of articulation, while it is more peripheral to more centralised in the order from before palatal, before apical and before velar in terms of the place of articulation. In an even closer view of the fine-grained phonetic control of the Northern Cities Shift in Buffalo, Labov points out that the 'following nasal consonant has the strongest effect in maximising peripherality and height' (Labov 1994: 457). For the place of articulation, he finds that the vowels with following apicals and palatals show greater height than those with following labials and velars, with the vowel preceding palatals located in high, nonperipheral position and with the vowels preceding apicals being uniformly more peripheral and higher (Labov 1994: 458).

In contrast with the Northern Cities Shift in which all the short **a** vowels are tensed/fronted and raised, the short **a** vowels are split in the Middle Atlantic states into a set of words with short low nonperipheral [æ] and another set with nuclei that are fronted to a peripheral position, generally mid to high, long, with a centring inglide (Labov 1994: 429-30): that is, the tensing and raising affect only some short **a** words. As in the case of the Northern Cities Shift, it is found that a following nasal consonant favours the selection of words for the second category, and the effect of the following nasal is more than a following apical, /d/ (Labov 1994: 506). A more subtle effect compared to that of the following nasal is found for a following voiceless fricative. According to Labov, when a word-initial short **a** occurs before a nasal, all words are tensed, while when it occurs before a voiceless fricative, only the more common, monosyllabic words are tensed (Labov 1994: 506)[15].

This Middle Atlantic short **a** tensing is considered by Labov (1994) to be a direct descendant of the southern British broad **a** tensing, a phenomenon called Pre-Fricative Lengthening by Wells (1982: 203-6), in which the successor of Middle English /a/ underwent lengthening variably before (front) voiceless fricatives by the end of the seventeenth century (Wells 1982: 203). The Pre-Fricative Lengthening has later brought about the TRAP-BATH Split (Wells 1982: 100-1), which is a good example of lexical diffusion in which sound changes do not apply to every word which meets their structural description (Wells 1982: 100, 204). For example:

> the changes from short [a] to long [a:] (later [æ], [ɑ:]) in the history of RP applied, among other environments, before /nt#/, as in *slant, grant, plant, shan't, can't,* etc. For reasons that are not clear, it never extended to the words *pant, cant,* and *rant*. The item *ant* seems to have vacillated, but has now firmly ended up with the short vowel. (Wells 1982: 100)

Even in the environment of a following voiceless fricative, there was inconsistency in Pre-Fricative Lengthening where the word was not a monosyllable (e.g. *passage*), and there is still fluctuation at the present day in words such as *exasperate, blasphemy* with RP /æ ~ ɑ:/ (Wells 1982: 205).

Thus, we saw in this section that the phonetic environments of a following (front) nasal and a following voiceless fricative seem to trigger the tensing of short **a** most, and in fact, according to Labov (1994: 430), these environments do generally condition the tensing of low vowels in English.

In relation to the environment of a following nasal, it is noteworthy to consider an effect of nasalisation to vowel space – i.e. a general shrinking of the perceptual vowel space (Wright 1986). Johnson (2003: 165) discusses this in relation to vowel shift patterns as follows:

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[15] For more details and discussions for the Northern Cities Shift and the Middle Atlantic dialects, see Labov (1994).

> Wright (1986) reports that the effect of vowel nasalization is a general shrinking of the perceptual vowel space; nasalized low vowels are higher in the space than are their nonnasalized counterparts. This observation leads to a speculation about the acoustic origin of vowel shift patterns. Vowels in several languages, including English, have undergone chain shifts, in which vowels rise by one step and the high vowels break into diphthongs. Nondistinctive vowel nasalization may play a role in initiating these chain shifts, because low vowels tend to have a certain amount of passive nasalization – the velum is pulled open by the palatoglossus muscle when the tongue is lowered (Moll, 1962; see also Lubker, 1968). This passive nasalization may lead to a perceptual re-evaluation of the quality of low vowels because, with the nasalization, they get an additional nasal tract formant and anti-formant. In this way a chain shift may get a start as a push chain, because of the acoustic and perceptual effects of vowel nasalization.

Although this does not seem to apply to the cases of short **a** vowels in the Northern Cities Shift and the Middle Atlantic dialects since their vowels before nasals are shifting to more front and peripheral area, not to higher, less peripheral area as suggested by Johnson, this is an interesting observation to bear in mind for the sake of the current research.

An acoustic phenomenon called F1 cutback may also attribute to vowel variations in different phonetic environments. The effect of F1 cutback is that the onset of F1 energy is delayed relative to higher formant energy for voiceless stops (Kent & Read 1992: 120-1) so that the F1 of the adjacent vowel after voiceless stops will start later at a higher frequency than that of the adjacent vowel after voiced stops which normally starts earlier at a lower frequency with a marked rising bend of frequency transition

3.3 Sociolinguistic variables – external factors

There are a number of social factors which internally differentiate human societies, and it forms the core of sociolinguistics (Kerswill 2007: 51). In this section, we will particularly focus on general sociolinguistic characteristics of, among others, sex, age, social class, and speech style which will later be investigated as independent variables.

3.3.1 Sex

One obvious difference between men's and women's speech is their tone of voice; women generally have higher-pitched voices than men. It is said that women's voices are indeed on the average about one octave or about 1.7 times higher than men's (Kent & Read 1992: 154). According to Cruttenden (2001: 11), typical pitch ranges are 100-150 Hz for men and 200-325 Hz for women. This difference in fundamental frequency is said to relate primarily to the different lengths of their vocal folds (Titze 1989, cited in Kent & Read 1992: 154). Physiologically speaking, men's larynxes tend to be larger than women's due to the male Adam's apple at puberty which causes men to have longer vocal cords (Chambers 1995: 106-7). Although this difference is one obvious sex difference, it is not as important as other variables of more general social significance which are considered as markers of sex[16] (Chambers 1995: 107). The following considers only those sex differences which have social significance; that is, the social category of 'gender' is being assessed simply through the sex differences.

It is widely known that differences in male and female speech can be one of the sources of language variation; sometimes women are the innovators, leading a language change, and sometimes men. Chambers (1995: 102-3) collects conclusions from many sociolinguistic studies that include a sample of males and females and cites them as follows:

> Wolfram (1969: 76) says that "females show a greater sensitivity to socially evaluative linguistic features than do males." Labov (1972: 243) says, "In careful speech, women use fewer stigmatized forms than men, and are more sensitive than men to the prestige pattern." Wolfram and Fasold (1974: 93) say, "Females show more awareness of prestige norms in both their actual speech and their attitudes towards speech." Romaine (1978: 156), explaining the preference by women for a different variant from the men in her study, concludes: "The females... are clearly more concerned with the pressure exerted by local norms and asserting their status within the... social structure." Elsewhere, she summarizes the sociolinguistic results as follows (1984: 113): "women consistently produce forms which are nearer to the prestige norm more frequently than men," and she reports, furthermore, evidence for gender differentiation in choosing linguistic variants as early as six years old. Trudgill (1983: 161) says that "women, allowing for other variables such as age, education and social class, produce on average linguistic forms which more closely approach those of the standard language or have higher prestige than those produced by men." Labov (1990: 205) states it this way: "In stable sociolinguistic stratification, men use a higher frequency of non-standard forms than women." Cameron and Coates (1988: 13) say that "women on average deviate less from the prestige standard than men," and add that "in modern urban societies it is typically true for every social class."

There is, thus, evidence in most sociolinguistic studies that 'women use fewer stigmatised and non-standard variants than do men of the same social group in the same circumstances' (Chambers 1995: 102, 2002: 352). Trudgill (1974), for example, found in his study of Norwich that vernacular non-RP [ɪn] forms at the end of words such as *sleeping* and *swimming* were more frequently used by men compared to women in each of his five social groups. Women tend to be

[16] Here the term 'sex' is used as a biological distinction (i.e. male and female), differentiated from 'gender', since recent developments in research on language and gender bring about the argument that gender should not be treated as a binary variable but rather as a continuum where speakers situate themselves socially between two reference points (Eckert 1998 cited in Milroy and Gordon 2003: 100).

associated with changes towards both prestige and vernacular norms, whereas men more often introduce vernacular changes (Chambers 1995: 102).

Wells (1982: 21) points out that Britain is getting towards a sexually more equal society, and predicts that if these advances continue, 'there may well be a diminution in the extent to which women's scores tend to differ from men's in the higher-class direction'. Moreover, according to Trudgill (2000: 74), especially in the case of men's speech, lower class or non-standard linguistic varieties also have some kind of 'prestige' which Labov has called 'covert prestige'. It is called 'covert' because attitudes of this type are not usually overtly expressed and depart markedly from the mainstream societal values. Among certain subcultural groups such as amongst certain male groups or local communities, specific kinds of accents, words, or linguistic styles have particular kinds of social prestige.

Foulkes & Docherty (1999: 15-16) recognise that many recent studies in Britain have identified gender as prior to class which has been considered as the most important social factor (e.g. Milroy 1999, Watt & Milroy 1999). In relation to the well-established tendency that females use fewer non-standard variants than males, they point out evidence that the dichotomy between standard and non-standard is being replaced by the opposition between non-local versus local (Milroy *et al.* 1994: 1-33, cf. §2.3.3 above); that is, females tend to use fewer local forms than males (Foulkes & Docherty 1999: 16). In other words, women generally seem to prefer non-local variants, which may or may not be identifiable as prestigious (Milroy & Gordon 2003: 103). Interestingly, it is also argued that women in fact create prestige variants because 'the variants that females prefer become ideologized as prestige variants' (Milroy & Gordon 2003: 103). According to Foulkes & Docherty (1999: 16), females do not necessarily go in the direction of the standard, but instead they are more susceptible to non-local forms. In this view, therefore, a speaker's speech can also be considered as a reflection of his/her personal orientation to their locality. Foulkes & Docherty (1999: 16) pick up one example for this point from the Cardiff study by Mees & Collins (1999: 185-202) in which a chronological increase of non-local glottal variants by Cardiff women is found in their real-time investigation, and this is suggested to be interpreted as a sign of weak orientation to the local community. Foulkes & Docherty (1999: 16) further argue that '[i]n the current climate, where non-standard varieties are becoming more and more influential, it follows that females are more likely to be the harbingers of incoming variants, even if they are non-standard in origin'.

In pursuing general patterns of differentiations between sexes, Labov (2001: 293) suggests, with the basis of various variationist studies in the past, a general Gender Paradox as: '[w]omen conform more closely than men to sociolinguistic norms that are overtly prescribed, but conform less than men when they are not'. This is derived from his three Principles as follows:

- For stable sociolinguistic variables, women show a lower rate of stigmatized variants and a higher rate of prestige variants than men. (Principle 2 in Labov 2001: 266)
- In linguistic change from above, women adopt prestige forms at a higher rate than men. (Principle 3 in Labov 2001: 274)
- In linguistic change from below, women use higher frequencies of innovative forms than men do. (Principle 4 in Labov 2001: 292)

By reviewing various past studies of gender differences, Labov (2001) has found that all the cases but one[17] show that it is women who actively create the differences between themselves and men as the innovators of most linguistic changes in adopting new prestige features more rapidly than men, in reacting more sharply against the use of socially stigmatised forms, and in responding more rapidly than men to changes in the social status of linguistic variables (Labov 2001: 321).

A number of interpretations have been proposed for the female-male discrepancy in the distributional pattern of their speech (cf. Cheshire 2002: 426). While one plausible explanation seems to be related to gender roles, it is pointed out that 'the gender role difference can hardly be the whole explanation' (Chambers 2002: 355) and 'no single interpretation can be possible' (Cheshire 2002: 427). Therefore, the question for the reason of this female-male difference remains unanswered (Chambers 2002: 355).

3.3.2 Age

As in the case of sex, there is also a physical variation between people with different ages due to normal characteristics of gradual aging such as wear and tear of their articulatory organs and the larynx and the slower rate of muscular activities and respiratory activity (Chambers 1995: 149). According to Chambers (1995: 149-50), two primary indicators of age seem to be progressive creakiness in voice quality and change in pitch. The former characteristic is also observed in RP as a sign of terminating juncture (Rogers 1991: 247 cited in Chambers 1995: 149). For the latter indicator, as far as adults are concerned, there are no systematic changes in pitch for adult women (above 20 years old), whereas adult men's voices seems to continue to decrease slightly as they get on in years (see more details in Chambers 1995: 150-1). These differences purely due to physiological ageing, however, are not of interest in this study. The following,

[17] The Australian adolescents in Sydney studied by Eisikovits (1981) show an opposite tendency in which males seem to be initiating the gender differentiation (Labov 2001: 267-8, 321).

therefore, considers only those age differences which have normally been used for the study of sociolinguistics.

Age is the social attribute which is primarily correlated with language change (Chambers 2002: 349); that is, variation in age is often considered to contribute to historical changes in language. According to Holmes (2001: 170-171), when a linguistic change is spreading through a community, there will be a regular increase or decrease in the use of the linguistic form over time. Younger people tend to use the more innovative form, and thus use less of the older form that is disappearing.

Now let us look at a plausible example in which age variation may play a very important role in language change in the future. According to Hughes *et al.* (2005: 49), words such as *cure, tour, poor* and *sure* have been traditionally pronounced with a centring diphthong /ʊə/, but are these days pronounced more and more with a monophthong /ɔː/, including by RP speakers. They say that, for the moment, this can be seen as a case of lexical variability. They also point out, however, that the existence of speakers for whom almost every potential /ʊə/ word is pronounced with /ɔː/ strongly suggests the disappearance of the phoneme /ʊə/ in its phonemic inventory. This suggestion can be supported by the preference opinion poll for the word *poor* appearing in LPD (Wells 2000: 592-593) wherein are the reports of the poll panel preferences carried out all over Britain in 1988 and 1998. According to Wells (1999a: 43), the poll reveals that, over the space of one decade, the number of people using the monophthong for the word *poor* has increased from 57% to 82% in total. Moreover, the research reveals that younger people tend to prefer the monophthong variant in terms of language change, so it is very likely that the diphthong /ʊə/ will become substituted by the monophthong /ɔː/ and lose its phonemic status in British English in future.

This poll study is one of the examples of 'real-time' investigations in that a series of observations for the same linguistic variable were made to similar populations diachronically. In some projects, this method of study is effectively used to explore language changes, especially when the required time frame is shorter (Chambers 1995: 193). Researchers can alternatively make use of past literatures for a real-time study. One good example in relation to the current research is the recent study of RP short vowels over the twentieth century conducted by Fabricius (2006, 2007) where she compares acoustic measurements from her latest interview data with data from several past published studies[18]. Real-time studies are, however, relatively fewer in the studies of the social sciences for practical reasons such as the problem of the time required to

[18] We will closely look at Fabricius's (2006, 2007) study in the later section, §4.6.

investigate real language changes by a single researcher (see Chambers 1995: 193) and the difficulty of finding comparable past literatures which can be made use of for a particular linguistic variable of a particular type of sample from comparable settings.

Another type of study which is used more often in sociolinguistic studies is called 'apparent-time hypothesis' study. When changes are in progress, it is sometimes possible to observe generational difference at a given time. Chambers (1995: 185) explains this in the following general terms:

> Where change is involved, a certain variant will occur in the speech of children though it is absent in the speech of their parents, or, more typically, a variant in the parents' speech will occur in the speech of their children with greater frequency, and in the speech of their grandchildren with even greater frequency. In the community at large, successive generations will show incremental frequencies in the use of the innovative variant. The logical conclusion, as time goes by, will be the categorical use of that new variant and the elimination of older variants.

Apparent-time hypothesis studies make use of such generational differences at a given time for changes in progress. In these types of study, linguistic behaviours of different age groups are observed simultaneously and the observations are extrapolated as temporal (Chambers 1995: 193). That is, with the perspective that younger speakers tend to use more of the newer or innovative forms and the older speakers use more of the older or conservative forms which they adopted in their own teenage years, differences between the speech of older people and younger people are interpreted as indications of possible changes in progress (Holmes 2001: 206). Thus, this hypothesis assumes that an individual's speech remains stable throughout life (Milroy & Gordon 2003: 37). What makes it difficult for us to interpret apparent-time linguistic observations is the assumption that people normally use more vernacular forms while they are young, but tend to use more standard forms as they get older due to the pressure of the society's expectations (Holmes 2001: 206). This leads us to one important notion called 'age-grading' (Hockett 1950, cited in Hudson 2001: 15) which we should bear in mind when observing such generational difference. Age-grading is a pattern of use in which particular linguistic variants are used by people of a particular age, who eventually stop using it when they grow older (Hudson 2001: 15, Milroy & Gordon 2003: 36). Hence, apparent synchronic differences between different generations may not necessarily be evidence of change in progress due to age-grading (Milroy & Gordon 2003: 36). It seems, however, that this does not confute the apparent-time hypothesis (Chambers 1995: 194, Milroy & Gordon 2003: 36). Firstly, stable age-graded variables are not very common in the sociolinguistic literature[19] (Chambers 1995: 188, Milroy & Gordon 2003: 36). Secondly, since age-graded changes are regular and predictable and may be considered as marking a developmental stage in the individual's life, most of them seem to be related to childhood or adolescence (Chambers 1995: 188-193, Chambers and Trudgill 1998: 151, cited in Milroy & Gordon 2003: 36). Thirdly, age-grading appears to be connected to features that involve a high degree of social awareness and 'would therefore be more readily subject to conscious manipulation' (Milroy & Gordon 2003: 36-7). Thus, the apparent-time hypothesis seems to be 'reasonably secure if we understand it to apply to particular types of features (those that do not attract social awareness) and to cover the course of one's adult life only' (Milroy & Gordon 2003: 37).

3.3.3 Social class

Social class is one of the key sociological concepts in language studies (Macy 2001: 362). This is equally true for the sociolinguistic variationist studies as it plays a prominent role in language variation, at least in industrialised countries (Milroy & Gordon 2003: 40). A number of past studies in the last half century have proved to show that there is certainly a positive correlation between linguistic variation and social class differences (e.g. Labov 1966, Wolfram 1969, Fasold 1972, Trudgill 1974, Fontanella de Weinberg 1974 cited in Macaulay 1976: 173). Although most of the studies regard social stratification as a continuum[20] (e.g. Labov 2001:113), their methods of determining people's social class seem to be rather diverse. In particular, as Macaulay (1976: 184) points out, they differ in two respects: (1) 'in the method of assigning individuals to a given point on the scale' and (2) 'in the method of dividing the continuous scale into classes'. The disunity in these methods may be attributed to the fact that there is little agreement or clarity about the meaning of the term among linguists (Macy 2001: 362).

In the following, to pursue a deeper understanding of social class and the validity of several methods applied to sociolinguistic studies, the term 'social class' will firstly be viewed from its historical aspect in relation to the study of sociology and sociolinguistics (§3.3.3.1). Secondly, the above-mentioned two aspects for methodology will be considered by reviewing various

[19] See Chambers (1995: 188-193) for the example of the use of "zee" rather than "zed" for the last letter of the English alphabet by a particular aged children in Southern Ontario in Canada, and the use of glottal stops by middle class 10-year old children in the study of Glasgow by Macaulay (1977).

[20] This depends on the society or community to be studied. Rickford, for example, identified Weber's model of classes as groups of people with different orientation to the market in the village of Cane Walk, Guyana (Rickford 1986: 216-217). Milroy (1987) found significance of network differences within working class groups in Belfast, Northern Ireland.

approaches applied to past socio-phonetic studies in terms of their validity as well as their problems (§3.3.3.2). By doing so, it is found that one's occupation seems to play the most important indicator for social affiliation. With the empirical evidence/results from those past studies, general relationships between social class and language variation will finally be discussed (§3.3.3.3).

3.3.3.1 Social class and its historical development in sociology and sociolinguistics

Let us now consider its historical background and its general agreement on characteristics of the principal social classes in sociology. The rest of this section is largely cited from three articles of Macy (2001: 362-369), Kerswill (2007: 51-61) and *Social Class* (2007, Encyclopaedia Britannica) which provide detailed historical concept of social class and socio-economic class in sociology in relation to sociolinguistics.

Theories of social class started to be elaborated in the 19th century with the development of the modern social sciences, especially sociology (*Social Class* 2007). Having been influenced by political philosophers such as Thomas Hobbs, John Locke, Jean-Jacques Rousseau who had discussed the issues of social inequality and stratification and the French social theorist Henri de Saint-Simon who had argued that a state's form of government corresponded to the character of the underlying system of economic production, the social theorist Karl Marx (1818-1883) further developed the theories of social class (*Social Class* 2007). Marx relates social structure to the means of production by which people are divided into 'capitalists' who own the means of production and 'proletarians' who sell their labour to the capitalists (cf. Macy 2001: 362, Giddens 2001: 284 cited in Kerswill 2007: 51, *Social Class* 2007). This is considered as a conflict model since the relations between the classes are antagonistic in terms of the appropriation of what is produced (*Social Class* 2007). Of particular interest for the study of sociolinguistics is that this theory which was grounded in the Victorian Age brought about the rise of 'class consciousness'[21] amongst people in Britain and that this class segregation in Britain led to a divergence in speech at the level of dialect and accent (Kerswill 2007: 51). While the new urban vernaculars emerging in places like Manchester and Leeds had strong working class connotations, the increasingly uniform 'Received Pronunciation' was used by the elite including not only the capitalists, but also

[21] Class consciousness is likely to be more salient in the Old World countries like in Britain compared to the New World countries such as the United States where social mobility is greater (see Milroy & Gordon 2003: 41).

traditional landowners, senior managers and civil servants and aristocracy[22] (Mugglestone 2003 cited in Kerswill 2007: 51). In this way, nineteenth-century British English was not only divided into regional dialects, but also social dialects or 'sociolects' (Kerswill 2007: 51).

While the Marxists keep emphasising the importance of class conflict, others revise, refute or provide an alternative to Marxism, focusing attention on the functional interdependence of different classes and their harmonious collaboration with each other, and proposing to include additional attributes for class such as knowledge and skill, authority, power and cultural capital (Macy 2001: 363, *Social Class* 2007). Among them was the German sociologist Max Weber (1864-1920) who, early in the 20th century, considered people as having different 'life chances' because of differences in skills, education and qualifications (Kerswill 2007: 52) by dividing Marx's proletariat into two classes: those who possessed a marketable skill and those with only their raw labour power to sell (Macy 2001: 364). In Weber's view, a capitalist society must recognise 'status' which is not directly derived from Marxian 'class' and which leads to differences in 'styles of life' (Weber; Giddens 2001: 285 cited in Kerswill 2007: 52) marked by such things as 'housing, dress, manner of speech, and occupation' (Giddens 2001: 285 cited in Kerswill 2007: 52). In this way, cultural factors were added into the concept of class (Kerswill 2007: 52).

In contrast to Marx's class theory, Weber's approach to class copes with the changing society over the 20th century, in which there appeared increasing numbers of people in the 'middle class' who derive their wealth, power, prestige and overall life chances not from capital or property but from their skills or knowledge as salaried knowledge workers (Kerswill 2007: 51, Macy 2001: 365). By the late 20th century, the classes in capitalist societies had tended to lose their distinctive character to the extent that class boundaries have grown less distinct than they once were (Crowther 1999: 114, *Social Class* 2007).

According to Kerswill (2007: 52), by the 1960s, Weber's notion of 'status' became central to sociolinguists. Most influential among them was William Labov whose adoption of 'status' was in fact descended from American functionalism in which people's occupations were considered to play important roles for the concept of social class. Later on, since the 1970s, purely functionalist models have greatly been replaced by combined models of different factors – i.e. status hierarchies, the means of production, and cultural factors – with a strong element of life-style

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22 This social attitude is considered to have brought about an interesting peculiar characteristic of RP in Britain. That is, in the class-conscious society where social class took precedence over geography as a determinant of speech so that there was far more geographical variation among people in the lower social classes than there is amongst those at the top of the social hierarchy, people who have passed through the public school system or who would like to sound like them started to develop their own language (i.e. RP) typically with no regional traits (Hudson 2001: 42).

choice. This view was further extended by the French sociologist Pierre Bourdieu who proposed the importance of cultural capital. In his view, language is considered as central to this form of capital, and this linguistic capital is embodied by socially highly-valued language forms such as standard English and Received Pronunciation in Britain. (cf. Kerswill 2007: 52)

Despite controversies over the theory of class, there seems to be general agreement among social scientists on the characteristics of the principal social classes – upper-, middle- and working classes – that sociologists generally posit in modern societies (*Social Class* 2007). In modern capitalist societies, first of all, the upper class is often distinguished by the possession of largely inherited wealth and/or property which confers many advantages upon them, such as income from wealth, a distinctive style of life, influence on economic policy and political decisions, superior educational and economical opportunities. The working class, in contrast, traditionally consisted of manual workers, and due to considerable differences within the class, a useful distinction is sometimes made between skilled, semi-skilled and unskilled workers that broadly corresponds with differences in income level. Traditionally associated with this class were relatively low living standards, restricted access to higher education, and exclusion from opportunities for decision making. One important factor which affected the working class in the second half of the 20th century was a general shift in the economy from manufacturing to service industries, which reduced the number of manual workers and increased the number of non-manual, but relatively low paid, workers which can merge into the middle class. The middle class is characterised not only by the relative social and economical position being between the upper- and the working classes, but also by their jobs. The core of the class, on the one hand, includes the middle and upper levels of clerical workers, those engaged in technical and professional occupations, supervisors and managers and small-scale self-employed workers. At both ends of the middle class, on the other hand, people with jobs such as wealthy professionals or managers in large corporations merge into the upper class, whereas people with jobs such as routine and poorly paid jobs in sales, distribution and transport merge into the working class. (cf *Social Class* 2007). Aside from the upper class whose characteristics are greatly attributed to their inherited wealth and privileges, both the middle and working classes seem to be largely characterised by the type of their occupations, which generally determines the level of the other factors such as education, status and income. Hence we see 'job' as an important factor to distinguish the middle and working classes.

Thus, as the society changes in Britain, the theories and definitions of 'social class' have been going through significant changes. Given these changes, sociolinguists have attempted several approaches to identify and classify social classes in order to reflect social reality in their own data.

In the next section, we will review those approaches applied to sociolinguistic studies and consider both the validity and the problems of different approaches.

3.3.3.2 Social class and sociolinguistic studies

Having mentioned various theories and concepts of social class in sociology, there are also various perspectives for the concept of 'social class' among linguists. It is generally described as the social stratification particularly related to power, wealth and status within a society, and often measured by occupation, education, economical characteristics such as income, housing type, neighbourhoods and so on (cf. Chambers 1995: 36, Trudgill 2000: 25, Holmes 2001: 135, Hudson 2001: 186, Kerswill 2007: 54).

As mentioned earlier in the beginning of §3.3.3, there is no single consensus for the methods of assigning individuals to a given point of the social scale and the methods of dividing the continuous scale into classes (Macaulay 1976: 184). Instead, there have been various kinds of approaches applied to the past sociolinguistic studies even within the same country or society. For the first aspect – the way to determine the social stratification of individuals – there are briefly two approaches in the societies in which their social stratification is considered to form a continuous scale: (1) multi-dimensional scaling approach with occupation, education, income, housing type, housing price, neighbourhoods etc. to be concerned together at the same time and (2) single-dimensional approach, solely with one of the relevant factors used to determine an individual's position in the social scale. In the following, actual studies which had applied either of these two approaches are briefly reviewed with the second aspect – the way to divide the social scale into classes.

The multi-dimensional scaling approach to determine the social rank of individuals was fully elaborated first in the study of New York City in the U.S. by William Labov (1966). Labov uses a ten-point scale (zero for lowest to nine for highest) based on the three dimensions of occupation, education and income with each factor weighted equally, divides them generally into four classes – lower, working, lower middle, and upper middle classes – but clusters speakers inconsistently for the purpose of analyses depending on his dependent (i.e. linguistic) variables (Labov 1966: 170-174, 211-20, also reported in Macaulay 1976: 184, Chambers 1995: 43-44, Milroy & Gordon 2003: 43). Labov states that these different independent variables are 'not themselves determinants of social class, a concept that involves the more subjective component of status, and the more elusive fact of power' (Labov 2001: 114). In this view, different types of indicators have different relations to a speaker's life trajectory and life chances (Labov 2001: 114). Labov (2001:

114) finds in his New York City study that the three indicators had different relations to linguistic variables that reflected these differences and reports as follows:

> Occupation is most closely linked to family background, and tends to be the strongest determinant of linguistic patterns established early in life, like (dh). On the other hand, educational status changes continuously throughout the early years, and education is linked more closely with superposed variables that are acquired later in life, like NYC (r). Income changes the most and reflects the most recent socioeconomic position of a speaker; it therefore tends to have the weakest relation to linguistic patterns. Thus individuals who do not fit into the typical range of their social class are frequently those who show status incongruence among the indicators: for example, a plumber whose income and residence reflect a recently acquired prosperity may display linguistic features more typical of his earlier career.

In his later study of Philadelphia, Labov uses again a three-component index for his subjects, but this time adopts three six-category indices for occupation, education and residence values (reported in Labov 2001: 61). Among these three factors, he later on examines the internal relations, and finds that house value and occupation are closely correlated while education is less closely correlated with either (Labov 2001: 180-182). Furthermore, it is found that, in general, occupation is correlated more closely with the linguistic factors than education or house value. He notes, however, that this is not always the case and emphasises that the combined index of socioeconomic position yield a stronger and more consistent pattern of social stratification than any individual indicator (Labov 2001: 182).

Another influential study which applied a similar multi-dimensional scaling approach to determine the social rank of individuals and which was carried out in Britain is the study of Norwich by Peter Trudgill (1974). He uses a more complicated index constructed from six indicators of occupation, education, income, type of housing, locality, and father's occupation, and this provides a continuous scale from zero (lower social class) to thirty (highest social class) (also reported in Macaulay 1976: 184, Chambers 1995: 43-44, Milroy & Gordon 2003: 43). The actual score for his subjects ranges between 3 and 26, and, based on the results for the use of a particular grammatical variable, their positions on these scales are used to construct five social classes: lower-working (3-6), middle-working (7-10), upper-working (11-14), lower-middle (15-18), and middle-middle (19-26) (cited in Chambers 1995: 45). Of our particular interest from his scoring approach is the fact that two of his six components are occupational components (own and father's). Because of this fact, although each component is equally weighted, the proportion of the component 'occupation' in the total score is in a sense double compared to other factors.

In the study of Detroit by Shuy, Wolfram and Riley (1968), they in fact use a weighted composite index of occupation, education and residence. Above all, each speaker's score for occupation is weighted most, i.e. being multiplied by 9, whereas those for residence and education are multiplied by 6 and 5 respectively. This gives a continuous scale, by which they distinguish their speakers into four social classes (upper-middle, lower-middle, upper-working and lower-working) (cited in Milroy & Gordon 2003: 43). That is, although their study is similar to those of Labov and Trudgill in the sense that they apply combined indices to determine an individual's social rank, their study differs from Labov's and Trudgill's in that, firstly, their multiple indicators are unequally weighted for speakers' social stratification, and secondly their subjects are divided into discrete classes on sociological criteria alone, without any linguistic factors.

Other studies which apply combined indices include Fasold (1972), Fontanella de Weinberg (1974) and Feagin (1979). Fasold (1972) uses three of the four characteristics employed in the Index of Status Characteristics (Warner, Meeker & Eells 1960) – occupation, house type and dwelling area, and divides subjects on sociological criteria alone (cited in Macaulay 1976: 184-185). Fontanella de Weinberg (1974) uses a six point occupational scale, supplemented with a four-point educational scale, and tries to divide subjects on the basis of particular linguistic variables (cited in Macaulay 1976: 184). Feagin (1979: 25-26), for a study of speech of a town in northeastern Alabama, exploited her knowledge as 'a native of the town, with local relatives and other contacts' to select a much more complex judgement sample, involving urban and rural teenagers and elders, both males and females, in two classes she calls 'upper class' and 'working class' (Chambers 1995: 39, Rickford 1986: 215).

In contrast to the multi-dimensional scaling approach, there is another approach in which a single indicator is used to determine people's social class. One of the well-known studies with this approach in the UK is that of Macaulay (1976) who uses a socioeconomic indexing based on occupation in his study of Glasgow, Scotland. Macaulay (1976: 173-188) employs the British *Registrar General Social Classes* (RGSC) scheme now renamed *Social Class based on Occupation* (SOC) in 1990 (Office for National Statistics 2001). The RGSC scheme rested on the assumption that society is a graded hierarchy of occupations (Rose 1995). Macaulay refines the three-way classification used by Kellas (1968) and reaches a four-way classification by subdividing the second group according to manual and non-manual occupations (Macaulay 1976: 174). This is because, according to Macaulay, the non-manual/manual distinction is generally considered one of the most important in a modern industrial society. The reasons for choosing occupation as the criterion of social class membership are not only because Macaulay believes that is the best single indicator of social class but also because it is one of the easiest factors to obtain advance information about (Macaulay 1976: 174). Table 3 shows Macaulay's social class categories based on occupation with the original categories of the RGSC scheme:

Table 3 Macaulay's social class categories based on occupation (From Macaulay 1976: 174)

Class *I*	Professional and managerial (RGSC: 1, 2, 3, 4, 13)
Class *IIa*	White-collar, intermediate non-manual (RGSC: 5, 6)
Class *IIb*	Skilled Manual (RGSC: 8, 9, 12, 14)
Class *III*	Semi-skilled and unskilled manual (RGSC: 7, 10, 11, 15)

Although Macaulay's subdivision of group *II* (which, according to Chambers (1995: 46), corresponds to upper-working class) is based on his intuition, his results prove it to be insightful. As a whole, his reliance on occupation alone as a class indicator turned out to be adequate as the results show a consistent correlation for all of his five phonological variables with his class distinctions as determined by occupation (Macaulay 1976: 175-7, commented in Chambers 1995: 47-8). This is especially remarkable when he separates his sixteen adult informants by gender and ranks them by their composite linguistic indices: there is no single individual who deviates from the order predicted on the basis of occupation alone (Macaulay 1976: 177-8). The only possible deviation is found between a Class *IIb* male speaker and a Class *III* male speaker whose scores are exactly the same (Macaulay 1976: 178). Macaulay infers from this evidence that it may have been wrong to treat these two classes, both of which are manual workers but different in their level of skills, as distinct classes (Macaulay 1976: 178-9). In fact, the differences between his groups for all of the five phonological variables become more clearly marked after these two classes are combined together (Macaulay 1976: 179). On top of this phonological (i.e. segmental) evidence, Macaulay finds further evidence which can be considered as support for joining these two classes; that is, not only do the subjects in these classes show similar characteristics at their suprasegmental (i.e. intonational) and dialectal (i.e. lexical and grammatical) levels, but also their comments on their perception about social class seem to indicate that there is only one class among them (see Macaulay 1976: 179-81). Having observed these consistent correlations of his Glasgow data with his informants' occupation, however, Macaulay notes the possibility that his successful social stratification derived solely by his speakers' occupation may be attributed to conditions peculiar to Glasgow. Firstly his adult informants are all mature enough (i.e. 48 in average) for their jobs to be more stable compared to the 20-30 years old (Macaulay 1976: 183). Secondly the stagnant economic situation since the end of World War I may have reduced people's social mobility (Macaulay 1976: 183-4). Thirdly his small sample size might have made it possible not to necessitate other additional information such as income, education, type of residence, etc (Macaulay 1976: 183-4). Thus, Macaulay's study gives a strong support for the use of occupation as the single indicator of social class. According to Chambers (1995: 47), all social scientists concede that it is the best single indicator.

In favour of the multi-dimensional scaling approach, Labov lists several reasons for its preference to the multi-dimensional approach as follows:

> [...] a combined index will help explain more aspects of class-based behaviour; it will tap different dimensions of socioeconomic status; and the consistency or inconsistency of various indicators will give us additional information about socioeconomic status patterns. A very large proportion of the useful and replicable results of sociolinguistic studies have been based on such indices [...] (Labov 2001: 60)

In contrast with this, while he admits its usefulness in a certain situation, Macaulay (1976: 184-5) comments on potential problems of the multi-dimensional scaling approach with a series of critiques given by various scholars to it:

> While it might appear to be obvious that more is always better than less, this does not necessarily follow in dealing with such a controversial subject as social stratification. Warner's Index of Status Characteristics (Warner *et al.* 1960) has been seriously criticized, not least on the ground that Warner confuses class with status (Kornhauser 1953), and the multi-dimensional approach in general is rejected by Parkin (1971) because it is 'difficult to reconcile with the notion of stratification as a system of structured inequality' (p.17). Multi-dimensional indices also run into the dangers pointed out by Brandis (1970) of treating nominal-ordinal scales as if they were interval scales. In the absence of evidence by which occupational, educational, and other factors can be ranked on equal interval scales, the degree of distortion produced through adding them to each other is totally unpredictable. It does not follow from this that a multi-dimensional approach to social stratification must be avoided by sociolinguistics, but it underlines the necessity to justify the use of the different dimensions in a particular situation. In other words, it should not be taken as self-evident that the use of several indicators necessarily provides a more accurate measure of social stratification than the use of a single one. This is something which must be carefully justified in terms of the local situation and not something which can be taken for granted on the basis of precedents in totally unrelated situations.

In this way, instead of being opposed to the multi-dimensional scaling approach, Macaulay suggests we consider the nature of each community before blindly applying this approach. In fact, Labov (1990: 232) has also used the single indicator of occupation, arguing, like Macaulay, that 'the single indicator of occupation has a slight advantage over the combined index in consistency and strength of the correlations'.

Another way to rank people is to use socioeconomic indices which assign scores to individual occupations. This is a scheme elaborated by sociologists. Chambers (1995: 42-43) introduces such indices calculated for Canada (from Blishen 1971) with greater correlations to other industrialised countries. This is similar to the single-dimensional approach by occupation alone in that people are ranked by their own occupational information, whilst this is similar to the multi-dimensional approach in that 'the index score for each occupation incorporates income and education data as well' (Chambers 1995: 43).

In the U.K., similar indices are used in the study of modern RP by Fabricius (2000). In addition to her separate educational factor, she uses a finely graded Cambridge Scale[23] which allocates scores to individual occupations to identify the social position of her informants. As Fabricius (2000: 77) cites, Prandy (1992: 1) describes the Cambridge Scale in these terms:

> The Cambridge Scale is a measure of differential advantage as indicated by the tendency of those enjoying similar life-styles to interact socially on the basis of equality. Like social class schemas it uses occupational groups as the basic units that it deals with, but unlike them it does not posit the existence of larger social groupings to which the occupations then have to be allocated... the relation of social interaction (simply derived from information on the occupations of respondents' friends or spouses) is used to determine whether or not a social continuum exists and, if it does, what its nature is, in particular whether it includes any large intervals between occupational groups that might suggest the existence of class boundaries. The existence of a finely graded hierarchy, rather than a structure of discrete, homogeneous classes, appears to have been borne out by evidence from the application of the scale.

The basic group scores[24] of 60 and above are considered to be the highest levels of the score (cf. Prandy 1992: 11). Since her subjects are all university students, Fabricius (2000) uses their parents' scores.

In contrast to the above-mentioned works with relatively elaborate ways of assigning people's social class, many recent studies seem to avoid the complexity of social metrics, favouring instead a focus on different neighbourhoods as a simple means to investigate broad differences in social class. Those examples are found in the study of Newcastle upon Tyne by Watt & Milroy (1999: 25-46), the study of Derby by Docherty & Foulkes (1999: 47-71), and the study of Glasgow by Stuart-Smith (1999: 203-22). The study of London by Torgersen *et al.* (2006: 249-63)

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[23] She apparently applies basic group scores (see footnote 24) making use of a *Computer-Assisted Standard Occupational Coding* (generally called CASOC and referred to as CAMSOC in Fabricius 2000) which has now been replaced by *Computer Assisted Structured Coding Tool* (called Cascot) (see §5.2.2.4.1 below).

[24] The basic group scores (available in Prandy 1992: 15-25) are the scores before taking account of additional quality of being female, self-employed, senior or junior for more detailed Cambridge Scores (see Prandy 1992: 7 for more details).

similarly selects different localities in London on the basis of demographic and social differences in collecting their informants with rather complex and diverse ethnic background. The recent tendency from a more elaborate way to a rather simpler way of classifying speakers into broadly defined social classes observed in a number of empirical sociolinguistic studies may be reflecting actual complexity of recent diverse social situations which include a great deal of people's social and/or regional mobility as well as an increasing number of immigrants in the late twentieth century (cf. Foulkes & Docherty 2007: 57) which form multi-ethnic populations in many cities such as London (cf. §2.5).

Thus, there is no single consensus either for the factors which determine people's social stratification or for the way to divide up the continuous scale of social stratification. Labov comments that 'the actual basis for the division of social classes seems to be immaterial' (2001: 31 FN25). One thing which seems to be agreed on by most of the sociolinguists for the first aspect, however, is that the occupational factor plays the most important role to determine people's social class in many cases of the studies in modern industrialised societies and that it can be used either as one of the multi-dimensional factors or as a single-dimensional factor. Ash (2002: 419) discusses as follows:

> If social class is determined by a combination of features, the single indicator that accounts for by far the greatest portion of the variance is occupation. Some researchers use occupation alone as a determiner of social class, and it is hard to imagine a composite index that excludes occupation.

As for the way in dividing up the continuous scale, it seems sensible to interpret social classes 'in terms of focal points rather than discrete entities' (Hudson 2001: 187) so that it can be easier to categorise individuals in the middle of a category than those near the boundary between two classes (Chambers 1995: 38). Having given the above-mentioned past studies, the current study adopts the single-dimensional scaling approach with a finely graded occupational scale, called CAMSIS, which will be looked at more closely in §5.2.2.4.1.

3.3.3.3 Social class and language variation

It has been said in general that people in higher social groups tend to use more of the prestigious norms than those in lower ones, and inversely that people in lower social groups incline to use more of the vernacular forms or localised forms than those in higher social groups. One of the examples for this type of pattern is the pronunciation of the English participial suffix on forms such as *sleeping* and *singing*. This is pronounced [ɪŋ] with a velar nasal consonant in careful speech styles of standard accents of English, whereas in casual middle class (MC) speech and in all styles of working class (WC) speech it is pronounced [ɪn], [ən] or [in] with an alveolar nasal consonant (Chambers 1995: 108). It was found in the study of New York City by Labov (1966) that regular social stratification is maintained for each speech style; that is, each step upward in class status is associated with a decrease in the use of alveolar nasals (reported in Labov 2001: 80-2). This use of standard [-ŋ] or non-standard [-n] has been studied in other English-speaking communities, and found that it also distinguishes social groups in a similar way, for example, in Norwich (Trudgill 1974) and Sydney (Horvath 1985).

With regard to causes of linguistic change, early theories predicted that the innovators would be at either the top (e.g. Tarde 1873 reported by Labov 2001) or the bottom (e.g. Whitney 1868, reported by Labov 2001) of the social hierarchy. However, the first elaborate sociolinguistic studies of change in progress conducted by Labov in Martha's Vineyard (1963, 1972) and New York City (1966) find that those who take a role as the innovating group are neither the highest social class nor the lowest social class, but groups between them: that is, an upper working class or lower middle class (Labov 2001: 31). This leads to a *curvilinear hypothesis*[25] stated as *Curvilinear Principle* that '[L]inguistic change from below originates in a central social group, located in the interior of the socioeconomic hierarchy' (Labov 2001: 188). It is added that they are central not only in a socioeconomic hierarchy but also in terms of local activity, local interaction, and local prestige (Labov 2001: 188). Since at least three, preferably four, divisions of the social hierarchy are required to identify this curvilinear pattern, it is argued by Labov (2001; 31-2) that 'the crucial division in the society from the point of view of language change was not middle class vs. working class, but rather centrally located groups as against peripherally located groups'. In relation to this, Labov (1966) found in his study of New York City that the lower middle class, who are located in the middle of social stratification, used a higher frequency of postvocalic 'r' than anyone else in the most formal styles. Labov considers this as evidence of the linguistic and social 'insecurity' of this group as well as a sign that these people often play a lead role in linguistic change (reported in Kerswill 2007: 55).

Current social mobility in Britain makes people move easily in and out of groups with different social backgrounds. Consequently, it is sometimes said that Britain is moving towards a 'classless society', and in particular towards becoming a completely middle class society (Crowther 1999: 115). This phenomenon could potentially affect language variation by class.

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[25] For the major evidence for this hypothesis, see the raising of (oh), (ay) and (aw) in New York City (Labov 1966), the backing of (el) in Norwich (Trudgill 1974), and the lenition of (ch) in Panama City (Cedergren 1973) as suggested in Labov (2001: 32).

3.3.4 Speech style

Stylistic variation is the variation in the speech of individual speakers (i.e. intra-speaker variation) rather than across groups of speakers (i.e. inter-speaker variation) (Schilling-Estes 2002: 375). How people speak is subject to the social context in which they speak. It has repeatedly been found in sociolinguistic studies that there is a considerable difference between a casual style of pronunciation, when the speaker is relaxed and not monitoring his or her speech, and a more formal style of pronunciation, when he or she is paying attention to how he/she behaves and speaks. It is a rule of thumb in variationist studies that a formal speech style is often, but not always, associated with high usage of 'standard' forms (Schilling-Estes 2002: 376). Therefore, one of more than two variants is said to be normally regarded as 'standard' or overtly prestigious usually on the grounds of more frequent use of this variant in more formal speech styles (Cheshire 2002: 425). Stylistic variation usually operates along the same scale as socio-economic or social class differences in speech, and also reflects differences in the social context in which a speaker finds him-or herself interacting at a given time. For example, Labov (1966) found in the study of New York City that styles appear to be ranked in the same way as class: in more formal styles, people use more of the pronunciation with postvocalic 'r' (reported in Kerswill 2007: 55). Since it was also found that people with higher social status tend to use more postvocalic 'r', it is considered that there is a link between high-status speakers and more monitored formal speech.

Trudgill (1974) employed in his study of Norwich four contextual styles for speakers divided into five social classes. The styles employed were WLS (word-list style) which is the most formal style, RPS (reading-passage style), FS (formal style), and CS (casual style) which is the most informal style, while the five social classes were MMC (Middle Middle Class), LMC (Lower Middle Class), UWC (Upper Working Class), MWC (Middle Working Class) and LWC (Lower Working Class). One of his linguistic variables, the use of non-RP [n] forms at the end of the suffix *-ing*, showed that people in lower social classes tend to use more of the vernacular non-RP form in more informal speech styles. That is, the scores for the use of non-RP [n] forms rose consistently from WLS to CS, and from MMC to LWC. This clearly indicates that, in more formal contexts, speakers of all classes increase the frequency of use of higher-status RP [ɪŋ] forms in their speech.

Linguistic styles also change due to the social characteristics of people with whom a person talks to. A simple social correlate of stylistic difference is explained by Chambers (1995: 5) that formality tends to increase proportionately to the number of social differences between the participants. According to Chambers (1995: 5), age is one of the most relevant factors so that the conversation between two women in the same age from the same neighbourhood is more likely to be less formal than the conversation between a middle-aged woman and an elderly woman in the same situation.

Labov develops a number of interview protocols to elicit utterances in various speech styles. In the studies of language variation, the essential difference between different speech styles is the level of people's self-consciousness during their speech as explained by Chambers (1995: 6):

> When people are asked to read lists of words they obviously concentrate on their pronunciation almost completely, especially when the reading is being recorded by someone who is admittedly studying language. The care and attention is even greater than usual if the words are arranged as minimal pairs (...).
>
> The reading of connected prose is also highly monitored – so much so that most people are well aware of sounding different when they read – but the requirement of maintaining coherence when reading a passage aloud deflects some attention away from speech and on to the content of the passage.
>
> In a free discussion, the content becomes even more important. Though self-monitoring is normal as an interviewee frames answers to the interviewer's questions, it must obviously be less than when reading a passage because the content of the answer must be foremost.
>
> The unmonitored style – casual speech – is the one that sociolinguists want most to study, and it is the one that cannot be elicited by any foolproof devices. After the interviews have been going on for several minutes, the subjects become accustomed to the recording apparatus and more relaxed with the interviewer. (...)

These types of speech styles are referred to by Chambers (1995: 6) as: word list, minimal pairs, reading passage, interview and casual styles respectively. In this study, as we will see in §5.2.3 below, the three of them – word list, reading passage, and interview styles – will be elicited from the subjects.

4 DRESS, TRAP and STRUT vowels in London

4.1 DRESS, TRAP and STRUT in the history of English short vowels

A history of the English short vowel system can be found in Trudgill (2004: 37-38). The short vowel system of Middle English was symmetrical and consisted of five vowels only: /ɪ/, /ɛ/, /a/, /ɔ/, /ʊ/ as in *pit, pet, pat, pot, put*. Thus, DRESS and TRAP were presumably a front and a central vowel, whereas STRUT did not exist. At around the end of the sixteenth century (Brook 1958: 90, cited in Trudgill 2004: 37) or the seventeenth century (Wells 1982: 197), however, the FOOT-STRUT Split (Wells 1982: 196-9) had begun in the southeast of England (Ihalainen 1994: 261, cited in Trudgill 2004: 37) in a way that the vowel /ʊ/ began to lose its lip-rounding in certain environments and the quality became closer to [ɤ]. This phonetic split eventually became a phonemic split between /ʊ/ and /ɤ/ (which later lowered to [ʌ] and became /ʌ/), postulated for the eighteenth century by Gimson (1962: 103, cited by Trudgill 2004: 133), which was further reinforced by the shortening of /uː/ to /ʊ/ in certain words, generating minimal pairs such as *look* and *luck*. This unrounded *u* was, according to Ihalainen (1994: 261, cited in Trudgill 2004: 38), considered to be vulgar until the mid-seventeenth century, when it was described by a Suffolk schoolmaster as the accepted pronunciation. Since then, southeastern English has had a six short vowel system, in which the vowel /a/ moved forward to /æ/ to give a new symmetrical system with three front and three back vowels.

Thus, compared to DRESS and TRAP vowels, the STRUT vowel is a relatively newer phonological innovation in English, and many local varieties in northern England and south western Wales do not have it (Trudgill 2004: 133). More importantly, the selection of these three vowels was made for the reasons, as we will see shortly, that (1) they move in a rather small part of the vowel diagram with confusion between them being reported and (2) the recent situation of the short vowels – particularly DRESS, TRAP and STRUT – do not seem to show full agreement with Labov's Principles of Vowel Shifting.

Recalling the correlation between accent and social class discussed in §2.4, people in a higher social class in London (i.e. London UMC here) are expected to speak with an RP or particularly with 'London Regional RP' in Cruttenden's term (Cruttenden 2001: 81, cf. §2.1.2), and those in a lower social class (i.e. London WC here) are likely to speak with an accent closer to or known as

Cockney. In the following sections, we will look at how these three vowels have been reported to have changed their quality in RP and London English in the course of 19th and 20th century.

4.2 DRESS in RP and London

The DRESS vowel, traditionally called 'short E', is discussed by Wells (1982: 128) as a phonetically relatively short, lax, front mid unrounded vocoid in RP, which should be transcribed as [e̞] (or [e̞] as described by Wells (1982: 128)) or [ɛ̝]. This is equivalent to the descriptions of this vowel by Gimson (1962: 101) having the vowel halfway between [e] and [ɛ]. In the latest edition of Gimson, Cruttenden (2001: 110) states that the general RP variety tends to be closer to [ɛ] than to [e], indicating the possible lowering of this vowel from the time of Gimson (1962). Trudgill (2004: 45-6) makes this point clearer by stating that RP and other southeastern English English accents more generally used to have much closer realisations of this vowel than is currently the case. Hughes *et al.* (2005: 48) represent it as /ɛ/ which is presumably the similar quality described by Cruttenden (2001: 110). Most other accents have a vowel in this lexical set generally similar to this vowel quality (Wells 1982: 128). The diphthongal realisations [ɛᵊ] or [eᵊ] can also be heard, being perceived as affected (Hughes *et al.* 2005: 48, Cruttenden 2001: 110).

The height and degree of centralisation of /e/ (as well as /ɪ/), however, vary; relatively close and peripheral qualities are associated particularly, but non-exclusively, with old-fashioned RP, while relatively open and central qualities (presumably transcribed [ë̞] or [ɛ̞̈]) are common with younger speakers (Wells 1982: 291, Hughes *et al.* 2005: 48). The similar lowering of this vowel is also found by Tollfree (1999: 165) in her SELRS data (which is presumably considered to overlap with our 'London UMC' here) in which older speakers have [ɛ] and some [ɛᵊ] variants while younger speakers have [ɛ] or more open variant form [ɛ̞]. Hawkins & Midgley (2005: 188) observe not only the lowering (i.e. higher F1) but also a slight backing/centralisation (i.e. lower F2) for this vowel from their oldest to youngest RP male speakers in their acoustic study of RP monophthongs[26]. They identify their youngest speakers (born in 1976-1981) as a so-called 'break-group'[27] whose members, by their definition, have more dispersed formant frequencies than members of the other age groups, which implies that the lowering of this vowel started in some

[26] This slight backing may be a consequence of the lowering of the front vowel in a vowel triangle as Labov explains (1994: 122).

[27] According to Hawkins & Midgley (2005: 192), a 'break-group' is a generational group of people who are in a situation to be able to choose more conservative or more progressive pronunciations individually from a range of variants available to them due to incipient rapid sound-change.

young people's speech at least by 1981 (the latest possible date of birth for the youngest group), but not as early as 1966 (the latest possible date of birth for their next age group of those born in 1961-1966) in their data (Hawkins & Midgley 2005: 192). There is more evidence for the backing/centralising of this vowel in a real-time acoustic study by Harrington, Palethorpe & Watson (2000: 70) in Queen Elizabeth II's speech from her Christmas messages in 1950s, 1960s and 1980s (i.e. a lower F2 in her 80's speech compared with her 50's and 60's speech)[28]. Thus, this vowel in RP seems to be not only lowering as mentioned by Hughes *et al.* (2005: 48), but also backing/centralising in current RP (Hawkins & Midgley 2005: 188).

The DRESS vowel of traditional Cockney is described by Sivertsen (1960: 53) as /e/, an unrounded, front, between half-close and half-open vocoid, which should be transcribed as [e̝] or [ɛ̝]. Trudgill (1986: 133) similarly describes Cockneys' realisations of this vowel as [ɛ̝], while surmising they may have been closer in nineteenth century Cockney than now with indirect evidence from rural East Anglia data from 1870. The closer variants of this vowel are thus not only found in old-fashioned types of RP, but also in those of Cockney (Wells 1982: 128, Cruttenden 2001: 110), while more open realisations are found among younger speakers (Wells 1982: 128, Tollfree 1999: 165). As mentioned by Torgersen & Kerswill (2004: 32), the evidence for the closer type of variants by older Cockney speakers can be found in the description of Matthews (1938: 169) as in 'git' for *get* and 'cimitery' for *cemetery*. The tendency towards lowering corresponds to Beaken's (1971: 150) argument that the lowering of this vowel is a feature of 'modern' Cockney in his time (i.e. more than 30 years ago). Similar lowering of this vowel is also found in more recent London data by Tollfree (1999: 164); in her SELE data (which is presumably considered to overlap with our 'London WC' here), older speakers have [ɛ] with some [ɛə] while younger speakers have [ɛ] or more open variant form [ɛ̞]. This lowering is also found in Ashford in Kent, about 40 miles southeast of London[29] (Torgersen & Kerswill 2004). In the latest study of this vowel in London conducted by Torgersen *et al.* (2006), the data from two London boroughs of Havering and Hackney, where the apparent-time data are available, show that the DRESS vowels are centralised (i.e. backing) in these two areas in London. For other

[28] Contrary to the F2 trend, the Queen's F1 goes against the current trend of lowering; that is, there is an F1 decrease in this vowel in the Queen's speech from the 50's to the 80's (Harrington *et al.* 2000: 72). This may be consistent with the recent tendency that older speakers have a lower F1 frequency than younger speakers, and may be a reaction to more open realisations of the young.

[29] Their initial vowel plots of the DRESS vowel for individuals in Ashford using non-normalised formant data do show the lowering (Torgersen & Kerswill 2004); however, this is not observed when Torgersen *et al.* (2006) later present mean vowel plots using normalised formant data. The same is true for the TRAP vowel in Ashford. Having given these results, Torgersen *et al.* (2006) comment that the 'lowering, if any, was probably not significant for these vowels'.

Cockney realisations, some other diphthongal variants, [eə~eɪ~ɛɪ], with a closing offglide before certain voiced consonants have been reported by Sivertsen (1960: 54), Wells (1982: 129) and Cruttenden (2001: 110). Thus, this vowel in London WC seems to be lowering at least in the last few decades, and it may possibly be centralising/backing as well.

4.3 TRAP in RP and London

The TRAP vowel, traditionally called 'short A', has the stressed vowel /æ/ in RP (Wells 1982: 129). Phonetically, according to Wells (1982: 129), it is a front nearly open unrounded vocoid, [æ], approximately halfway between cardinal vowels 3 ([ɛ]) and 4 ([a]). Recently, however, this [æ] variant seems to be confined mostly to older or more conservative speakers which in some cases may cause confusion with /ɛ/ (Hughes *et al.* 2005: 48). Many researchers agree that present-day RP TRAP has a more open [a]-like monophthongal quality in England (Wells 1982: 129, Bauer 1985&1994, Harrington *et al.* 2000: 73, Cruttenden 2001: 83 and 111, Trudgill 2004: 45. Hughes *et al.* 2005: 48). Cruttenden (2001: 83) describes the lowering of this vowel as a well-established change within RP, remarking that it is now closer to cardinal vowel no. 4 [a] rather than cardinal vowel no. 3 [ɛ] which it once was closer to in the description of the first edition of the same book (Gimson 1962: 101). Roach (1991: 15) also reflects this lowering of the TRAP vowel, plotting it in the location much nearer to [a] in his vowel diagram. Interestingly, Wells (1982: 129) comments that this lowering may possibly be a reaction against the closer [ɛ~ɛ̝] type of realisation associated with Cockney. There is also an acoustic report of backing for this vowel in data from female speakers born between 1919 to 1960 by Bauer (1985, 1994: 117). He states his data agree with the study by Henton[30] (1983, cited in Bauer 1994: 119) which compares vowel formant frequencies between the male RP data from Wells (1962) and those from Henton (1983). Similar backing as well as lowering for this vowel is also found in the Queen's later speech (Harrington *et al.* 2000: 70). In the study of Hawkins & Midgley (2005: 188), the similar lowering and a slight backing are found from their oldest to youngest RP male speakers; for this vowel, they identify two age groups (born in 1946-1951 and 1961-1966) as 'break-groups' implying that this lowering phenomena presumably began at or before the early 1950s (the latest possible date of birth for the group), but not as early as 1936 (the latest possible date of birth for

[30] Not all Bauer's results agree with those obtained by Henton (1983). Bauer finds, as mentioned, evidence for lowering of this vowel, while Henton finds evidence for its raising (Bauer 1994: 119).

their next age group of those born in 1928-1936). The latest acoustic study for this TRAP vowel in the configuration with STRUT vowel in RP is conducted by Fabricius (2006, 2007) who compares acoustic measurements of male RP speakers from her unpublished corpus collected in Cambridge with other data from several published corpora (i.e. Deterding (1997), Wells (1962), Hawkins & Midgley (2005), Harrington *et al.* (2000))[31]. Her data show an interesting ongoing change that she names 'TRAP/STRUT rotation' in the short vowel space across generations due to the juxtaposition of TRAP and STRUT vowels between its horizontal and vertical alignments over the course of the twentieth century[32]. She presumes that this is the ongoing result of approximately half a century of TRAP backing and lowering, which can be seen to trigger the observed rotating of the STRUT vowel upwards into a mid-central position towards schwa and ultimately towards DRESS (Fabricius 2006: 3). Thus, the findings in the study of Fabricius (2006) are also indicating that the TRAP vowel is lowering and backing. This [a], or possibly the retracted variant [a̱], which is perceptually very similar to the fronted realisation of /ʌ/ in RP, may cause confusion with /ʌ/ (Wells 1982: 291, Hughes *et al.* 2005: 48), or may even result in neutralisation of these two phonemes (Cruttenden 2001: 111). Lengthening of this vowel is also common in some words in the south (especially the southwest) of England (Wells 1982: 129-130, Cruttenden 2001: 111). The closer variants, possibly with a centring offglide, [ɛ~ɛᵊ] or [æ̝~æᵊ], are perceived as refined, affected or old-fashioned (Cruttenden 2001: 111, Hughes *et al.* 2005: 48). The opening diphthongs [ɛæ~eæ] can also be heard among U-RP (Wells 1982: 281). Thus, TRAP in RP has been undergoing lowering and backing.

The TRAP vowel of traditional Cockney is described by Sivertsen (1960: 53), Wells (1982: 129) and Cruttenden (2001: 112) as [ɛ], an unrounded, front, half-open vocoid slightly closer than RP. Trudgill describes Cockney's realisations of this vowel as [æ̝] (1986: 133), while suggesting that in the middle of the nineteenth century, regional accents in the whole area around London had a TRAP vowel much closer than current [æ], and in some cases even closer than [ɛ] (2004: 45). The evidence for the closer type of variants by older Cockney speakers can be found in the past literature: e.g. Ellis (1889) as the older evidence, Matthews (1938), and Gimson (1962) as the relatively recent evidence. Ellis (1889: 226) quotes from a Mr D'Orsey who writes of London

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[31] More details will be reviewed in §4.6 below.

[32] For details, the short vowel space in RP is observed in her data from an 'early triangle' configuration of the vowel space with STRUT as the lowest point and with TRAP being above it and more front, through a 'quadrilateral' configuration in the mid-twentieth century with TRAP and STRUT on a similar level, to at last in presumably the later twentieth century a 'later triangular' configuration with TRAP lowest in an open central position and with STRUT above it in a mid central position (Fabricius 2006: 18-19)

English that '*cab* is *keb*, *bank* is *benk*, *strand* is *strend*', and from Mr Baumann who represents London English words such as *cab, catch, standard* with <e> (all cited in Trudgill 2004: 44). Matthews (1938: 79) transcribes TRAP vowels as in [keb] for *cab* and [ben] for *ban* (cited in Torgersen & Kerswill 2004: 31). It is also known that RP and other southeastern English English accents generally used to have closer realisations of /æ/ than is currently the case (Trudgill 2004: 45). The majority of realisations from the data of Hurford (1967) cited in Torgersen & Kerswill (2004: 31) are [ɛ], [æ] and [a], with a raised realisation [e] and some retracted realisations [ə] or [ɐ]. This closer variant [ɛ] as well as the diphthongal realisation [ɛⁱ] have been thus associated with Cockney (Wells 1982: 129, 305). Slightly more open realisations [æ~æ:] are also found in a more recent study by Tollfree (1999: 166), in her SELRS and SELE data, which is slightly lower than the Cockney variant [ɛ̞] found by Hughes *et al.* (2005: 74) who also identify a diphthong [ɛi]. Another possible diphthongal realisation [ɛᵊ], the same as a refined, affected or old-fashioned RP variant, is also pointed out by Cruttenden (2001: 112). Przedlacka (2002: 61, 74-5) found lower realisations (i.e. [a]~[æ]) among her teenage EE speakers from Surrey, compared to those from Buckinghamshire, Essex and Kent who showed closer realisations (i.e. mainly [æ]~[ɛ̞]). The most recent apparent-time study of this vowel in London by Torgersen *et al.* (2006) finds that the vowel is not only lowering but also backing in London. Moreover, the study of the vowel in two nearby localities, Ashford (in Kent, about 50 miles southeast of London) and Reading (in Berkshire, about 40 miles west of London), also shows that this vowel is 'becoming less front' in southeast England in general, reported in Torgersen *et al.* (2006) (see footnote 29). The current trend of this vowel in London, thus, can be assumed to be towards a more open [a]-like monophthongal quality and also backing along with the trend in England as mentioned above.

4.4 STRUT in RP and London

The STRUT vowel traditionally called 'short U', according to Wells (1982: 131-132), has the stressed vowel /ʌ/ in RP. As we saw earlier, the STRUT vowel is a relatively recent phonological innovation in English, stemming from the early /ʊ/ sound in the process called FOOT-STRUT Split (Wells 1982: 196), and is now used mainly in the south, especially southeast, of England and in RP (Trudgill 2004: 37-38, 133). A little front of [ʌ] seems to have been the RP norm at the beginning of the twentieth century, before it fronted to the central vowel quality [ɐ], which is described as the present-day RP pronunciation of this vowel (Trudgill 2004: 113). Similar but only slightly different descriptions are given by many other phoneticians. Roach (1991: 15) places this vowel in a vowel quadrilateral diagram as slightly more open than the open-mid tongue height, slightly centralised front vowel with the lip position neutral. Wells (1982: 131-2) describes it as a relatively short, half-open or slightly more open, centralised back or central, unrounded vocoid somewhere like [ɐ], the same phonetic transcription as Trudgill. Similarly, Cruttenden (2001: 113) describes it as having a centralised and slightly raised quality [ä̝], as well as a more back variant [ʌ̈] with upper class speakers (i.e. 'Refined RP' speakers in his term). Tollfree (1999: 166) finds [ɐ] or [ʌ̝] in her SELRS data. Additionally, older speakers may realise it as a rather more retracted vowel (Hughes *et al.* 2005: 49). Consequently, it may be assumed that the vowel is fronting. In Bauer's (1985) study, however, even though he states that his data suggest a general fronting (Bauer 1994: 117), they show no evidence that this vowel is more retracted in his older RP speakers and the data even appear to indicate some backing from a centralised position (discussed in Torgersen & Kerswill 2004: 29-30). In the study of Harrington *et al.* (2000: 72), similar backing is also found in the Queen's speech in later years (i.e. 60's and 80's compared with 50's) in the form of a decrease in F2. Unlike those aforementioned studies, however, the data of Hawkins & Midgley (2005: 188) indicate that this vowel is rather stable across their four age groups of RP male speakers[33]. Moreover, in addition to the backing, the findings from Fabricius (2006, 2007) show evidence of raising of this vowel, as can be found in the study of Henton (1983: 358), and even its centring as well in the later twentieth century. Thus, although many studies identify changes in the quality of STRUT in RP in the last century, there is not a consistent agreement on the direction of movement (Harrington *et al.* 2000: 66, Fabricius 2006: 2).

The STRUT vowel of traditional Cockney is represented by Sivertsen (1960: 83) with a symbol [ʌ], not as a back vowel, but as an unrounded, front vowel between open-mid and open, which is not very different from the RP TRAP but not as front as that. Wells (1982: 305), however, describes this vowel in Cockney as ranging from a fronted [ɐ̟] to a striking front quality like that of cardinal 4, [a], as described by Cruttenden (2001: 113). Similarly Tollfree (1999: 166) finds [ɐ] and [a] in her SELE data. Hughes *et al.* (2005: 73) also identify /ʌ/, realised as [a̝], as explained by Trudgill (2004: 133-6) as a consequent realisation of a lowering and fronting process of

[33] Hawkins & Midgley (2005: 192) find evidence of incipient change of F1 dispersion in the STRUT vowel in their youngest age group (born in 1976-1981) which is identified as a 'break-group' for this vowel; however, they observe that it is very tentative in a sense that all other age groups have similar degrees of dispersion for F1.

STRUT in London[34] which is approaching to a point of [a], and as a continuation of a long ongoing process of change dating back to the late sixteenth century. This lowering and fronting process of STRUT is also observed in his STRUT data in East Anglia, which is discussed as a consequence of regional diffusion from London (Trudgill 1986: 50-2). Similarly, more front realisations are found among EE teenagers from Buckinghamshire (i.e. [ɐ̟]~[ɐ]) compared to those from Essex, Kent and Surrey (i.e. [ʌ̟]), and among female EE teenagers compared to the male ones in the study of Przedlacka (2002: 61-2, 76-7). The findings of Hurford (1967: 382), however, show that, although one of his oldest speakers has a front variant [a], most of the speakers have an open central variant [ɐ̞] and some others have a central [ɐ]. From these findings, the lowering and fronting process of the STRUT vowel, especially the recent STRUT Fronting (Trudgill 2004), is concluded by Torgersen & Kerswill (2004: 32) to have occurred in the first half of the twentieth century, but to have been reversed (i.e. *backing*) by the middle of the twentieth century in southeast England. Their study of English vowel changes in Ashford and Reading not only shows similar backing of this vowel in these two localities, but also indicates evidence for *convergence* of this vowel between two different localities (Torgersen & Kerswill 2004)[35]. In the case of Ashford, the vowel is also shown to be raising. Similarly, Torgersen *et al.* (2006) find in their study of the London vowel system that the STRUT vowels are both backing and raising. Hence, in summary, the STRUT vowels which once underwent the lowering and fronting process now seem to be in a new stage of backing and raising process not only in London but also in the rest of the southeast of England.

4.5 Correlations among DRESS, TRAP and STRUT

The various descriptions in the previous sections are summarised in Figure 3 in (London) RP and London regional accents respectively. The figure shows current tendencies of the possible movements, indicated by arrows, for the three vowels. All the possible variants for each vowel are indicated in the right shadowed boxes whilst the ovals indicate the region of the variants within the vowel quadrilateral.

[34] Trudgill (2004: 136) describes London as one of the most advanced accents of English, along with New Zealand and Australia, as far as this STRUT vowel is concerned.

[35] The backing of the STRUT in Reading is not observed when Torgersen & Kerswill (2004) initially present vowel plots for individual speakers using non-normalised formant data; however, their later vowel plots of the same but normalised formant data do show the backing in Torgersen *et al.* (2006).

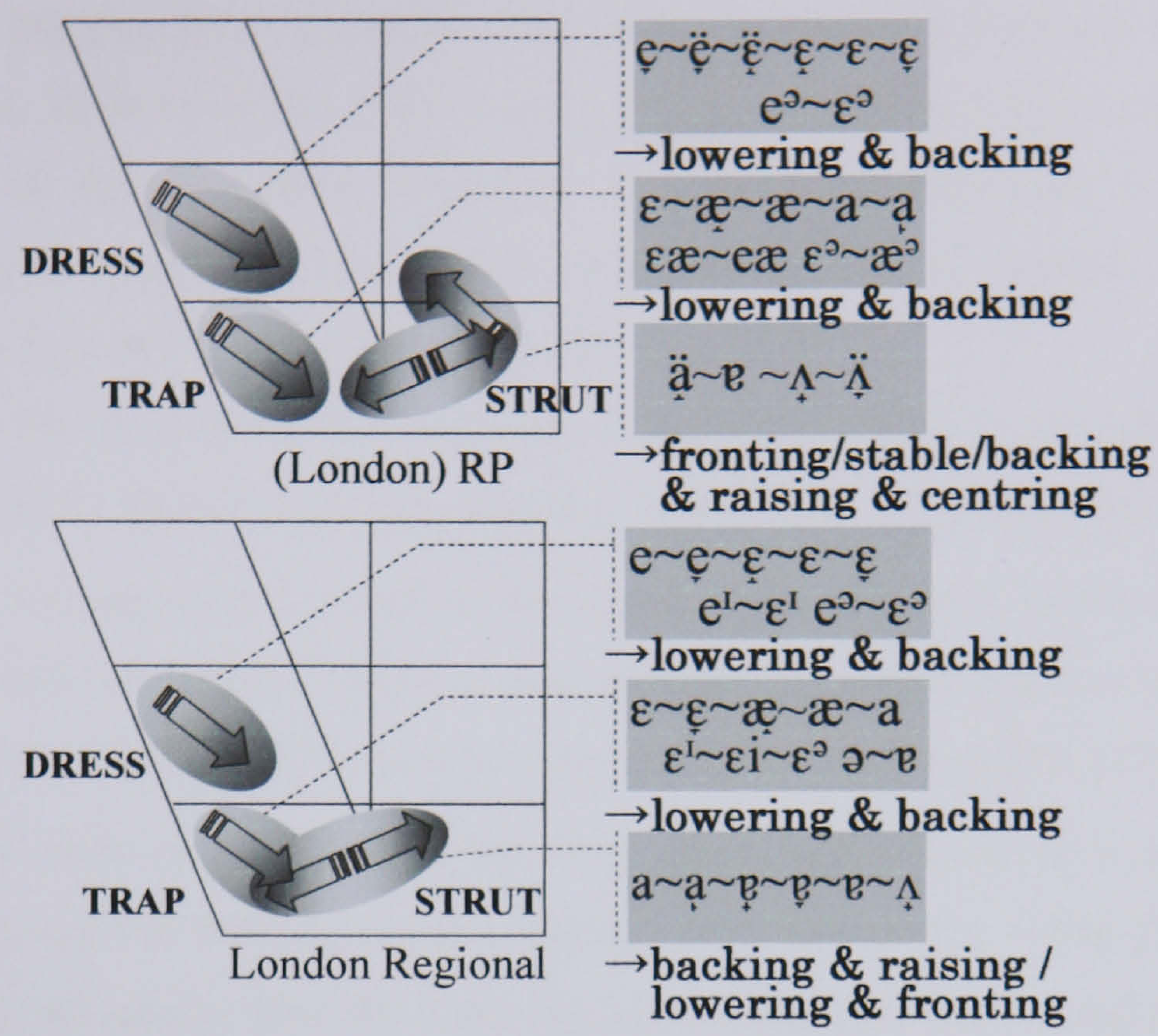


Figure 3 Diagrams of possible realisations and changes in DRESS, TRAP and STRUT vowels in (London) RP and London regional accents in vowel quadrilaterals from various studies (cf. §4.2, §4.3, and §4.4)

There have been reported a number of interrelations among DRESS, TRAP and STRUT possibly because of their complicated vowel movements. In RP, on the one hand, Wells (1982: 292) mentions variable merger of TRAP and STRUT for some speakers presumably due to the lowered and centralised KIT and DRESS. Hughes *et al.* (2005: 48) comment on possible confusion of older speakers' [æ] for TRAP as a realisation for DRESS. In London regional accents, on the other hand, replacement of TRAP with DRESS (Sivertsen 1960: 59), confusion between TRAP and STRUT (Beaken 1971: 150) and overlap of TRAP and DRESS (Beaken 1971: 150) are reported.

It is possible that these mergers and confusions of two different phonemes are caused by independent movements of each of these three vowels. As far as RP and London regional accents are concerned, however, this does not seem to be the case. The fact that they have mainly been reported either for the current older speakers or from the literatures of a few decades old indicates that it is very likely to have been rather a consequence of the early stage of a chain shifting process, in which, possibly as a push chain, the distribution of the entering element is in close approximation to the leaving element which may or may not eventually move (Labov 1994: 200). In fact, less evidence for merger/confusion among these three vowels is reported in the studies of the recent younger generations in RP or in the southeast of England including London English (e.g. Hawkins & Midgley 2005, Fabricius 2006, 2007, Torgersen & Kerswill 2004, Torgersen *et al.* 2006). Instead, as discussed by many researchers (e.g. Trudgill 1986, Labov 1994, Trudgill 2004, Torgersen & Kerswill 2004, Torgersen *et al.* 2006), the changes in these vowels are regarded as being integrated with the overall movement of the English short vowels, often in a context of a more dynamical chain shifting system.

Trudgill (2004: 42-43) proposes the southeastern drag chain which involves not only TRAP and DRESS but also KIT. This is a process whereby TRAP is lowered from [ɛ] to [æ] as the first stage, DRESS is subsequently lowered as the second stage, then KIT is finally lowered as the third stage. It is said that modern Cockney demonstrates the second stage, in which DRESS and TRAP have been lowered but KIT retains its closer realisation [i] (Trudgill 2004: 43). In his view, STRUT does not seem to be a part of this drag chain, but undergoing a long-term ongoing independent lowering and fronting process, starting from the quality before the FOOT/STRUT Split, [ʊ], through the quality after the Split, [ʌ], and the lowered and fronted [ɐ], heading to the further fronted [a̩] over the last 500 years (Trudgill 2004: 133-4). This further fronting is said to be progressed in the English of London and other parts of the southeast (Trudgill 2004: 133). He argues that London (along with Australia and New Zealand) is the most advanced area for this particular vowel change, citing Wells' description of this vowel in London: 'like that of cardinal 4, [a]' (Wells 1982: 305) (Trudgill 2004: 136). This fronting of STRUT in London, however, has been reported to have started being backed in the middle of the 20th century (Torgersen & Kerswill 2004: 46).

Torgersen & Kerswill (2004), who initially find similar lowering of DRESS and TRAP but also backing and raising of STRUT in their Ashford non-normalised data[36], suggest that the vowels are following an anticlockwise chain shift. Observing the chain shift also involving the fronting of FOOT and the raising of LOT[37] in Ashford, they describe the change as a classic chain shift and propose that the crowding of the vowel space which is presumably caused by the lowering of TRAP forced STRUT to move back, whereby it is considered that the lowering of TRAP initiates the chain shift (Torgersen & Kerswill 2004: 45). The changes are also argued to fit well with Labov's Principles II and III (Labov 1994, cf. §3.1), although Labov's proposition for the raising of the short front vowels proves to be wrong in their data (Torgersen & Kerswill 2004: 45). The other locality of their study, Reading, however, indicates no signs of chain shift. Instead, although FOOT is fronting as in Ashford, STRUT is backing and lowering from the mid central position to

[36] See footnote 29 and below.

[37] The measurements of LOT are only made from male speakers (Torgersen & Kerswill 2004: 40).

the low back position where the same vowel is heading in Ashford with stable DRESS and TRAP which have long been relatively open in Reading (Torgersen & Kerswill 2004: 45).

The initial non-normalised data from Torgersen & Kerswill (2004) are normalised and revisited in the later study of London short vowels conducted by Torgersen *et al.* (2006). Although the overall vowel shifts are more or less the same, the newly normalised acoustic data reveal slightly different vowel shifts from the initial results in Torgersen & Kerswill (2004). As far as DRESS, TRAP and STRUT are concerned, the shifts for DRESS and TRAP have turned out to be slightly different; to be concrete, TRAP in Ashford turns out to be backing but not lowering, whereas DRESS in Reading is found to be lowering rather than stable. The shifts found for STRUT are unchanged; namely, STRUT is backing/raising in Ashford and backing/lowering in Reading, moving towards similar positions in both towns (Torgersen *et al.* 2006: 252). The changes in STRUT are argued to indicate convergence between two short vowel systems from different starting points presumably caused by geographical diffusion from London combined with a measure of levelling (Torgersen & Kerswill 2004: 46, Torgersen *et al.* 2006: 252). The changes in FOOT and STRUT in Reading are regarded as 'natural' by referring to Labov's Principle II and III, and as structurally unmotivated changes (Torgersen & Kerswill 2004: 45-6). Thus, while acknowledging the validity of internal factors, encapsulated by principles of chain shifting such as those of Labov, they clearly verify that external factors can conflict with and take priority over those natural factors in particular cases, arguing that 'dialect contact is not simply exceptional, but (along with extra-linguistic factors) is integral to the understanding of this [social and linguistic] embedding [of change]' (Torgersen & Kerswill 2004: 48). Their findings thus shed light on the importance of external factors, such as dialect contact and levelling, for the vowel shift.

As expected, the later study of London short vowels by Torgersen *et al.* (2006) confirms that the anticlockwise short vowel chain shift observed in Ashford is happening in the speech of working-class Londoners. In the study, they analyse a complete set of short vowels of young and old working class informants in inner and outer London boroughs. Their data consist of three existing London datasets – i.e. IViE (Intonation Variation in English) project (Grabe, Post & Nolan 2001), the COLT corpus (Corpus of London Teenage Language) (Stenström, Andersen & Hasund 2002), some recordings made by William Labov in London in 1968 – as well as the data collected from Hackney (inner London) and Havering (outer London) as part of a large project on language change in London (*Linguistic innovators: The English of adolescents in London,* ESRC grant RES-000-23-0680) (Torgersen *et al.* 2006: 53). Of particular interest to the current study is their apparent-time investigation for their inner (Hackney) and outer (Havering) London speakers.

The younger speakers are aged 16-19, while the older speakers are in their 70s and 80s at the time of recording in 2005 (Torgersen *et al.* 2006: 253-4). Half of their Hackney speakers are not 'Anglo' speakers (by which they mean speakers who have a 'white London' background) but 'non-Anglo' speakers, whereas all the other Hackney and Havering speakers are Anglo speakers. An apparent-time comparison is made for each of two localities separately. As far as DRESS, TRAP and STRUT are concerned, the observed vowel shifts in both localities are argued to be in line with the southeastern (anticlockwise) vowel shift (Torgersen *et al.* 2006: 258-9). Havering shows centralisation of DRESS, backing of TRAP and backing and raising of STRUT. Hackney similarly shows centralisation of DRESS, backing and lowering of TRAP and backing and raising of STRUT. The possible difference in terms of these three vowels between these two regions is pointed out firstly that TRAP and STRUT are less front for the old speakers in Havering compared to those in Hackney whose TRAP and STRUT are described as fully front (Torgersen *et al.* 2006: 258-9), and secondly that the location of STRUT is lower than TRAP for the old speakers in Hackney whereas it is on a level with TRAP for the old speakers in Havering (Torgersen *et al.* 2006: 258-9). Having observed these results, the changes for TRAP and STRUT are argued to be 'more dramatic in inner-London (Hackney) since the differences there are greater between the young speakers with backed vowels and the old speakers who have fronted TRAP and STRUT' (Torgersen *et al.* 2006: 261). In the case of Hackney, in order to investigate possible effects of ethnicity, they further show detailed vowel shifts for young male Anglo speakers and for young male non-Anglo speakers respectively. Although there does not seem to be any evidence for effects of ethnicity in their realisations of DRESS, TRAP and STRUT, the FOOT vowel is found to be more back for the non-Anglo boys than for the Anglo-boys, whereby they conclude that 'a back FOOT vowel seems to be a feature of the non-Anglo vowel system in Hackney' (Torgersen *et al.* 2006: 259). A similar situation is also identified for Afro-Caribbean speakers from the IViE data. Acknowledging Hackney as a place to have 'a high density of people of immigrant descent including Afro-Caribbeans' (Torgersen *et al.* 2006: 262), it is argued that there is variation in the realisations of FOOT between a group of Afro-Caribbean and other non-Anglo speakers, and a group of Anglo-teenagers (Torgersen *et al.* 2006: 262). From the fact that West Indian English has a non-fronted FOOT, they surmise to consider it as a model of this back FOOT realisation (Torgersen *et al.* 2006: 261-2). Unlike this more conservative type of the back FOOT vowel, however, the STRUT vowel for non-Anglo speakers has a back half-close quality, which makes it appear that 'Hackney FOOT *restrains* the fronting of this vowel, while Hackney STRUT arguably *promotes* the backing noted throughout the region' (Torgersen *et al.* 2006: 262, with their original emphases). This leads them to consider 'inter-ethnic relations as a source of innovation in London English' and to conclude that 'the progress of language change in inner London is influenced by contact with non-native varieties of English and a number of ethnicity specific varieties ('ethnolects')' (Torgersen *et al.* 2006: 262).

Hawkins & Midgley's (2005) study of male RP speakers may support the order of this anticlockwise chain shift partially. Based on their generational 'break groups' (see footnote 27) identified throughout the study, they estimate the timing of the beginning for the lowering of TRAP and DRESS, and possibly for the change of STRUT too. First of all, the lowering of TRAP has been identified as the earliest rapid change, starting presumably after 1936 but before 1950s, and has been well progressed. Secondly, the lowering of DRESS is thought to have begun after 1966 but before 1981. In the case of the STRUT vowel, although it has shown relatively little variation between their generational groups, the group of speakers born between 1976 and 1981 is pointed to as a possible break group (Hawkins & Midgley 2005: 189-90), which leads us to estimate that the change in STRUT might have begun, as in the case for the lowering of DRESS, after 1966 but before 1981.

Fabricius (2007)[38] also finds the lowering and backing of TRAP and the backing and raising/centring of STRUT, both of which are considered to be a part of this anticlockwise chain shift. It is argued that, as in Torgersen & Kerswill (2004) and Torgersen *et al.* (2006), although the lowering of TRAP does fit well with Labov's Principle II (Labov 1994), the raising of STRUT goes against it. She extends her discussion to the concept of Labov's peripherality (Labov 1994), arguing that a lowered TRAP and a raised and centred (i.e. nonperipheral) STRUT may fit with Labov's more generalised General Vowel Shift Principle (Labov 1994: 262, 601, see also §3.1 above). However, her statement is made based on the reversed principle – i.e. 'in chain shifts, peripheral vowels become more open and non-peripheral vowels become less open' as cited from Labov (1994: 601) in Fabricius (2007: 311) – which is in fact found to be a misprint appearing in some copies of his book[39]. Since the principle should have read as 'in chain shifts, peripheral vowels become less open and nonperipheral vowels become more open' as cited earlier (§3.1) in the current thesis, her argument should have in fact been opposite; namely, the lowering and backing of TRAP (which is presumably peripheral) and the backing and raising/centring of STRUT (which is presumably nonperipheral) in her RP data are *not* in accordance with Labov's General Vowel Shift Principle.

[38] Fabricius's (2007) study will be closely looked at again in the later section (§4.6) for her innovative 'configurational analysis' which is also applied to the data in the current study (Chapter 8).
[39] It was confirmed by Labov himself through personal emails exchanged.

The recent situations of the short vowels – particularly DRESS, TRAP and STRUT – in London (or more generally the southeast of England) and RP, thus, do not seem to show full agreement with Labov's General Principles of Vowel Shifting. Moreover, they clearly indicate that Labov's speculation for tensing and raising of the short front vowels – especially DRESS and TRAP for the purpose of this study – is wrong. His two informants should now be considered to represent those of current elderly speakers. Although Labov's speculation on the vowel shift of short vowels does not seem to be the current situation in London, southeast England, or RP, the closer and fronter (i.e. more peripheral) realisations of the DRESS and TRAP are in line with those for the current older London, southeastern, or RP speakers observed in the above-mentioned recent studies.

This naturally leads us to doubt the validity of Labov's General Principles of Vowel Shifting, but to believe that it is more likely that external factors (such as social factors or possibly a dialect contact as suggested in Torgersen & Kerswill (2004)) may explain the vowel change better than internal factors, as far as the accents in London and/or southeast of England are concerned. Having given all these results and discussions from the past studies, the next chapter presents the research questions for the current study, followed by the research methods. Before moving on to it, however, recent novel sociolinguistic methods innovated by Fabricius (2007) and her results should be reviewed in more detail.

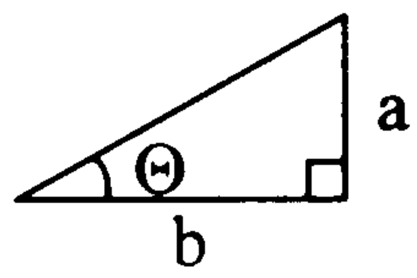
4.6 Fabricius's (2007) angle and distance calculations

Angle and distance calculations are innovative methods developed by Fabricius (2007: 293-320) to make the hitherto two-dimensional description for the vowel formant plots of two vowels more precise and independent of the analyst viewing the data. In the following, the first section is devoted to a rather comprehensive explanation for the methods themselves before actual results from Fabricius's study are presented in the second section.

4.6.1 Methods

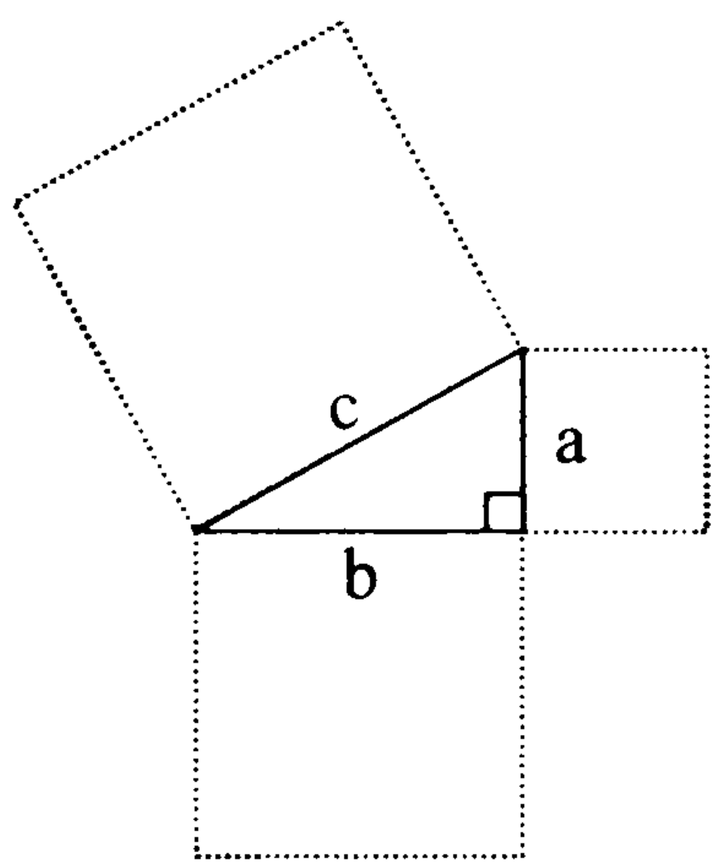
Fabricius (2007: 302) provides a rather brief explanation for the procedure of the methods, without mentioning too much detail about mathematical theories. This section, therefore, attempts to supply slightly more detail, with some possible extra considerations to be given on the use of the methods.

The angle calculation makes use of the function *tangent* (tan), defined in trigonometry as shown below:



Tan Θ = side opposite to Θ / side adjacent to Θ
$= a / b$

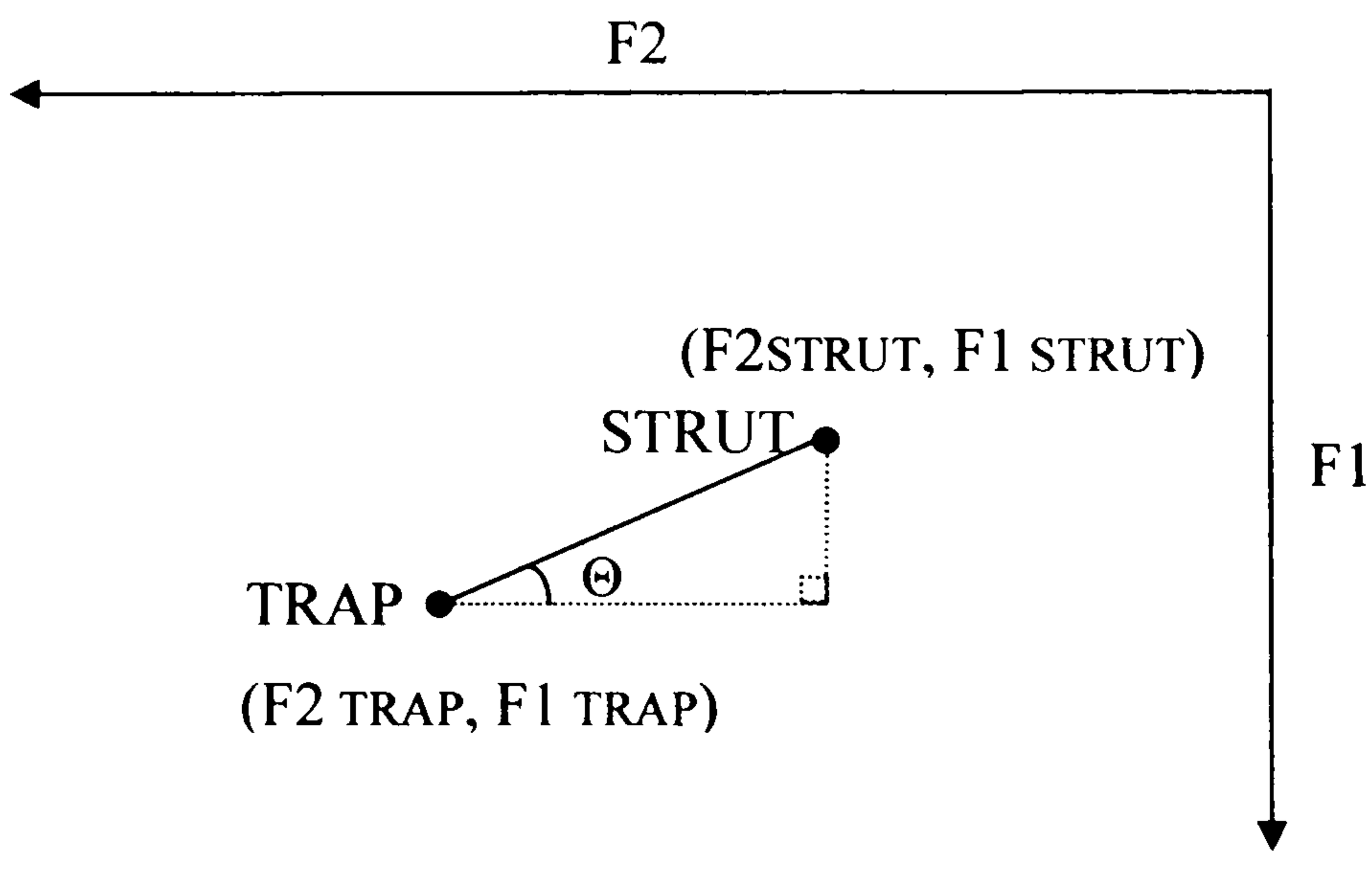
The distance calculation, on the other hand, makes use of the Pythagoras theorem that the square on the hypotenuse of a right-angled triangle is equal in area to the sum of the squares on the other two sides as shown below:



$$c^2 = a^2 + b^2$$

(Pythagoras theorem)

Let us now consider how these mathematical functions are applied to the actual vowel formant space in order to get the angle and distance in question. Vowel plots for TRAP and STRUT vowels over the traditional inverted F1 and F2 axes are diagrammed below:



Following Fabricius (2007: 302), TRAP is used as the anchor point to obtain the angle of the line from TRAP to STRUT relative to the horizontal line (i.e. Tan Θ) as in the following formula:

$$\tan \Theta = ((F1_{TRAP} - F1_{STRUT}) / (F2_{TRAP} - F2_{STRUT}))$$

The inverse of the function tangent is the *arctangent*, which derives the value of the angle in radians. The angle can then be converted from radians to degrees.

Although not mentioned by Fabricius (2007), one thing to be noted regarding the angle measurement should be that, before calculation, it should be necessary to bear in mind the following considerations. If F2STRUT is greater than F2TRAP, then the obtained angle T (negative) in degrees must be added to +180 in order to get the angle between +90 and +180 degrees[40]. If both F1STRUT and F2STRUT are greater than F1TRAP and F2TRAP respectively, then the obtained angle T (positive) in degrees must be added to −180 in order to get the angle between −90 and −180 degrees. Similar considerations need to be taken when either pair of F1 or F2 is exactly the same, i.e. the two points, STRUT and TRAP, are aligned horizontally (i.e. 0 ° or ±180 °) or vertically (i.e. +90 ° or −90 °), respectively.

As an additional and complementary measurement, the Euclidean distance is also calculated to determine the actual separation between the two points in question. Recalling the Pythagoras theorem, the Euclidean distance is derived from the following formula:

$$\text{DISTANCE} = \sqrt{((\text{F1 TRAP} - \text{F1 STRUT})^2 + (\text{F2 TRAP} - \text{F2 STRUT})^2)}$$

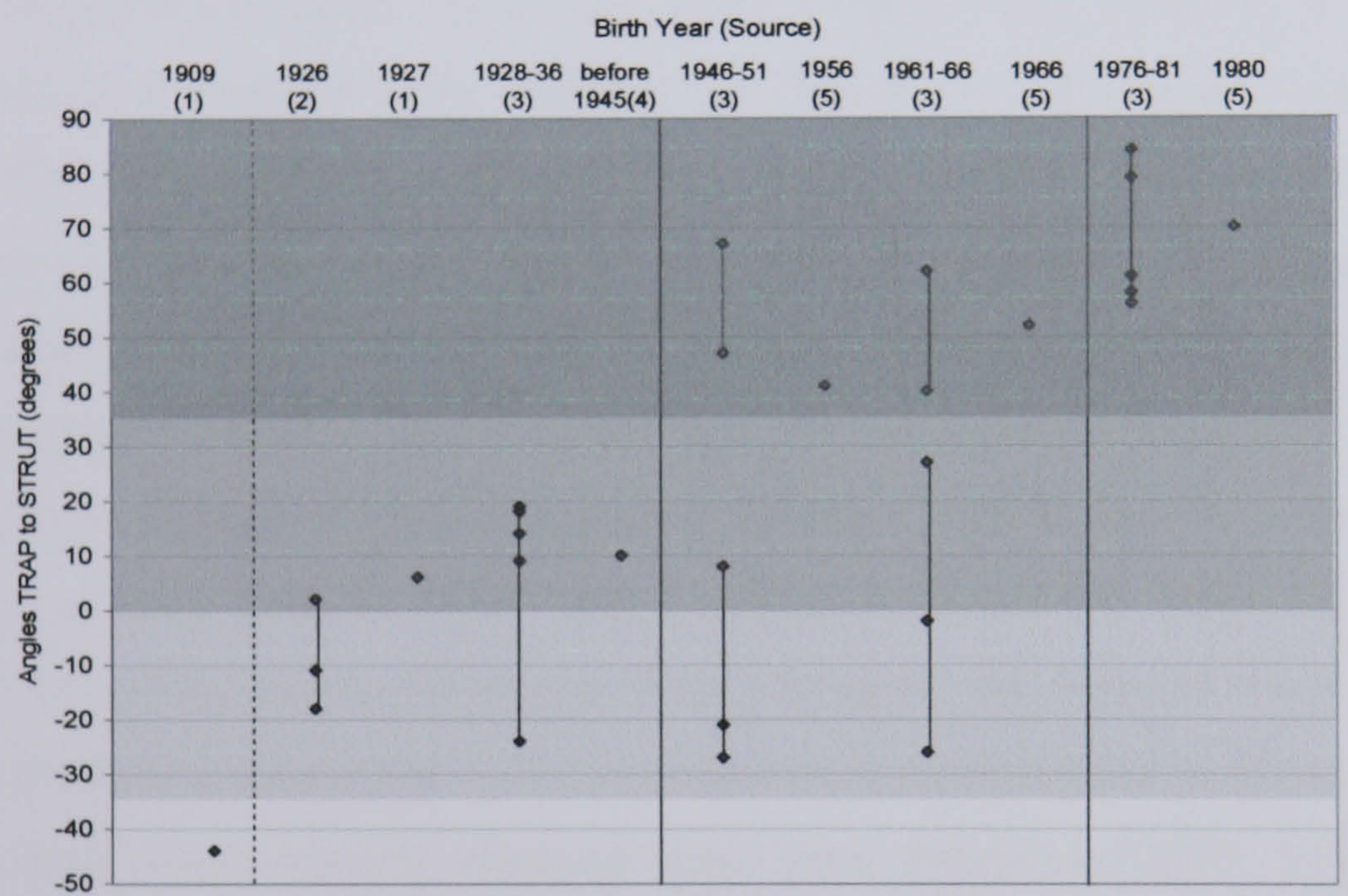
Fabricius summarises that 'through comparisons of different two-dimensional plots using angle and Euclidean distance calculations, differences in the relative placements of two vowels can be expressed simultaneously on both the F1 and F2 dimensions' (2007: 303) and adds that 'the methodology is to be seen as a supplement to the standard sociophonetic method, as it quantifies the juxtaposition of two vowel points, a central concern for understanding changes in vowel configurations over time' (2007: 303-4).

4.6.2 Configurational analysis of TRAP and STRUT in RP (Fabricius 2007)

In addition to the traditional descriptions of relative placements of vowels in a visual two-dimensional F1/F2 vowel space that have already been cited passim in the previous sections, Fabricius (2007: 293-320) applied these methods to find out evidence for configurational change of the juxtaposition of TRAP and STRUT vowels within the short vowel subsystem of the RP accent of English over the course of the twentieth century. For her real-time investigation, four

[40] In our data, there are two cases which needed this operation; one was the angle before voiced fricatives for the speaker F06, and the other was the angle before voiced stops for the speaker F07. Their SF21 values for STRUT vowels were greater than those for TRAP vowels so that obtained values, −80 and −81, were added to +180, which derived the final angle, +100 and +99 respectively.

past published corpora with available acoustic vowel formant values (i.e. Wells 1962, Roach, Knowles, Varadi and Arnfield 1993 analysed in Deterding 1997, Harrington *et al.* 2000, Hawkins & Midgley 2005) as well as her own interview data (see Fabricius 2000) were investigated (for more details, see Fabricius 2007: 298-9). As a result, the elicited and spontaneous data consisted of those of (predominantly male) speakers whose birth years were fairly distributed throughout the twentieth century (i.e. at earliest in 1909 and at latest in 1980). The given or measured vowel formants were then transformed by the *S*-procedure (Watt & Fabricius 2002 and also see §5.2.6 below) from Hertz into normalised *S* values, from which angle and Euclidean distance values were calculated. Figure 4 is reconstructed from Fabricius's data (Fabricius 2007: 303, Table 3), representing angle measurements in degrees:



Sources: (1) Deterding (1997), (2) Harrington *et al.* (2000), (3) Hawkins & Midgley (2005), (4) Wells (1962), (5) Fabricius (2000)

Figure 4 Distribution of angle measurements in degrees for RP speakers (constructed from Fabricius 2007: 303, Table 3)

In the figure, each dot indicates an average angle measurement per individual speaker, or, in the case of the data derived from Wells (1962) an average value for 25 speakers (Fabricius 2007: 301). As a result, her overall data show the trend towards a diachronic realignment of the relative positions of TRAP and STRUT. Her quantitative and qualitative detailed observations seem to identify four types of angles from TRAP to STRUT: (1) steeper negative angles, (2) shallow negative angles (shaded in the lightest grey in the figure), (3) shallow positive angles (shaded in the lighter grey in the figure), and (4) steeper positive angles (shaded in the darkest grey in the figure). Since it is not made clear how she judges to distinguish a series of angle values into these four patterns, the exact boundaries between them, except one between (2) and (3), are rather arbitrary. However, the general diachronic change in the angles of the vowels is clearly shown. The first type of angle was only found for her oldest speaker born in 1909 (from Deterding 1997) with the angle −44 degrees. In this configuration, the TRAP is higher and more front than the STRUT which forms the lowest open vowel in the system. The slightly younger speakers whose birth years were 1944 or earlier – i.e. 3 separate decades of broadcast messages of the Queen born in 1926 (Harrington *et al.* 2000), a speaker born in 1927 (Deterding 1997), Hawkins & Midgley's oldest group of speakers born in 1928-36 (Hawkins & Midgley 2005), and average values for 25 speakers born before 1945 (Wells 1962) – showed the second pattern (i.e. −24 degrees at lowest) and the third pattern (i.e. +19 degrees at highest), for which the data points are joined in the figure. For these speakers, the STRUT is immediately behind the TRAP so that they form a horizontal lower base of the vowel space. The middle-aged speakers – i.e. Hawkins & Midgley's 'break groups' (Hawkins & Midgley 2005: 192) born in 1946-51 or 1961-66, and two speakers born in 1956 and 1966 from Fabricius's Cambridge corpus (Fabricius 2000) – showed the greatest variations from the second (i.e. −27 degrees at lowest), the third (i.e. +27 degrees at highest) and the fourth pattern (i.e. between +40 and +70 degrees). The data points for the fourth pattern are joined in the figure to make it clear to distinguish from the other patterns. The youngest speakers – i.e. Hawkins & Midgley's youngest group of speakers born in 1976-81 (Hawkins & Midgley 2005), and a speaker born in 1980 from Fabricius's Cambridge corpus (Fabricius 2000) – consistently showed the fourth pattern (i.e. from +56 up to +84 degrees) where STRUT occupies a mid, nonperipheral position and TRAP occupies an open peripheral position with TRAP being the lowest open vowel. Having observed these data, Fabricius (2007: 310) summarises as follows:

> [T]he short vowel space in RP over the course of the twentieth century undergoing a change from
> - an early configuration with STRUT as the lowest point, and both TRAP and STRUT peripheral, through a phase with
> - a configuration in the mid-twentieth century, with TRAP and STRUT both peripheral and on a similar level, to, finally
> - a late configuration, with TRAP lowest and STRUT non-peripheral, characteristic of the later twentieth century.

During this configurational change, Fabricius identifies a process that she labelled 'TRAP/STRUT rotation' whereby the lowering and backing of TRAP is accompanied by the backing and raising/centring of STRUT (2007: 310). She surmises from the fact that both of her continuous and elicited data from similar age groups in different settings and different genres of speech show similar patterns that this historical vowel change is operating below consciousness and this may be evidence for the change to be independent of 'formality', 'genre' or 'setting' constraints (Fabricius 2007: 313-4).

5 Research Questions & Methodology

5.1 Research questions

Although a number of studies have reported substantial evidence for a complex shifting of these three vowels over the last century, it is still not entirely clear in which directions these three vowels are moving and what kind of internal relations they have in their short vowel system particularly in London. There have been no studies which thoroughly investigate correlations of the recent movements of these vowels in London or RP with various sociolinguistic variables and phonetic environments.

In order to pursue a clearer picture for these three short vowels in London English with regard to social and phonological aspects, the following questions are considered in this thesis.

Q1. Are the three short vowels (DRESS, TRAP and STRUT) in London English shifting?
Q2. If the vowels are shifting, in which directions are they shifting in London WC and London UMC respectively?
Q3. Is there any indication of social effects on the movements of these vowels? Is there any particular social group of people who seem to lead a particular change?
Q4. Is there any consistent stylistic variation for the movements of these vowels?
Q5. Is there any tendency for shifting with regard to the following segment?
Q6. Is there a significant configurational change between TRAP and STRUT in London English? If so, is there any correlation with social, phonological, and regional characteristics?

In order to answer all these questions, the following three major investigations will be carried out:

1. Investigation for the relative positions of DRESS, TRAP and STRUT for social and/or phonological correlations in London English for Q1, Q3, Q4, and Q5 (→ Chapter 6)
2. Apparent-time Investigation of DRESS, TRAP and STRUT for apparent-time comparisons in London UMC and London WC respectively for Q1 and Q2 (→ Chapter 7)
3. Configurational analysis of TRAP and STRUT in London English in relation to social, phonological aspects in London English for Q6 (→ Chapter 8)

As a whole, the main aim of this thesis is to investigate both acoustically and sociolinguistically a corpus of speech data of 32 selected speakers from London to find any systematic differences and/or similarities of the DRESS, TRAP and STRUT, correlated with social and phonological variables. With the results from these acoustic and sociolinguistic investigations, it is hoped to find out possible internal and/or external motivations for the movements of these vowels in London English.

There is one thing to be noted. On top of above-mentioned research questions, there was also an additional question for regional variation within London. Therefore, initially all the 32 informants were also divided into possible regional subgroups – North, East and South Londoners – and the regional variation among these three areas was investigated thoroughly in the same way as the other social factors. However, the sample was too unbalanced to be valid as shown in Table 4 and Figure 5 below; each regional group not only consisted of unequal numbers of speakers (i.e. 11 North Londoners, 14 East Londoners, and 7 South Londoners), but also mainly consisted of particular social group(s), so that the results seemed to reflect those social factors instead of regional factors. For example, the South Londoners, most of whom were predominantly Y-UMC (younger upper-middle class) speakers, showed very similar results as the Y-UMC group. Although the North and East speakers always showed statistically non-significant difference and sometimes showed statistically significant difference from the South speakers in their realisations of these three vowels, the fact that they both lacked enough samples from the Y-UMC group prevented the results from being reliable enough. For these reasons, it was decided not to include the details about the regional variation in the current thesis. One remarkable finding, however, should at least be noted here. While the South Londoners occasionally showed different realisations of TRAP and STRUT vowels from the North and East Londoners, the realisations for the North and East Londoners were always not significantly different. This could possibly suggest that regional variation in TRAP and STRUT within London, if there is any, lie possibly between South Londoners and North&East Londoners. This may be partially enhanced by Przedlacka's (2002: 74-5) finding that her teenage EE speakers from Surrey (i.e. South Western) showed significantly different realisations for the realisations of TRAP vowel height from those from Buckinghamshire (i.e. North Western), Essex (i.e. North Eastern) and Kent (i.e. South Eastern) who all showed closer realisations than Surrey speakers. This regional difference within London, therefore, would be an interesting hypothesis to be tested with more samples in the future.

For the purpose of the above-mentioned investigations, acoustic formant data for the three vowels are classified according to (i) sex, (ii) age group, (iii) social class, (iv) combinations of sex, social class and age group, (v) speech styles, and (vi) phonetic environments. The details of the methodology will be presented in the next section.

5.2 Methodology

5.2.1 Fieldwork sites

Two places were selected as fieldwork sites for the research project. One was London, and the other Leeds in which the author was based. The data were collected in May 2004 in Leeds, and in May, June and September 2004 and April 2007 in London.

5.2.2 Subjects and their social correlation

During the period of fieldwork (mainly in May, June and September 2004 and additionally in April 2007), a corpus of speech data from 76 informants was obtained by means of the 'snow-ball' technique (Milroy & Gordon 2003: 32) in several social network connections (see §5.2.2.3 below); 9 informants were interviewed in Leeds, and the other 67 in London. Out of these 76 informants, 32 speakers who matched the regional and social criteria are selected for the current study. They are equally divided according to their age, sex, and social class. They are also divided into three groups according to their localities within London incidentally for the reason mentioned in 5.1. These divisions are shown in Table 4 with speakers' IDs and ages in parentheses:

Table 4 Speaker's ID with classification due to age, sex, social class and localities within London (North Londoners in the white cells, East Londoners in the light grey cells, and South Londoners in the dark grey cells)

	Young								Old							
	Working Class				Upper-Middle Class				Working Class				Upper-Middle Class			
Female (age)	F01 (18)	F02 (22)	F03 (25)	F04 (30)	F05 (20)	F06 (21)	F07 (21)	F08 (25)	F09 (52)	F10 (65)	F11 (68)	F12 (73)	F13 (50)	F14 (51)	F15 (61)	F16 (70)
Male (age)	M01 (22)	M02 (24)	M03 (25)	M04 (29)	M05 (17)	M06 (20)	M07 (22)	M08 (23)	M09 (53)	M10 (54)	M11 (59)	M12 (61)	M13 (59)	M14 (59)	M15 (65)	M16 (66)

Each criterion used for the selection of the subjects will firstly be explained in detail in terms of age and sex (§5.2.2.1) and regionality (§5.2.2.2), followed by social correlation between speakers (§5.2.2.3). Classification of the speakers into social class is then presented (§5.2.2.4).

5.2.2.1 Age and sex

Subjects are subdivided into two age groups, young and old. The number of the young is 16 in total and they are aged between 17 and 30 (i.e. born between 1974-87), while the number of the old is also 16 in total and they are aged between 50 and 73 (i.e. born between 1931-1954): that is, the age groups are separated by at least 20 years.

Similarly, the subjects are subdivided into two sex groups, female and male. As can be seen in Table 4, there is no doubt that the semi-randomness of the sample prevented an exact numerical representation of each age/sex group. Table 5 shows the speakers' age distribution, means and standard deviations (SDs) for all the groups divided by sex and social class in relation to the age groups. It should be noted that, although the age distribution is wider for the old than for the young in general, the means and SDs are more or less well-balanced within the young groups (i.e. Y-F, Y-M, Y-WC, Y-UMC), old groups (i.e. O-F, O-M, O-WC, O-UMC), and general groups (i.e. F, M, WC, UMC).

Table 5 Speakers' age distribution, means and SDs

		By Sex		By Social Class	
		Female	Male	WC	UMC
Young	N	8	8	8	8
	Mean	22.8	22.8	24.4	21.1
	S.D.	3.77	3.54	3.89	2.36
Old	N	8	8	8	8
	Mean	61.5	59.3	60.6	60.1
	S.D.	8.93	5.04	7.65	7.02
Total	N	16	16	16	16
	Mean	42.1	41.0	42.5	40.6
	S.D.	21.08	19.31	19.62	20.76

5.2.2.2 Regionality

The most important point for the selection of the speakers was their regionality, i.e. where they were born and where they had lived. The criterion for regionality was that the subjects had to be so-called 'Londoners'. In any case, people who were (ideally born and) brought up in London or who claimed to be Londoners were potential subjects. It was left open to individual interpretation where the boundary for London lay and what type of people the word *Londoners* indicated. For this reason, although 'London' generally means the administrative area of Greater London containing 32 London Boroughs, of which twelve (plus the City of London) make up Inner London and twenty Outer London, some of the initial 76 speakers who claimed to be '*Londoners*' were in fact not from Greater London but from adjacent areas around London (i.e. Hertfordshire, Essex, Kent, Buckinghamshire, Berkshire or Surrey) or even from other parts of England in the case that they either were only born in or had lived in (Greater) London for a short period. Their regional information was elicited in the recorded interview session and detailed on the questionnaire.

Figure 5 shows the administrative area of Greater London (which will be simply called 'London' hereafter) and surrounding counties. It is indicated on the map where the selected 32 speakers come from. Figure 6 presents their simplified residential history as well as their birth place; full residential information with detailed localities is provided in Appendix 1.

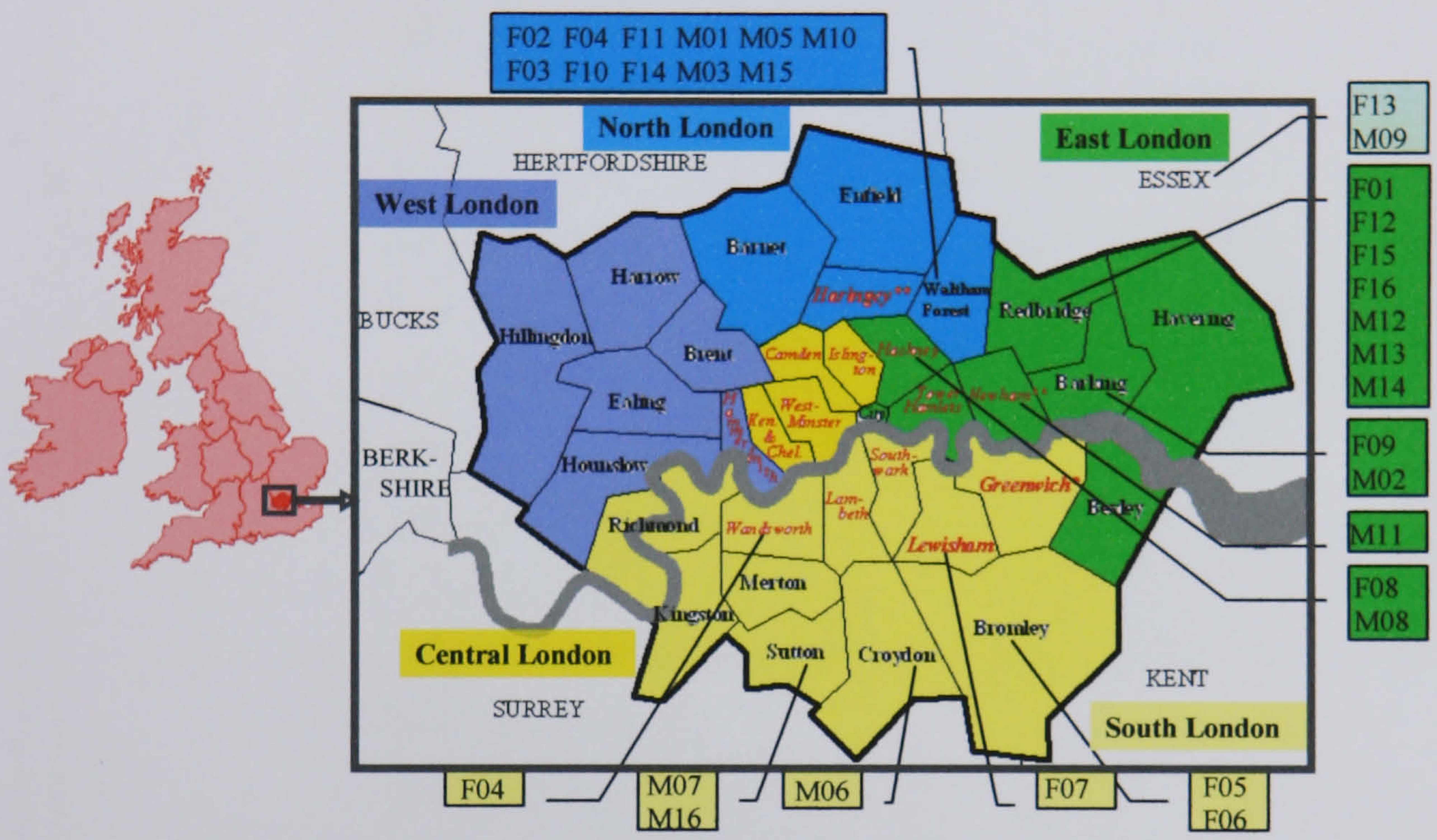


Figure 5 The map of the administrative area of Greater London (containing 32 London Boroughs, divided into North, East, South, West and Central Londons by colours), surrounding counties, and the origins of all the selected 32 speakers

As can be seen in Figure 6, most of the speakers were born, brought up and have lived in London almost all their lives. Particular exceptions, however, should be noted for several speakers. Both F01 and F15 were born not in London but in Essex, and had lived in Essex (i.e. Epping Forest and Vange respectively) for the first five years of their lives before settling in (East) London for the rest of their lives. Most importantly, F13 and M09 had lived not in London but in Essex for most of their lives, although they had been both born in East London (Redbridge); however, there were reasons that their speech data were chosen for the purpose of this study. As for M09, he had lived until the age of 29 in Chigwell in Essex, which is near the border of the London Borough of Redbridge before he had moved to London (Redbridge) at the age of 39. Besides, more importantly, his speech had been judged as Cockney by Prof. John Wells for my previous study: this could be because he had spent most of his time in East London (Redbridge) for his job as a

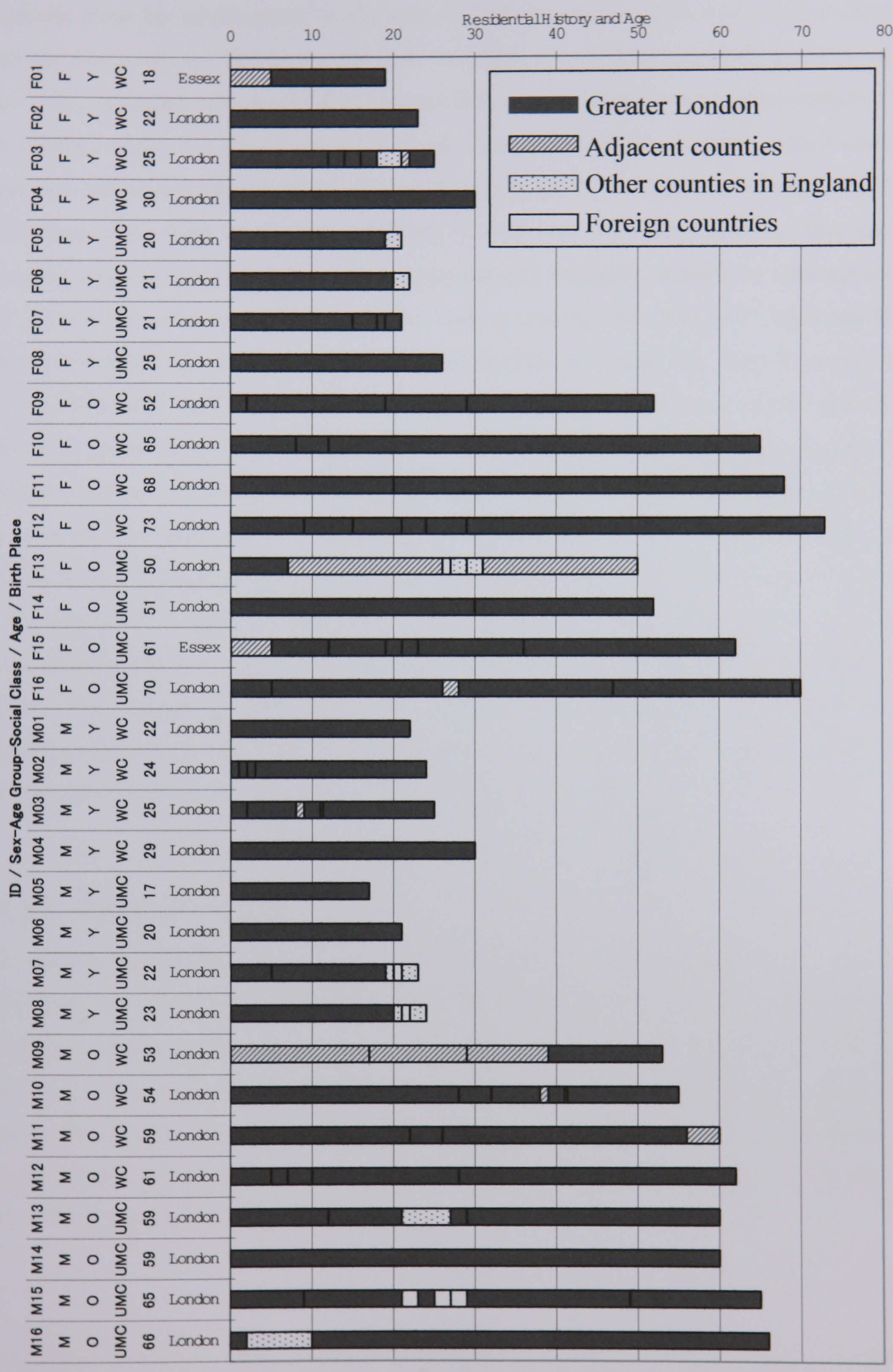


Figure 6 Speakers' residential information

mechanic since his adolescence. In the case of F13, she had lived in East London (Redbridge) until she was seven and had afterwards lived in Loughton and Buckhurst Hill in Essex, which are near to the boundary with Redbridge. On top of this, she had spent substantial period of time in the central London for her job as a TV (news) presenter/producer at BBC, which enhanced to make me believe her speech should be a certain type of RP. In addition, she had also lived in other parts of England (i.e. Leeds, Bradford, Norfolk and Cambridgeshire) for four years after spending a year in the USA for her postgraduate degree. Similarly, there were other speakers who had spent a few years outside of London for various reasons. F05, F06, M07, M08 and M13 had spent a few years for their university education outside of London, i.e. West Yorkshire (Leeds) for F05, F06, M07 and M08 and Bedfordshire (Luton) for M13; in the case of M07 and M08, they also spent a year abroad (i.e. in Japan for M07 and in Russia for M08) during their courses. F03 had lived in Hull for a few years for her job, and M10 and M34 had lived abroad (i.e. in Australia for M10 and in Africa for M34) for their own jobs; M03, the son of M10, had also lived in Australia. M35 had spent eight years of his childhood (from age 2 to 10) in other counties (mainly in Cambridgeshire) where he had been evacuated during the war. In the case of F16 and M11, although they had been living in London for most of their lives, F16 had lived in Buckhurst Hill in Essex for two years in her 20s and M11 had lived in Witham in Essex for the last four years. Despite all these subtle residential diversity, all the speakers will be treated as 'Londoners' for the purposes of the current study.

5.2.2.3 Social correlation

In considering the social background of the subjects, it should be duly noted how I gathered the informants in Leeds and London. Because of the limited period available for collecting data in practice, I made use of various means. Apart from some advertisements and fliers at both the University of London and the University of Leeds, I made use of the well established social network through my own friends in London and Leeds, some Rotary Clubs[41] in London and the acquaintances I got to know through the project with the 'snow-ball' technique (Milroy & Gordon 2003: 32) as mentioned earlier (§5.2.2).

[41] The members of Rotary Clubs of an international organisation Rotary International, know as 'Rotarians', are business and professional leaders who aim to provide humanitarian service, encourage high ethical standards in all vocations, and help build goodwill and peace in the world. Their motto is 'Service above Self'. For these unique characteristics, many of the Rotarians were expected to be on the upper-side of the social scale.

Most of the speakers were introduced by the speakers I had known or interviewed beforehand and the social network was put to good use. For this reason, some speakers were related to each other (e.g. marital relation, parent-child relation, or kinship), some were acquainted with each other (e.g. colleagues, friends, neighbours etc), and some were from the same community (e.g. church, worksite, school etc). The correlation chart of the speakers is diagrammed in Figure 7 in which speakers IDs starting with F or M in bold are the selected 32 speakers in this study:

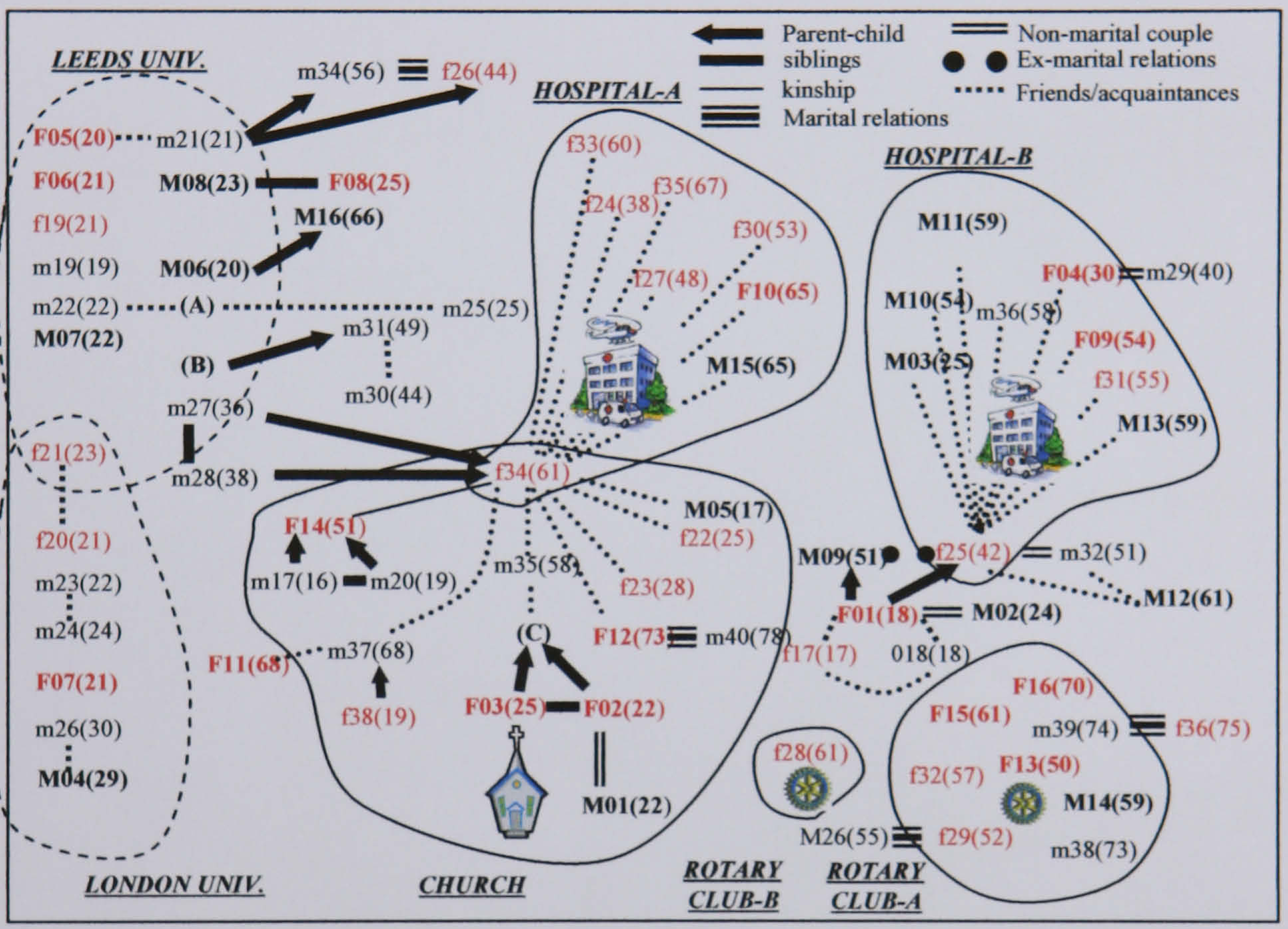


Figure 7 Correlation chart between speakers and their age in parentheses

The use of social network turns out to have important consequences for collecting data from several groups of people with a similar social background in terms of their jobs, education, religious or social activities. This was particularly achieved not only by the great cooperation of some key persons (e.g. f25 and f34) who introduced a number of their friends and/or colleagues but also the full support of a few Rotary Clubs in London.

Consequently, I could obtain roughly seven social groups that most of the speakers belong to, and an additional one group for the people who do not directly belong to any one of the seven. Those groups are:

(1) Church in North London,
(2) Hospital-(A) in North London
(3) Hospital-(B) in East London

(4) Rotary Club-(A) in East London,
(5) Rotary Club-(B) in East London
(6) University of London
(7) University of Leeds
(8) Others

The detail of how I contacted with each speaker and the information of the correlation between speakers are shown in the Table 6:

Table 6 Contact detail with each speaker and the information of the correlation between speakers

ID	Contact Detail	Through/Introduced by	Community Number	Correlation with other speakers
F01	1st contact acquainted	London	8	M09 and f25's daughter, M02's fiancée, friend of f17 & m18
F02	2nd contact	by m35	8	(C)'s daughter, F03's sister, M01's girlfriend
F03	2nd contact	by f34	8	(C)'s daughter, F02's sister
F04	2nd contact	by f25	3	f29's partner, f25's colleague
F05	1st contact acquainted	Leeds Uni	7	m21's friend
F06	1st contact acquainted	Leeds Uni	7	
F07	1st contact non-acquainted	London Uni Ad	8	
F08	2nd contact	by M08	8	M08's sister
F09	2nd contact	by f25	3	f25's colleague
F10	2nd contact	by f34	2	f34's colleague
F11	2nd contact	by m37	8	m37's neighbour
F12	2nd contact	by f34	1	f34's friend, m40's wife
F13	1st contact non-acquainted	London RC-A	4	
F14	2nd contact	by f34	8	mother of m17&m20, relative of f34&m27&m28
F15	1st contact non-acquainted	London RC-A	4	
F16	1st contact non-acquainted	London RC-A	4	
f17	2nd contact	by F01	8	friend of F01 & m18
f18	2nd contact	by m37	1	m37's daughter
f19	1st contact non-acquainted	Leeds Uni	7	
f20	2nd contact	by f21	6	f21's friend
f21	1st contact acquainted	Leeds Uni/London Uni	6 7	f20's friend
f22	2nd contact	by f34	1	f34's friend
f23	2nd contact	by f34	1	f34's friend
f24	2nd contact	by f34	2	f34's friend
f25	1st contact acquainted	London	3	F01's mother, m32's partner, M09's ex-wife, colleague of M03&M10&m36&M11&M13&F04&F09&f31
f26	2nd contact	by m21	8	m21's mother, m34's wife
f27	2nd contact	by f34	2	f34's colleague
f28	1st contact non-acquainted	London RC-B	5	
f29	1st contact non-acquainted	London RC-A	4	m33's wife
f30	2nd contact	by f34	2	f34's colleague
f31	2nd contact	by f25	3	f25's colleague
f32	2nd contact	London RC-A	4	
f33	2nd contact	by f34	2	f34's colleague
f34	2nd contact	by m27	1 2	mother of m27&m28, relative of F14&m17&m20, friend of M05&m35&m27&m40&f22&f23&F12, colleague of M15&f24&f27&f30&f33&F10&f35
f35	2nd contact	by f34	2	f34's colleague
f36	2nd contact	by m37	8	m39's wife
M01	2nd contact	by F02	8	F02's boyfriend
M02	2nd contact	by F01	8	F01's fiancé
M03	2nd contact	by f25	3	M10's son, f25's colleague
M04	2nd contact	by m26	6	m26's friend
M05	2nd contact	by f34	1	f34's friend
M06	1st contact acquainted	Leeds Uni	7	M16's son
M07	1st contact non-acquainted	Leeds Uni	7	(B)'s friend
M08	1st contact acquainted	Leeds Uni	7	F08's brother
M09	1st contact acquainted	London	8	F01's father, f25's ex-husband
M10	2nd contact	by f25	3	M03's father, f25's colleague
M11	2nd contact	by f25	3	f25's colleague
M12	2nd contact	by f25	8	neighbour of m32&f25
M13	2nd contact	by f25	3	f25's colleague
M14	1st contact non-acquainted	London RC-A	4	
M15	2nd contact	by f34	2	f34's colleague
M16	2nd contact	by M06	8	M06's father
m17	2nd contact	by F14	8	F14's son, m20's brother, relative of m27&m28&f34
m18	2nd contact	by F01	8	friend of f17&F01
m19	1st contact acquainted	Leeds Uni	7	
m20	2nd contact	by F14	8	F14's son, m17's brother, relative of m27&m28&f34
m21	1st contact acquainted	Leeds Uni	7	son of m34&f26, F05's friend
m22	2nd contact	by (A)	7	(A)'s friend
m23	1st contact acquainted	London	8	m24's friend
m24	1st contact acquainted	London	8	m23's friend

m25	2nd contact	by (A)	8	(A)'s friend
m26	1st contact non-acquainted	London Uni	6	M04's friend
m27	1st contact acquainted	Leeds Uni	7	f34's son, m28's brother, relative of relative of F14&m17&m20
m28	2nd contact	by m27	8	f34's son, m27's brother, relative of relative of F14&m17&m20
m29	2nd contact	by F04	8	F04's partner
m30	2nd contact	by (B)	8	m31's friend
m31	2nd contact	by m30	8	(B)'s father, m30's friend, relative of F14&m17&m20
m32	1st contact acquainted	London	8	f25's partner
m33	2nd contact	by f29	8	f29's husband
m34	2nd contact	by m21	8	m21's father, f26's husband
m35	2nd contact	by f34	1	f34's friend, (C)'s friend
m36	2nd contact	by f25	3	f25's colleague
m37	2nd contact	by f34	1	f18's father, f34's friend, F11's neighbour
m38	1st contact non-acquainted	London RC-A	4	
m39	1st contact non-acquainted	London RC-A	4	
m40	2nd contact	by f34	1	f34's friend, F12's husband

The leftmost column tells contact detail of each speaker; '1st contact acquainted' indicates the speaker already acquainted and asked directly to cooperate on the project, '1st contact non-acquainted' speaker who was a total stranger before but I could contact through some kind of medium such as a want ad at any university or any Rotary Club which I asked for a favour, and '2nd contact' the speaker who was introduced by any other speaker or my acquaintances. The next column indicates through what medium or where the speaker was found if he/she was acquainted, or by whom he/she was introduced otherwise. The numbers in the column of 'Community numbers' correspond to the numbers of the above-mentioned groups. The rightmost column shows clearly-known correlation with other speakers. This information, however, is not used in this research.

5.2.2.4 Social class classification

Because of the widespread disagreement existing among sociologists with regard to the nature of social class, it is hardly surprising that sociolinguistic surveys have used different methods for determining social class (Macaulay 1977: 57). As have been reviewed earlier in the §3.3.3, however, occupation seems to always play an important role in deciding people's social class. Therefore, in this study, all the speakers were classified into social classes according to their or their parent's occupation. In order to do this, it was necessary to devise a set of criteria for ranking individuals.

5.2.2.4.1 Classification of speakers

Recalling earlier reviews of the past studies (§3.3.3.2), like Macaulay's, I will rely on occupation alone as a class indicator, while unlike Macaulay's, I will use not only the discrete national occupational classification (SOC, the Standard Occupational Classification), but also the continuous Cambridge Scales – collectively referred to as *CAMSIS: Social interaction and Stratification Scale* (Prandy 2000). Table 7 shows the categories of Social Class based on Occupation (SOC):

Table 7 The categories of Social Class based on Occupation (SOC) (From Occupational Information Unit, Office for National Statistics 2001)

I	Professional, etc. occupations
II	Managerial and Technical occupations
III	Skilled occupations
	(N) non-manual
	(M) manual
IV	Partly skilled occupations
V	Unskilled occupations

If we compare these categories with those of Macaulay (1976) in Table 3, the categories I and II (Professional, managerial and technical occupations) are presumably equivalent to Macaulay's highest social class *I*, the category IIIN (skilled non-manual occupations) to Macaulay's *IIa*, the category IIIM (skilled manual occupations) to Macaulay's *IIb*, and the categories IV and V (partly skilled/unskilled occupations) to Macaulay's lowest social class *III*. It was decided here, however, to classify not into four but three social classes, with the lower three categories of SOC being together as the lowest social class. Consequently, in this study, the SOC categories I and II (professional, managerial and technical occupations) are considered as the highest social class, UMC (upper middle class), the category IIIN (skilled non-manual occupations) as LMS (lower middle class), and the categories IIIM, IV, and V (skilled manual, partly skilled/unskilled occupations) as the lowest social class, WC (working class). Similarly, following Fabricius (2000), it was decided that people with an occupational basic group score above 60 (see footnote 24) should be regarded as the highest social class, i.e. UMC. Both classifications, however, do not always match. For example, a job item {Nurses} (SOC-No. 340) is categorised into the category II in SOC, which should be considered as UMC; in the Cambridge Scales, however, {Nurses} is assigned the basic group score 34.84, which should probably be considered LMC. Because of this discrepancy, in this study, each speaker will be classified into one of the following three social classes, *i-iii*, in accordance with the combined criteria of SOC and the basic group scores of the Cambridge Scales. This combined social classification scheme is tabulated in Table 8 below:

Table 8 Social class divisions based on the combination of SOC and Cambridge Scales

	Social Classes	SOC	Basic Group Scores from Cambridge Scales (Prandy 1992)
i.	UMC: Upper Middle Class	I	(any score)
		II	over 60
ii.	LMC: Lower Middle Class	II	below 60
		IIIN	(any score)
iii.	WC: Working Class	IIIM	(any score)
		IV	(any score)
		V	(any score)

All the occupations categorised as the SOC 1990 Unit Group I (Professional, etc. Occupations) are regarded as the UMC. The division between the UMC and the LMC was loosely made by the threshold of the basic score 60 within the SOC Group II (Managerial and Technical Occupations) due to the above-mentioned discrepancy. The division between the LMC and the WC was made between non-manual occupations (IIIN: Skilled occupations – Non-manual) and manual occupations (IIIM: Skilled occupations – Manual) as applied in Macaulay (Macaulay 1976: 174 and also see §3.3.3.2 above). All the occupations categorised as the SOC Unit Groups IV (Partly skilled occupations) and V (Unskilled occupations) are considered as the WC. Moreover, in addition to the SOC Unit Groups and the basic scores for the Cambridge Scale, the UK version of the *Cambridge Social Interaction and Stratification* (CAMSIS) scores was taken into account to bolster the speakers' relative positions within the order of social interaction and stratification (Prandy 2000, Lambert 2007). According to Lambert (2002), '[t]he CAMSIS scale scores represent an occupational unit's relative position within the national order of social interaction and stratification' with optional fine employment status distinctions. The UK version of the scale provides the following eight employment status categories to choose: 0 (missing), 1 (self-employed with 25 or more employees), 2 (self-employed with fewer than 25 employees), 3 (self-employed without employees), 4&5 (manager of large/small establishment), 6 (supervisor), 7 (Employee) (Prandy 2002). Because of the insufficient information regarding employment status, however, the mean male scores of each job title (i.e. the score with employment status category '0: missing') were used. Furthermore, the scales are derived within the context of gender groupings so that the analysis of social stratification through occupations graded by the CAMSIS measure seems appropriate within gender groups (Lambert 2002). However, it is suggested to use the scores on the scale derived solely for male occupations for the case that a mixed gender population is investigated. Since the current study deals with mixed genders, the male CAMSIS scores were used for both male and female speakers.

First of all, all of the speaker's self-declared own occupations, parents' occupations, and/or spouses' occupations were all assigned to any one of the occupation titles on the list of SOC90. Classification into social classes is made based on (1) his/her own main full-time occupation for older speakers, (2) his/her spouse's occupation if it is a recent full-time career and ranked higher than their own occupation, or (3) his/her parent's full-time occupation for young speakers. The detailed procedure for selecting SOC-90 occupational title matched with the self-declared title of each speaker was as follows:

1. The self-declared job-title was input in Cascot (cf. footnote 23 above), a free online tool on http://www2.warwick.ac.uk/fac/soc/ier/publications/software/cascot/choose_classification/, in order to look for a 4 digit code for the corresponding group title in SOC2000.
2. In the case that the Cascot provided more than one code and it was not sure which one to choose, job descriptions for the potential group titles were referred in "SOC 2000 Vol.1 Structure and descriptions of unit groups" (Office for National Statistics 2000) in order to select one closest to the speaker's self-declared job.
3. With the selected 4 digit code, a corresponding 3 digit SOC 1990 ID for the SOC90 was looked for in "SOC 2000 Vol2 The coding index" (Office for National Statistics 2000).
4. With the 3 digit ID, a basic group score for the Cambridge Scale was obtained from Prandy (1992: 15-25).
5. Finally with the 3 digit ID, a CAMSIS score and the social class classification (I–V) were obtained from the excel/SPSS file called "gb91soc90.por" or "gb91soc90.sav (Prandy & Lambert 2004) and the "OOSS User Guide 1990: 07, Social Class based on Occupation: Definition in Terms of Standard Occupational Classification 1990 (SOC 1990) Unit Groups and Employment Status" (Office for National Statistics 2001) respectively.

Prior to the selection of speakers for this study, all the initial 76 speakers were given one of the SOC Unit Groups, the basic group score of the Cambridge Scale, and the CAMSIS score. Finally, for the purpose of selecting equal numbers of WC and UMC speakers (cf. §2.4) from the samples, the final 32 speakers who matched other social and regional criteria were selected both from the lower end of the scale and from the higher end of the scale for the current study. All the sixteen speakers from the lower end of the scale turned out to be WC, while most of the other half of the speakers from the higher end of the scale fell into the UMC category. The exceptions were found only for three female speakers (i.e. F05, F13 and F14) from the upper end of the scale, whose basic group scores of the Cambridge Scale were slightly lower than the highest threshold score 60 (i.e. 58.42, 54.18 and 53.73 respectively) with the SOC Unit Group II as can be seen in Table 9 below:

Table 9 Speakers' own/spouse's/parent's occupational information and their social classes with SOC categories and CAMSIS scores (with selected occupations in bold letters)

Social Class	Age group	ID	Self-declared job title in questionnaire [& interviews] - F: Father's, M: Mother's, O: Own, S: Spouse's	SOC-90 label[42]	SOC	CASOC basic scores	CAMSIS scores (male mean)
WC	Y	F01	F: Car Mechanic [car repairer]	*540 Motor mechanics, auto engineers (inc. road patrol engine	III M	21.15	43.3
			M: Ambulance driver	**642 Ambulance staff**	III M	**25.83**	**46.6**
WC	Y	F02	**F: Bus driver for school**	***873 Bus and coach drivers**	III M	**14.20**	**35.1**
			M: Part-timer (Administrator for school)	420 Filing, computer and other records clerks (inc. legal conveyancing)	III N	26.74	50.6
WC	Y	F03	**F: Bus driver for school**	***873 Bus and coach drivers**	III M	**14.2**	**35.1**
			M: Part-timer (Administrator for school)	420 Filing, computer and other records clerks (inc. legal conveyancing)	III N	26.74	50.6
WC	Y	F04	F: [Dec] **Engineer**	***516 Metal working production and maintenance fitters**	III M	**23.28**	**41.2**
			M: part-time carer [before]	*644 Care assistants and attendants old	IV	18.89	43.5
WC	O	F09	**O: Ambulance support assistant**	**642 Ambulance staff**	III M	**25.40**	**46.6**
WC	O	F10	O: [Rtd- long time ago] Office work - shipping office	430 Clerks (n.o.s.)	III N	26.74 36.32	51.9
			S: Building worker	***509 Other construction trades n.e.c. building**	IV	**9.67**	**38.4**
WC	O	F11	O: [Rtd- long time ago] BT Operator(Telephonist)	*462 Telephone operators exchange	IV	33.48	49.3
			S: [London] Taxi Driver	***874 Taxi, cab drivers and chauffeurs**	III M	**17.3**	**42.3**
WC	O	F12	Own: [Rtd-long time ago] Window Dresser	*556 Tailors, dressmakers	III M	29.18	44.9
			S: Taxi Driver	***874 Taxi, cab drivers and chauffeurs**	III M	**17.3**	**42.3**
WC	Y	M01	**F: Painter [and decorator for council]**	***507 Painters and decorators**	III M	**10.81**	**38.8**
			M: Administrator [for NHS Hospital as a ward administrator, part-time]	420 Filing, computer and other records clerks (inc. legal conveyancing)	III N	26.74	50.6
WC	Y	M02	**F: has own business [roofer]**	***501 Roofers, slaters, tilers, sheeters, cladders**	IV	**14.98**	**34.2**
			M: help for husband [roofer]	*501 Roofers, slaters, tilers, sheeters, cladders	IV	14.98	34.2
WC	Y	M03	**F: Ambulance Personnel [ambulance driver]**	**642 Ambulance staff**	III M	**25.83**	**46.6**
			M: Ambulance Personnel [ambulance driver]	**642 Ambulance staff**	III M	**25.83**	**46.6**

[42] An asterisk (*) before the label indicates there are more than two different scores for the label depending on the employment status.

WC	Y	M04	**F: Builder**	***504 Builders, building contractors**	III M	**29.22**	**46.5**
			M: Catering business	*953 Counterhands, catering assistants help	IV	16.76	48.3
WC	O	M09	**O: car repairer**	***540 Motor mechanics, auto engineers (inc. road patrol engine**	III M	**21.15**	**43.3**
WC	O	M10	**O: Ambulance man [driver]**	**642 Ambulance staff**	III M	**25.83**	**46.6**
WC	O	M11	**O: Ambulance Driver [semi-retired**]**	**642 Ambulance staff**	III M	**25.83**	**46.6**
WC	O	M12	**O: London Cab Driver**	***874 Taxi, cab drivers and chauffeurs**	III M	**17.3**	**42.3**
			S: Housewife				
UMC	Y	F05	F: Psychiatric nurse	340 Nurses	II	34.84	52.4
			M: Manager of a residential home for the elderly	**102 Local government officers (administrative and executive**	II	**58.42**	**70.7**
UMC	Y	F06	**F: Lawyer [Solicitor]**	**242 Solicitors public**	I	**73.51**	**85.2**
			M: Health Admin	430 Clerks (n.o.s.)	III N	26.74 36.32	51.9
UMC	Y	F07	**F: Professor of Statistics**	**230 University and polytechnic teaching professionals**	I	**85.04**	**82.3**
			M: Solicitor	242 Solicitors public	I	73.51	85.2
UMC	Y	F08	**F: Doctor (Oncologist)**	**220 Medical practitioners**	I	**85.02**	**87.4**
			M: Doctor (General Practitioner)	**220 Medical practitioners**	I	**85.02**	**87.4**
UMC	O	F13	**O: TV presenter/producer**	**384 Actors, entertainers, stage managers, producers and directors**	II	**54.18**	**70.7**
UMC	O	F14	**O: Inspector of Taxes**	**362 Taxation experts**	II	**53.73**	**67.8**
UMC	O	F15	**O: Estate Agent**	**170 Property and estate managers**	II	**60.74**	**68.5**
			S: [Rtd printer on Newspaper printing]	891 Printing machine minders and assistants	III M	21.35	44.9
UMC	O	F16	**O: Solicitor**	**242 Solicitors public**	I	**73.51**	**85.2**
			S: [Taxi driver]	*874 Taxi, cab drivers and chauffeurs	III M	17.3	42.3
UMC	Y	M05	**F: Teacher in a private secondary school**	**233 Secondary (and middle school deemed secondary) education**	II	**80.03**	**70.9**
			M: Head teacher in a state primary school	234 Primary (and middle school deemed primary) and nursery e	II	65.06	65.5
UMC	Y	M06	**F: (Rtd) Journalist**	**380 Authors, writers, journalists**	II	**62.12**	**75.8**
			M: Airline worker	630 Travel and flight attendants	III M	27.90	52.2
UMC	Y	M107	**F: Lawyer**	**242 Solicitors public**	I	**73.51**	**85.2**
			M: (Rtd) Nurse	340 Nurses	II	34.84	52.4
UMC	Y	M108	**F: Doctor [Oncologist]**	**220 Medical practitioners**	I	**85.02**	**87.4**
			M: Doctor [General Practitioner]	**220 Medical practitioners**	I	**85.02**	**87.4**

UMC	O	M13	**O: (Rtd) Math Teacher at a lower secondary school [Present] Part-time Ambulance Care Assistant**	**233 Secondary (and middle school deemed secondary) education**	II	**75.7**	**70.9**
			S: Teacher [at nursery school]	234 Primary (and middle school deemed primary) and nursery education teaching professionals	II	65.06	65.5
UMC	O	M14	**O: Certified Accountant**	**250 Chartered and certified accountants**	I	**60.18**	**72.5**
			S: (Dec)Legal Secretary [full-time before marriage, part-time afterwards]	451 Legal secretaries	III N	47.22	62.6
UMC	O	M15	**O: (Rtd)Scientist at Botanic Garden for 30yrs**	**201 Biological scientists and biochemists**	I	**72.02**	**74.7**
UMC	O	M16	**O: Technical Journalist**	**380 Authors, writers, journalists**	II	**62.12**	**75.8**
			S: Passenger handling for Airline at an airport	630 Travel and flight attendants	III M	27.90	52.2

The table provides detailed information of the speakers' own and spouse's (if applicable) occupations (for the old speakers) and information of speakers' parents' occupations (for the young speakers), their allocated SOC job labels and categories, the basic group scores of the Cambridge Scale, UK employment status categories, and the CAMSIS scores. Their selected jobs and Cambridge Scale scores are in bold.

Returning to the three upper-end female speakers with the basic group scores under 60, Table 9 shows that their CAMSIS scores are 70.07 (F05), 70.7 (F13) and 67.8 (F14) respectively. Given that the CAMSIS score for F15, who is categorised into the UMC, is 68.5, these scores should be high enough to be considered the same as F15's class. As agreed among sociolinguists, the social stratification in western industrial societies such as Britain is rather continuous so that the class division is unlikely to be discrete in reality but is rather ambiguous. The point here is, as discussed earlier in §3.3.3.2, that it is sensible to interpret social classes in terms of central characteristics rather than peripheral ones (Hudson 2001: 187, Chambers 1995: 38). For this reason, all the three female speakers were classed as UMC speakers in this study.

5.2.3 Materials

Three kinds of speech style were elicited from the subjects; this is because, as discussed earlier (§3.3.4), stylistic variation often operates along the same scale as social class differences in speech, and also reflects differences in the social context in which a speaker finds him- or herself interacting at a given time. The three kinds of speech style were: interview style (IS), reading-passage style (RPS), and word-list style (WLS). Each session was divided into roughly four sections: (1) interview section, (2) reading-passage section, (3) word-list reading section, and (4) questionnaire writing section.

For each vowel, 18~20 tokens in the three different speech styles (IS, RPS and WLS) were selected. Referring to Labov (2001: 155), the phonological environments in which the selected target vowels occur were restricted; target vowels occurred in the stressed syllable of a content word, but not in a syllable with initial-glide (e.g. 'yet', 'wagon', 'one'), initial consonant clusters of obstruent + liquid (e.g. 'president', 'flat', 'front'), or liquid-final ('tell', 'marry', 'Surrey') since locating vowel boundaries is more difficult in these environments. Due to these restrictions, it was not always possible to find 20 tokens for some vowels of some speakers.

The total number of tokens investigated was 5688, calculated by 18~20 tokens for each variable x 3 linguistic variables x 3 speech styles x 32 speakers (Table 7)[43].

Table 10 The number of tokens of three vowels in three speech styles for investigation

			DRESS			TRAP			STRUT			*Sub-*
Age	Class	ID	IS	RPS	WLS	IS	RPS	WLS	IS	RPS	WLS	*total*
Young	WC	F01	19	20	20	20	20	20	20	20	20	*179*
		F02	20	20	20	20	20	20	18	18	20	*176*
		F03	20	20	20	20	20	19	20	19	20	*178*
		F04	20	20	20	20	20	19	19	19	20	*177*
	UMC	F05	20	20	20	20	20	20	20	19	20	*179*
		F06	20	20	20	19	20	20	20	19	20	*178*
		F07	19	20	20	18	20	20	20	18	20	*175*
		F08	20	20	20	20	20	20	20	18	19	*177*
Old	WC	F09	20	20	20	20	20	20	20	19	20	*179*
		F10	20	20	20	20	20	20	20	18	20	*178*
		F11	20	20	19	19	19	20	20	19	20	*176*
		F12	20	20	20	20	20	19	20	20	20	*179*
	UMC	F13	20	20	20	20	20	20	20	18	20	*178*
		F14	20	20	19	20	20	20	20	19	20	*178*
		F15	20	20	20	20	20	20	20	19	20	*179*
		F16	20	20	20	20	20	20	20	19	20	*179*
Young	WC	M01	20	20	20	20	20	20	20	18	20	*178*
		M02	20	20	19	20	20	20	20	18	20	*177*
		M03	19	20	20	20	20	20	20	18	20	*177*
		M04	20	20	20	20	20	20	20	18	20	*178*
	UMC	M05	19	20	19	20	20	20	20	18	20	*176*
		M06	20	20	19	20	20	20	20	19	20	*178*
		M07	18	20	20	20	20	20	20	19	20	*177*
		M08	20	20	20	20	20	20	20	19	20	*179*
Old	WC	M09	20	20	20	20	20	20	20	18	20	*178*
		M10	20	20	20	20	20	20	20	18	20	*178*
		M11	20	20	19	20	20	20	20	19	20	*178*
		M12	20	20	20	20	20	20	20	18	20	*178*
	UMC	M13	20	20	19	20	20	20	20	18	20	*177*
		M14	20	20	20	20	20	20	20	19	20	*179*
		M15	20	20	20	20	20	20	20	18	19	*177*
		M16	20	20	20	20	20	20	20	18	20	*178*
Sub- total			*634*	*640*	*633*	*636*	*639*	*637*	*637*	*594*	*638*	***Total***
			1907			*1912*			*1869*			***5688***

43 Apart from these 5688 tokens of DRESS, TRAP and STRUT, additional 640 tokens for KIT and START were also measured for the purpose of vowel normalisation procedure which will be detailed below (§5.2.6).

5.2.3.1 Interview section for the Interview Style (IS)

The first interview section is subdivided further into two parts: a question-and-answer part and a picture-interpretation part. In the former, each speaker was asked questions mainly on personal factual data (i.e. birth place, residential history, educational history, parental and family information, etc) and some more general questions mainly based on the interview protocol (Appendix 2). In the latter, each speaker was presented with ten drawings extracted from a picture book called *Where's Wally?* (Handford 1997), and asked to answer a number of questions about each of them (Appendix 3). The questions were designed to elicit key words containing the target vowels. The more details for this section will be discussed below (§5.2.4).

5.2.3.2 Reading-passage section for Reading-Passage Style (RPS)

In the RPS section, each speaker was asked to read aloud a prepared story passage (Appendix 4). The passage was originally created by the author in order to include the key words providing all the three target phonological variables (i.e. DRESS, TRAP and STRUT vowels), each of which was designed to have at least 29 tokens in total as follows:

Table 11 Target words and their phonological variables in Reading-Passage

	DRESS				TRAP					STRUT		
1	heading	get	remembered	any	having	bass	that	catch	bass	Sunday	honey	country
2	ten	Betty	tremendously	protective	ham	catch	tactful	began	hand	sun	love	just
3	ten	then	many	left	catch	tackle	act	catch	bass	couples	love	recover
4	many	special	get	special	bass	happy	that	bass	stand	hunch	nothing	become
5	except	every	less	unforgettable	atmosphere	Hatty	began	bass	bass	tugged	touched	other
6	get	getting	end	best	anglers	happy	that	fact	that	tough	covered	tugging
7	set	nevertheless	everyone	legendary	families	have	hand	catch		just	tugging	cut
8	ahead	never	legend	ever	that	happy	bass	bass		hundred	tug	hunkered
9	set	bent	everything		catch	Cathy	catches	perhaps		hundred	suddenly	covered
10	best	never	many		bass	tad	family	bass		suddenly	someone	

5.2.3.3 Word-list section for Word-List Style (WLS)

In the WLS section, each speaker was asked to read aloud a prepared list of words in controlled phonological environments where most of them had initial /t/ or /h/ with one of DRESS, TRAP and STRUT vowels in primary stressed syllables followed by an alveolar/postalveolar consonant (i.e. /t/, /tʃ/, /d/, /n/, /s/, /ʃ/ and /z/). All the words were embedded in the carrier phrase "Say ____ again". Table 12 shows the target words in the word-list, with the phonological environments.

Table 12 Target words in a word-list with the detail of the phonological environments

Begin with:	Followed by:					No. of tokens
	/-t/ “/-tʃ/	/-d/	/-n/	/-s/ “/-ʃ/	/-z/ “/-s/	
/ hʌ- /	hut	huddle	hunt	hustle	husband	
	hut	huddle	hunch	huss	husband	/ʌ/=10
/ tʌ- /	tut	(study)	ton	tusk	tuzzy	
	(stutter)	(studhorse)	tunnel	tux	tuzzy	/ʌ/=10
/ hæ- /	hat	had	hand	hassle	has-been	
	“hatch	haddock	handle	hasp	hazard	/æ/=10
/ tæ- /	tat	tad	tan	tass	fantasmo	
	(static)	tadpole	tantrum	tassel	phantasma	/æ/=10
/ hɛ- /	hetero	head	hen	hest	hesitate	
	heterosex	ahead	hence	hest	hesitant	/ɛ/=10
/ tɛ- /	Tetley	teddy bear	ten	test	“testable	
	tetrapod	ted	tent	testy	“testify	/ɛ/=10
					*tez	
					*tezzy	

The words with asterisk (*) are non-sense words, while those with quotation mark (“) indicate use of alternative sound as the following segment. The word-list was designed to provide at least 20 tokens for each vowel. The list also includes words for distraction. The list will be provided in Appendix 5.

5.2.3.4 Questionnaire-writing section

In the questionnaire-writing section, speakers were asked to answer a series of questions in order to sort the speakers into various groups. The questionnaire is divided into three sections: (1) personal information, (2) parents' and/or spouse's information and (3) language background and attitude. In the first section, the questions were mainly about their personal factual information such as birth place, residential history, and educational background, and/or occupation. In the second section, speakers were asked not only about their parental information, but also about their spouse's information if applicable. In the third section, they were questioned about their own language and social background as well as their attitudes to their own accent and the other accents, particularly RP, Cockney and Estuary English. In this study, however, language background and attitude will not be considered but left for the future research.

Prior to the questionnaire-writing, the statement of privacy sheet was given to each speaker asking for permission to use their data.

5.2.4 Recordings, procedure, and procedural notes

A SONY DAT Walkman model no. TCD-D100 was used for the recordings, with a SONY ECM-MS907 microphone and a Sony 60 minute DAT tape.

The recordings took place in Leeds and London. In the former case, all the recordings were carried out in a soundproof chamber of the Phonetics Laboratory in the Department of Linguistics & Phonetics of the University of Leeds. In the latter case, however, such a soundproof environment was not available. Nonetheless the main concern had always been that all recordings should take place in as quiet a place as possible for the sake of better recording quality for the later instrumental analysis. As a result, most of the interviews were conducted in the speakers' own houses or work places, most of which were quiet enough, apart from occasional unavoidable background noise.

While the care thus had to be taken for the better recording quality, further attention needed to be paid in aiming to obtain the target stylistic variations from each speaker. In order to elicit three kinds of speech styles from each subject, each interview session was conducted in the following order: interview section, reading-passage section, word-list section, and questionnaire-writing section. The reason for this order was to maximally prevent the speakers from being conscious to their own speech as well as from guessing particular linguistic/phonetic variables if they ever tried to do so. Moreover each interview section was preceded by a casual and friendly chatting with the interviewer before the session in order to make the following interview section as informal as possible.

First of all, in order to elicit Interview Style (IS), direct interview was conducted for at least 10-15 minutes for each subject, followed by the picture-interpretation part which normally took 5-10 minutes. The speaker was asked to read aloud a reading-passage once for Reading-Passage Style (RPS). Then, for Word-List Style (WLS), they were instructed to repeat the same sentence again if they misread it before having been asked to read out all the sentences in the word-list twice. At the end, they were asked to permit the current author to use their data on the Statement of Privacy form before filling in the form of questionnaire. All these procedure took approximately 40-50 minutes for each subject. Although all of the subjects were aware that I was interested in their speech, none of them knew and noticed that I was specifically interested in the target sounds in their speech. As a result I believe that their responses were as natural as possible in the circumstances.

There are, however, a few notes to be made in relation to the interview sessions.

First note is about the interviewer. All the interviews were carried out by myself. In almost all the interviews, I could feel I was favourably accepted by the speakers, although I was neither a

Londoner (i.e. 'insider' for them) nor English, but a foreigner whose native language was not even English. There could be a number of possible reasons for this acceptance. Firstly, since all the speakers were either already acquainted with me or introduced to me by their friends or family members, they seemed to regard me not as a total stranger but as either a friend or a 'welcome guest outsider'. Secondly, my status as a university student, socially something 'neutral', might have given them some sense of ease rather than feeling of tension. Thirdly, my great interest in London, especially Londoners, might have made a favourable impression on them. As a whole, I did not find any particular disadvantage in or significant consequence from having an outsider interviewer.

Secondly more details for the interview section should be discussed here. The main purpose in the section was to elicit a comparatively more casual and natural way of speaking. In other words, what the speaker said was not as important as how he/she spoke. Therefore, I occasionally changed the questions in the interview in response to the speakers' answers. Trudgill (1974: 53) describes the fieldwork interviews in his Norwich study as follows:

> Interviews were kept as informal as possible, and most were conducted sitting in armchairs in the informant's living room. The informant's family and friends were in most cases encouraged to remain present, if the informant wished them to do so. This increased the possibility of obtaining examples of casual speech [...].

Similarly, I tried to make the atmosphere of the interviews as informal and friendly as possible, and to make the speakers feel as relaxed as possible. The recordings took place in their own, parent's or partner's house (for 18 speakers), in their own office (for 6 speakers), in their university's classroom (for 2 speakers), in the interviewer's house (for 1 speaker), and in their university's phonetics laboratory (for 5 speakers). The last case probably deserves special mention since its setting is quite different from the other four settings. Despite its rather formal setting, however, the actual atmosphere of all the interviews in the phonetics laboratory seemed to be much less tense than it could possibly sound, but rather relaxing. There are two possible reasons for this. Firstly, all the five speakers had been acquainted with the interviewer; this could make them feel less uncomfortable even in such a rather unusual setting. Secondly, the four of them had in fact been previously interviewed by the same interviewer in the same setting for another project; therefore, it was believed that they had more confidence and comfort in being interviewed than for the first time, because, otherwise, they could have declined to be interviewed in the same situation again.

Moreover, the speaker's family and friends were encouraged to be present in the same room during the session if he/she preferred, but kindly asked to keep a substantial distance from the microphone and to avoid making noise in consideration of the recording quality. The allowance of the presence of the third person(s) during the interview was partially due to the same reason as described by Trudgill (1974), but mainly due to the intention to make the atmosphere of the interview as comfortable and relaxing for the speaker as possible. Although it is based purely on my speculation, the presence of their friends and family might have not only been of help to the speaker to feel more comfortable during the interview, but also increased the formality during the subsequent reading-passage and word-list sections due to his/her awareness of being monitored by more audience. In some cases, it seemed that those attendees helped elicit apparently more casual type of speech from the speaker. To make the stylistic variation consistent for all the speakers, however, the speaker's speech obtained through conversation directly with his/her attendee(s) was generally not used for analysis. As a whole, for the data analysed for this study, I did not observe any particular stylistic difference between those interviews with and without others present.

5.2.5 Data Analysis

All the target words were digitised onto the Praat speech analysis programme at a sampling rate of 22kHz. The frequencies of the first, second and third formants were measured for each vowel and the first two formants were only considered for the reason described below. Measurements were made with the formant tracker function; however, they were sometimes measured manually when it was necessary. The detailed measurement criteria will be discussed below.

There is a widespread agreement among phoneticians that formant analysis of vowels normally requires measurement of at least the first two formants (F1 and F2), and also the third formant if the vowels being investigated are r-coloured (Kent & Read 1992: 139, Hayward 2000: 166-167) or high front vowels (Ladefoged 2003: 105). In terms of the location of instrumental measurement of those formant frequencies, however, there seems no consensus among studies of vowels formant analysis. Instead, there are various ways from a simpler type of approach by taking a single point of the steady state over the vowel's spectrogram, to an elaborated type of analysis by taking different formant 'inflection' (Labov 1972: 29, cited in Docherty & Foulkes 1999: 52) depending on different sorts of vowels considering the nature of acoustic characteristics of each vowel.

One of rather complex but elaborated ways of selecting the point of measurement of a vowel is found in the project on Linguistic Change and Variation (so-called, LCV) – the investigation of sound changes in progress in Philadelphia – carried out by Labov and colleagues in the 1970s (from 1973 to 1977). It is reported that LCV takes the following procedure to select the point of measurement of the 'vowel nucleus' (Labov 2001: 155-6):

(a) If an F1 maximum appeared outside of a transition, it was selected.
(b) Within an F1 steady state, an F2 minimum or maximum was used to specify the nucleus more closely.
(c) For short syllables with no F1 maximum (like *pick*), a pitch period close to the center of the resonant portion was taken; always with the consideration that the nucleus must be approximately 40msec from the beginning of consonantal transitions. In such cases, the second resonant pitch period was generally selected for voiceless initials; with voiced initials, the third.
(d) For the raising and fronting of tensed short **a** in *man, bad,* etc., the F2 maximum is preferred to the F1 maximum since it corresponds better to the impression of the maximum height of the vowel.

A similar approach can be found in the studies of Harrington *et al.* (2000: 67). Their measurements of F1 and F2 are made at around the vowel's midpoint if there is a steady state of formants visible in the vowel's spectrogram. Otherwise, a point where formants show their maximum or minimum value is taken in consideration of the acoustic reflection to the articulatory location of vowels; that is, the F1 maximum for open vowels, F1 minimum for close vowels, F2 maximum for front vowels, and F2 minimum for back vowels. They also take account of an intensity peak to position the place of measurement when there is an evidence of the intensity peak during steady state.

This method sounds sensible if we are sure that 'open vowels' are actually realised as open, 'front vowels' as front, and 'back vowels' as back. In other words, if there is a possibility that one particular vowel, say a back vowel, is realised as a 'back' vowel in one speaker, but as a 'front' vowel in another speaker, taking measurement at F2 minimum does not necessarily characterise that particular vowel well enough for different speakers who potentially pronounce the vowel in a different way.

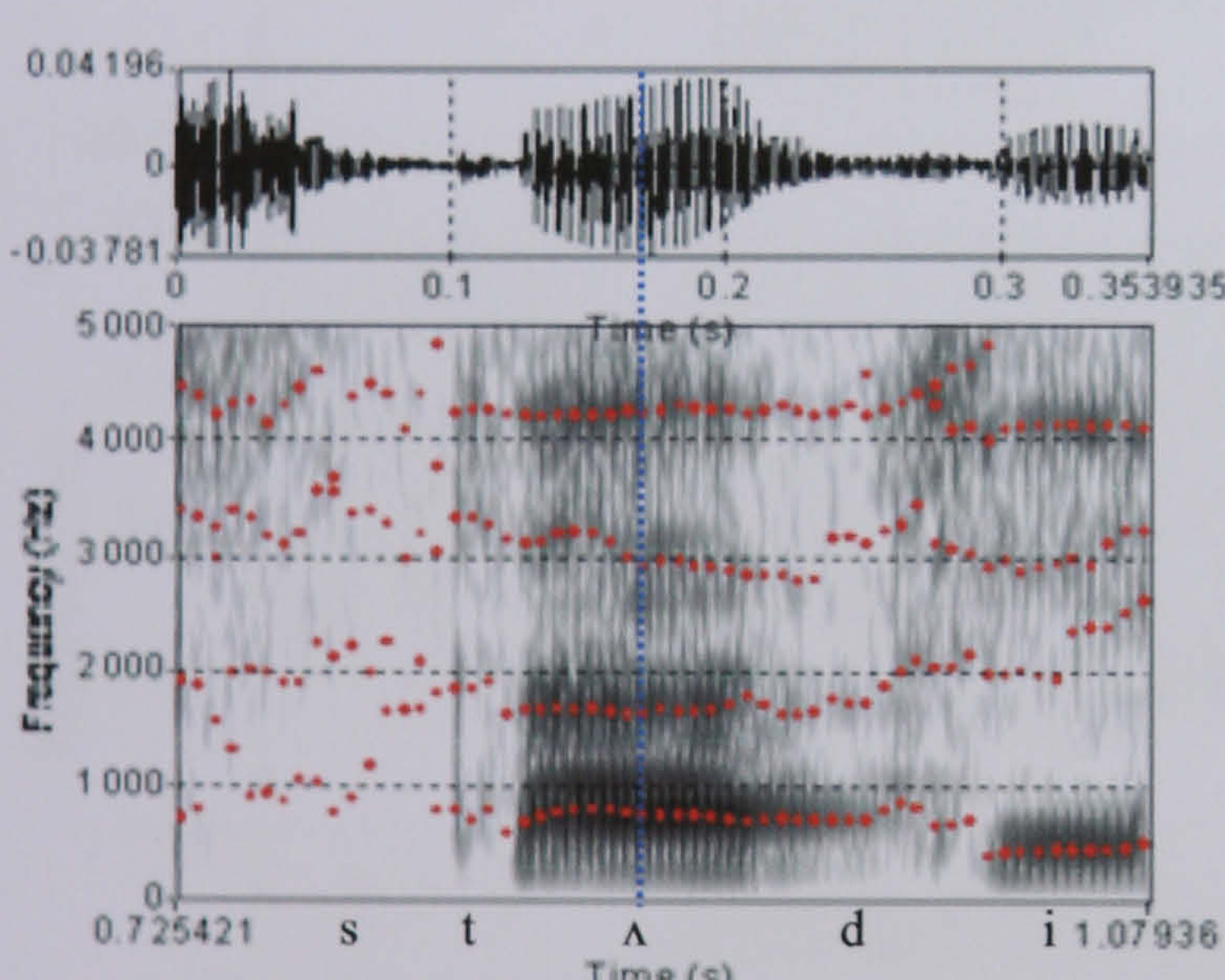
Considering the nature of the current study in which we expect one vowel to be more open or more front for some speakers in some speech styles than others, it may be safer not to apply this approach of measurement at a point where formants show their maximum 'inflection' to be consistent all the way through analysis for all the speakers. Instead, the following procedure to select the point of measurement of the vowel is used:

(1) If there is a visible steady state on a vowel's spectrogram, then the midpoint of the steady state is taken to reflect the central tendencies of vowels.

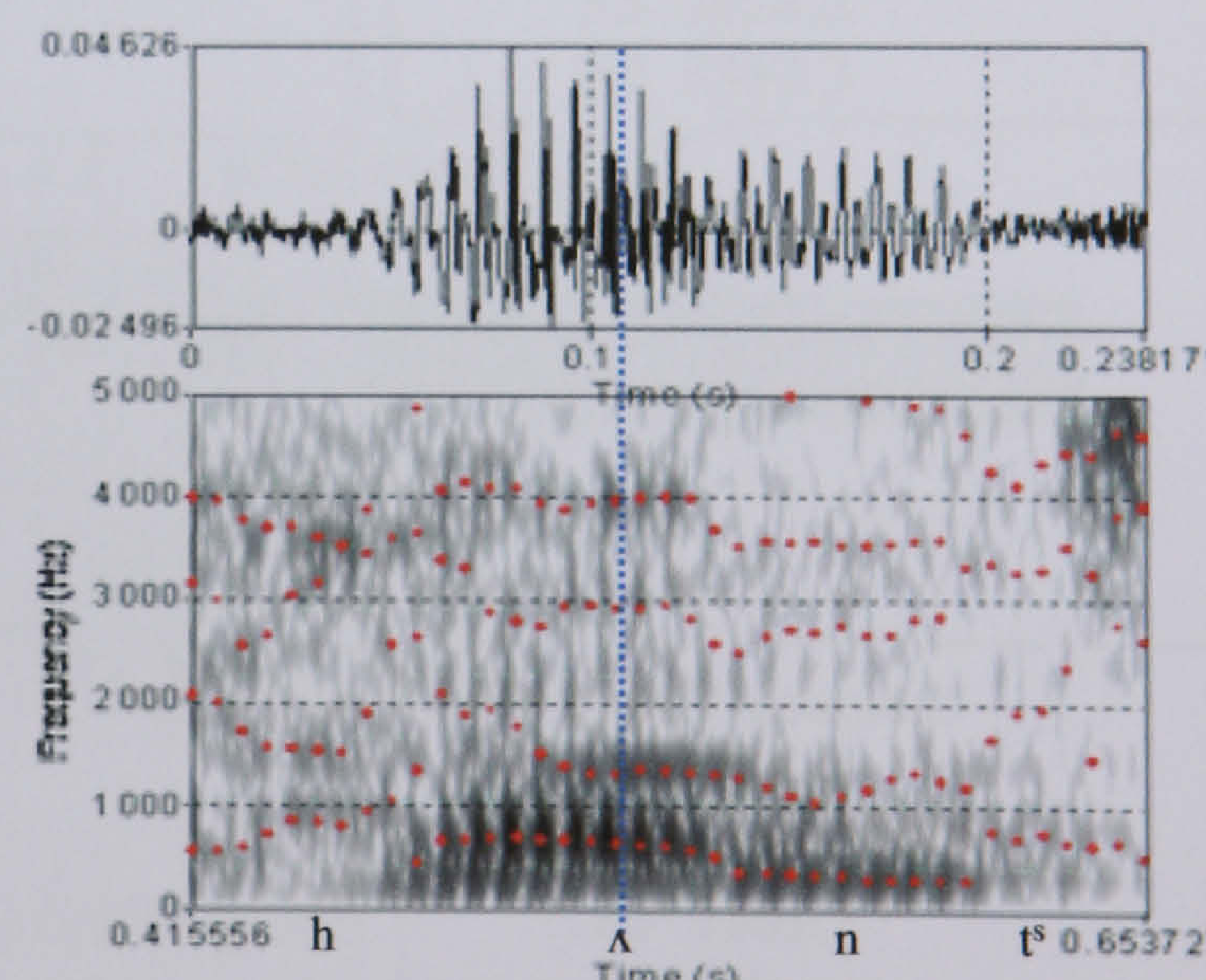
(2) If there is not such a steady state over a vowel's spectrogram, then the measurement is made at the midpoint of the whole vowel duration to maximally avoid consonantal transitions.
(3) If a vowel sounds noticeably a diphthongal realisation or the formants show evidence for diphthongization, measurement is taken at three different points, one near the beginning but not so close as to be part of the consonant transition, one at the midpoint of the whole vowel duration, and the other near the end but again sufficiently far from any effect of the following consonant[44] (cf. Ladefoged 2003: 105).
(4) Manual correction is also made when the function of the formant tracker in Praat tracks any spurious formant or any wrong formant (more detail below).

As noted earlier in this section, the nucleus of a vowel must be approximately 40 msec from the beginning of consonantal transitions (Labov 2001: 156); therefore, as in the study by Labov (1972: 29), the vowel was measured at a point at least 50 msec from the beginning of the formants for the vowel unless it was impossible to do so. Examples of actual spectrograms from the current data are shown below. The formants tracked by Praat are shown with a series of superimposed dots, while place of measurement is shown by a vertical dotted line.

(1) midpoint over the steady state formants



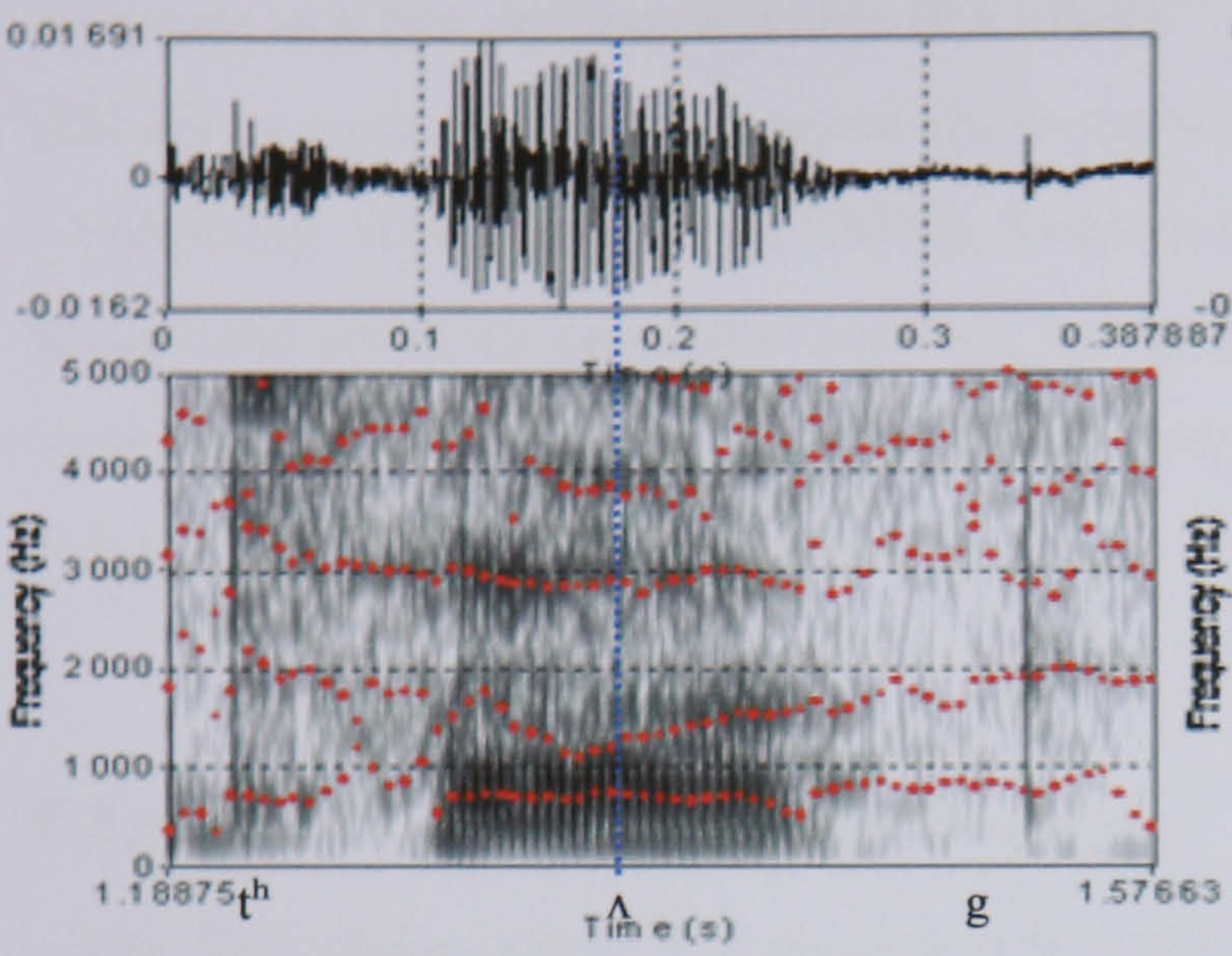
F01_IS_U01Studying



M03_WLS_U05hunt

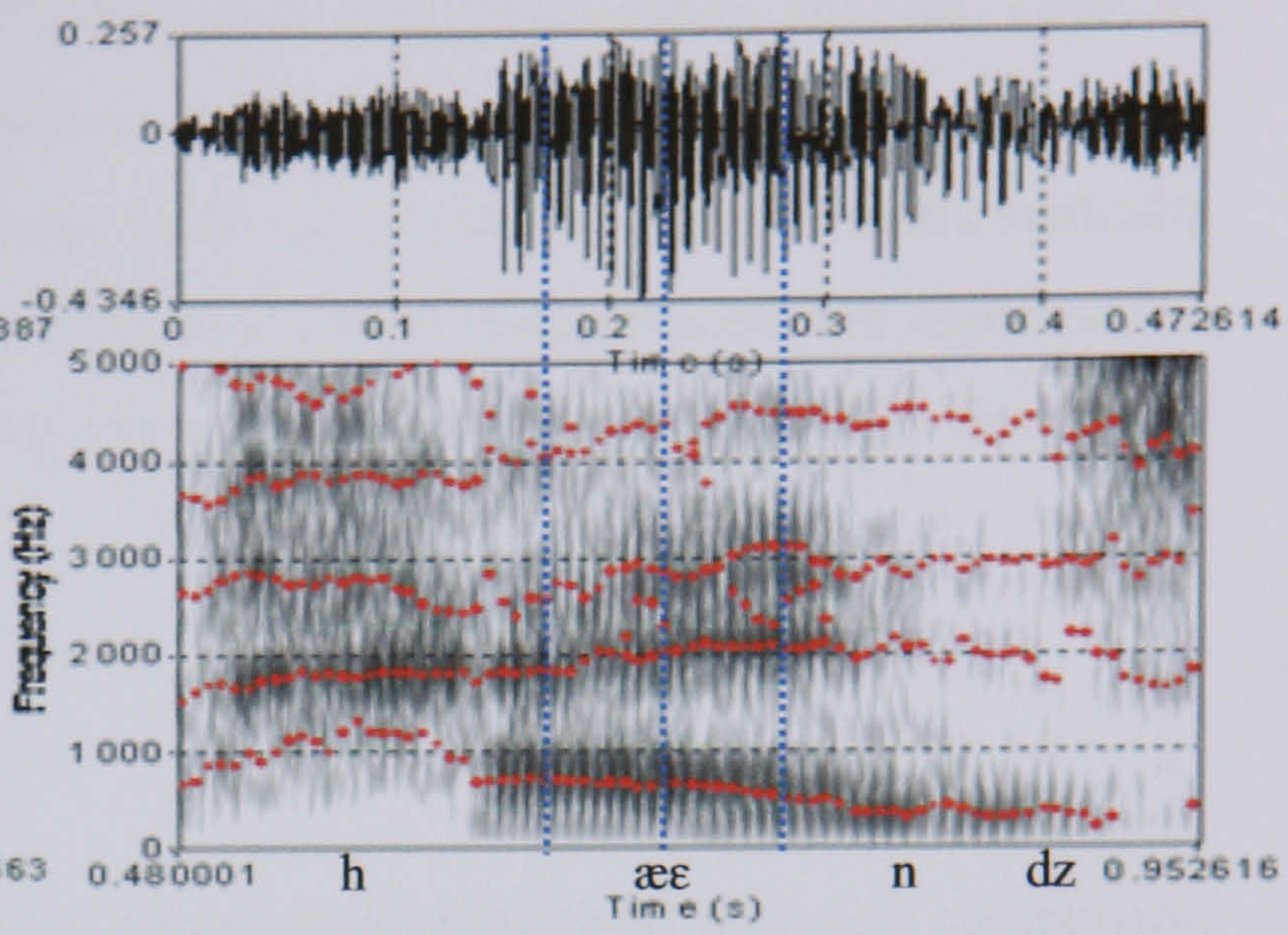
[44] Since there were very few diphthongal realisations in the data, only the values at the mid point were decided to be considered in the current research.

(2) midpoint over the non-steady state formants



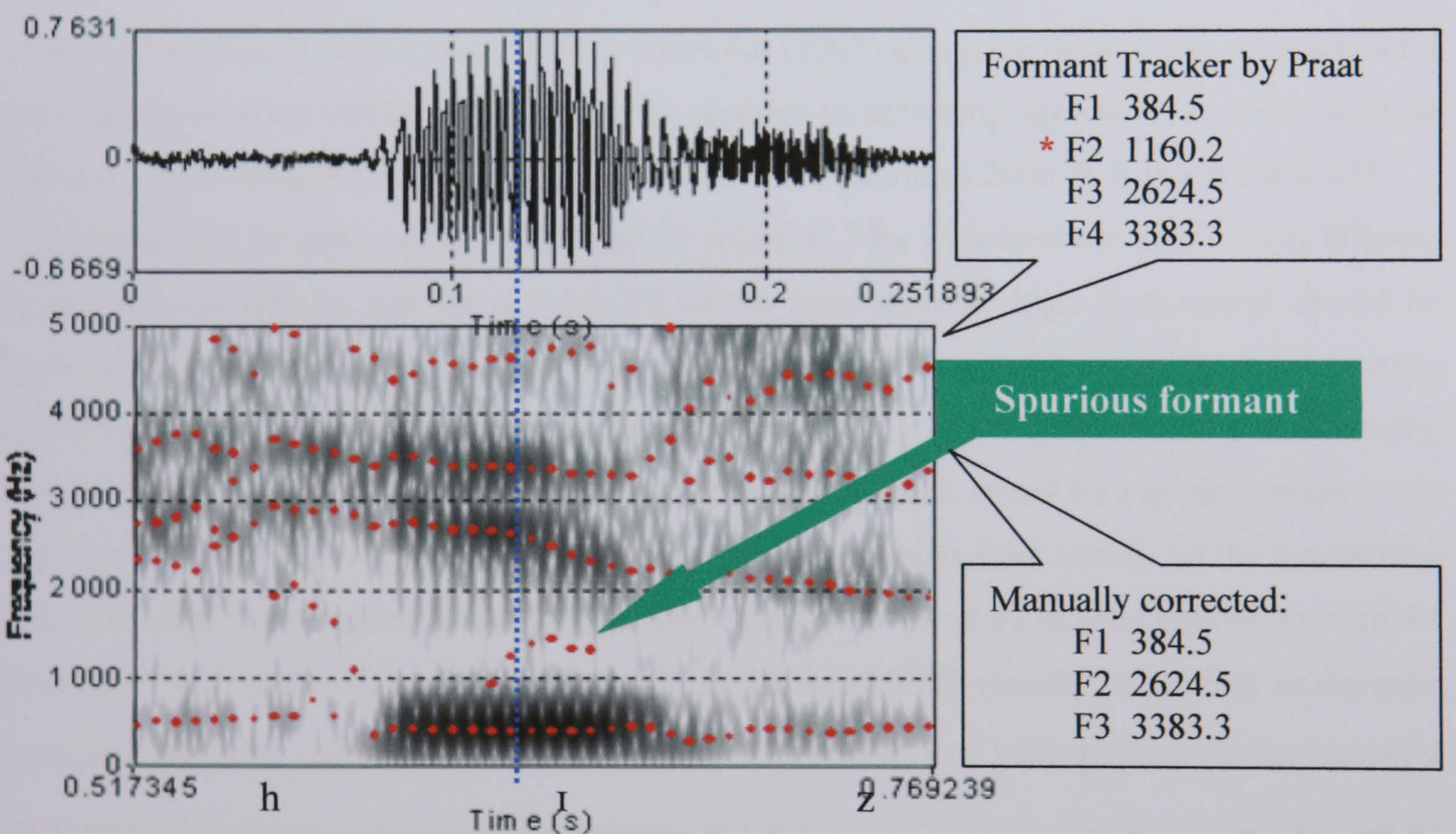
F01_RPS_U17tug

(3) three points for a diphthongal realisation



M14_IS_A18hands

(4) Manual correction for spurious formants



F30_I09his

During the analysis, there were further complications for the location of measurement for individual cases. Although we do not go into details in this study, all the information of unusual or problematic spectrograms and the procedures of the selection of the point for measurement were written down, as instructed by Ladefoged (2003: 105), for consistent measurements throughout the analysis.

All the target vowels were also auditorily judged and transcribed by the author with occasional reference to a free on-line clickable IPA charts[45]. The results from this auditory analysis, however, will not be considered in the present study and left for the future research.

Following Watt & Fabricius (2002), frequencies in Hz were converted into a mathematically normalised scale, an S-transformed unit, where individual vowel measurements are expressed as ratios of the value of *S* which is calculated using average formant frequencies for the three outer points of a (triangular) vowel space.

5.2.6 *S-procedure* vowel normalisation

The *S-procedure* (Watt & Fabricius 2002) which allows direct visual and statistical comparison of vowel triangles for multiple speakers is applied in this study. All raw formant values are divided by each speaker's 'centre of gravity' *S* value which is the grand mean of F_n for peripheral vowels with which we could derive maximum and minimum F_n values.

The *S-procedure* is evaluated by Watt & Fabricius (2002) alongside linear Hertz measurements and Bark normalised values, and found to be superior in achieving agreement in vowel triangle area and vowel triangle overlap (Watt & Fabricius 2002, Fabricius 2006: 9, Kamata 2006: 25).

The procedure for determining the F1 and F2 values of *S* for an individual speaker is as follows. Firstly, the average F1 and the average F2 of the most extreme high front vowel should be assumed to represent the lowest F1 and the highest F2, and the average F1 of the most extreme low vowel should be assumed to represent the highest F1 for a given speaker's sample. Secondly, the average F1 and the average F2 of the most extreme high back vowel for a given speaker are in principle no more than the average F1 of the most extreme high front vowel, on the assumption that the speaker's most close and most back possible vowel has an F2 exactly equivalent to its F1 frequency. Watt & Fabricius (2002) choose FLEECE and TRAP vowels, [i] and [a], as the most extreme high front vowel and the most extreme low vowel, and label [u'] for the hypothetical most high back vowel. The schematised representation of the 'vowel triangle' on the reversed F1 ~ F2 plane cited from Watt & Fabricius (2002: 164) is recreated below:

45 Available from http://www.yorku.ca/earmstro/ipa at present (15th February 2008).

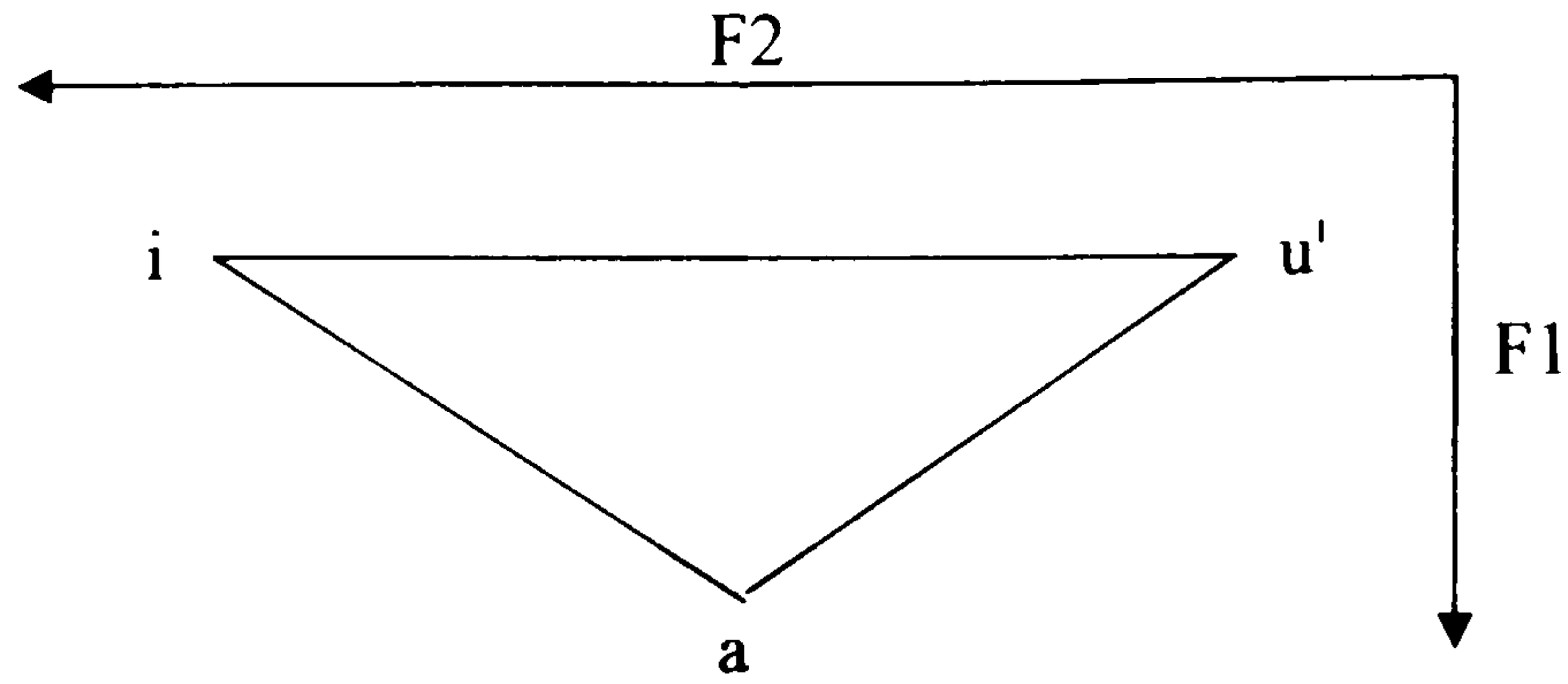


Figure 8 Schematised representation of the 'vowel triangle' used for the calculation of *S*. i=min. F1, max. F2 (average F1~F2 for FLEECE); a=max. F1 (average F1~F2 for TRAP); u'=min. F1, min. F2, where F1 (u') and F2 (u') = F1(i).

Although they choose these vowels as their peripheral vowels, they also suggest other potential vowels in case that FLEECE and TRAP do not provide a reliable estimate of these limits in a given accent; that is, KIT or FACE as the most extreme high front vowel, and START as the most extreme low vowel (Watt & Fabricius 2002: 163).

In the current study, KIT and START vowels were selected as peripheral vowels for the calculation of *S* on the ground of the nature of the accents in London. The reason that FLEECE and TRAP vowels were not selected here is because a FLEECE vowel is said to be subject to diphthongisation in London speech, while the TRAP vowel is the one in question here that is possibly shifting.

The KIT and START vowels selected here were 10 tokens each from each speaker in their WLS speech, and were measured in the same manner as for the target vowels described in the previous section (§5.2.5). All the mean formant values of measured KIT and START vowels and the hypothetical u' are presented in Appendix 6 together with the calculated *S*-values for each speaker.

The actual calculation of *S* for the speaker M02 will be shown as an example below in the same manner as demonstrated by Watt & Fabricius (2002: 173). The following are the mean F1, F2, and F2-F1 values for [ɪ ɑ u'] from M02's KIT and START vowels in his WLS data:

Vowel	F1 (Hz)	F2 (Hz)	F2-F1 (Hz)
ɪ	366.8	1977.1	1610.4
ɑ	598.6	1031.6	432.9
u'	366.8	366.8	0.0*

[*Theoretical value]

The ground mean values of each of F1, F2 and F2-F1 are calculated for *S* as follows:

$$S(F1) = \frac{366.8 + 598.6 + 366.8}{3} = \frac{1332.2}{3} = 444.0$$

$$S(F2) = \frac{1977.1 + 1031.6 + 366.8}{3} = \frac{3375.5}{3} = 1125.2$$

$$S(F2 - F1) = \frac{1610.4 + 432.9 + 0}{3} = \frac{2043.3}{3} = 681.1$$

The KIT, START and u' means in Hz can be converted into *S* units as below:

$$\begin{Bmatrix} 366.8 \\ 598.6 \\ 366.8 \end{Bmatrix} \div 444.0 \qquad \begin{Bmatrix} 1977.1 \\ 1031.6 \\ 366.8 \end{Bmatrix} \div 1125.2 \qquad \begin{Bmatrix} 1610.4 \\ 432.9 \\ 0 \end{Bmatrix} \div 681.1$$

Vowel	F1 (Hz)	F2 (Hz)	F2-F1 (Hz)
ɪ	0.826	1.757	2.364
ɑ	1.348	0.917	0.636
u'	0.826	0.326	0.000

Figures below show M02's vowel triangle (in bold black line) as well as those of all the other speakers not only on linear Hz scale (Figure 9) and on S-transformed scale (Figure 12) but also on a Bark scale[46] (Figure 10) and an ERB scale[47] (Figure 11). It should be noted that, as evaluated by Watt & Fabricius (2002), there is a substantial improvement in the match among the areas both in F1 and F2-F1 dimensions for the different triangles on the S-transformed scale than on linear Hz scale, on Bark scale, and on ERB scale, especially between M02's (shown in bold black line) and F16's (shown in bold red line) or F05's (shown in bold blue line), which considerably mismatch each other in both F1 and F2-F1 dimensions on a linear Hz scale, and even on the Bark and ERB scales.

[46] Following Watt & Fabricius (2002: 162), the raw frequency values (*f* in Hz) are *z*-transformed using Traunmüller's equation: $z = (26.81 \times f) / (1960 + f) - 0.53$ (Traunmüller 1990).

[47] Following Hayward (2000: 142), the raw frequency values (*f* in Hz) are transformed into ERB rate using an equation provided by Moore (1997): $E=21.4*\text{Log}_{10}[.00437*f+1]$.

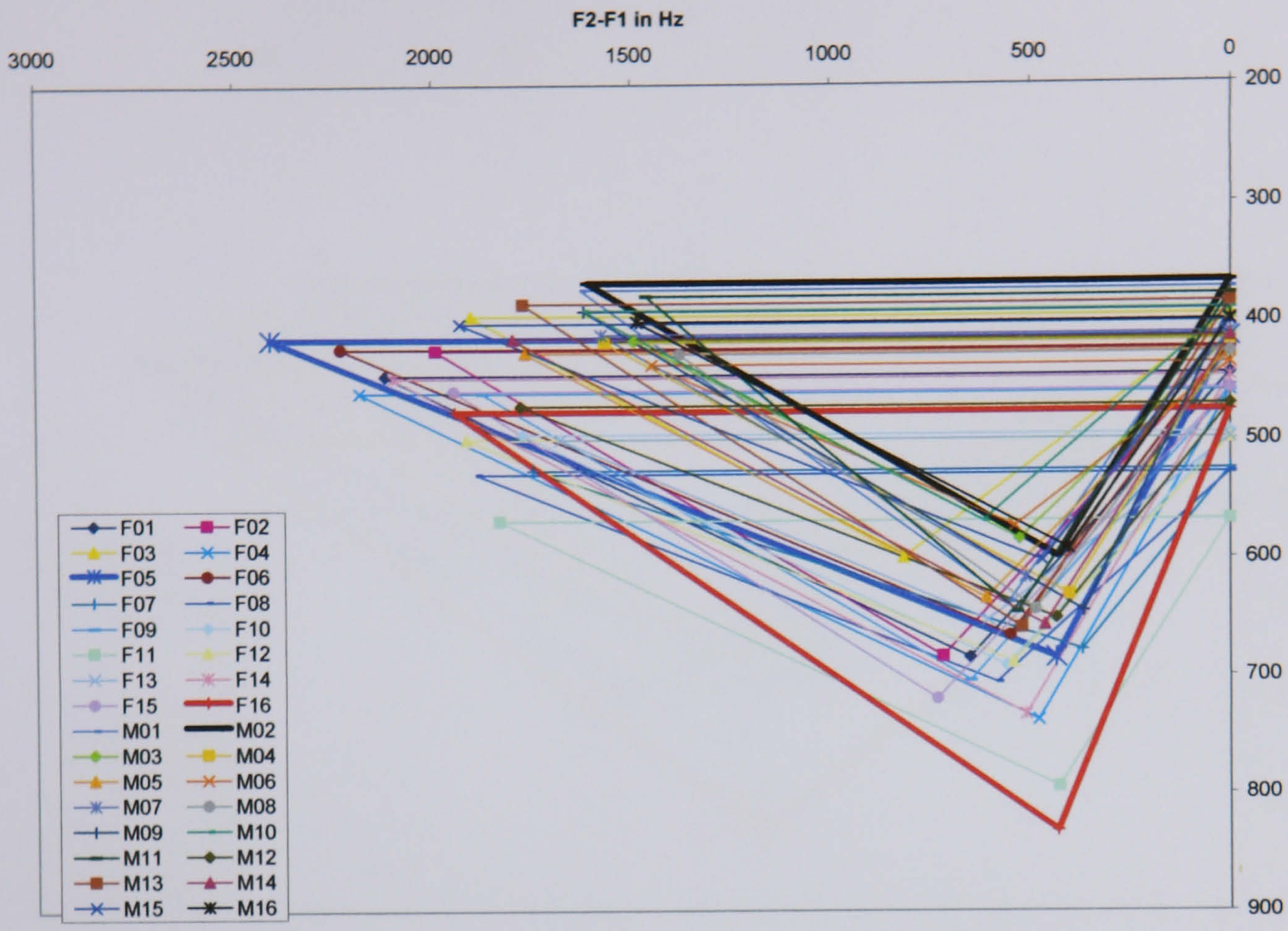


Figure 9 Comparison of KIT ~ START ~ uː vowel triangles for all speakers on linear Hz scale

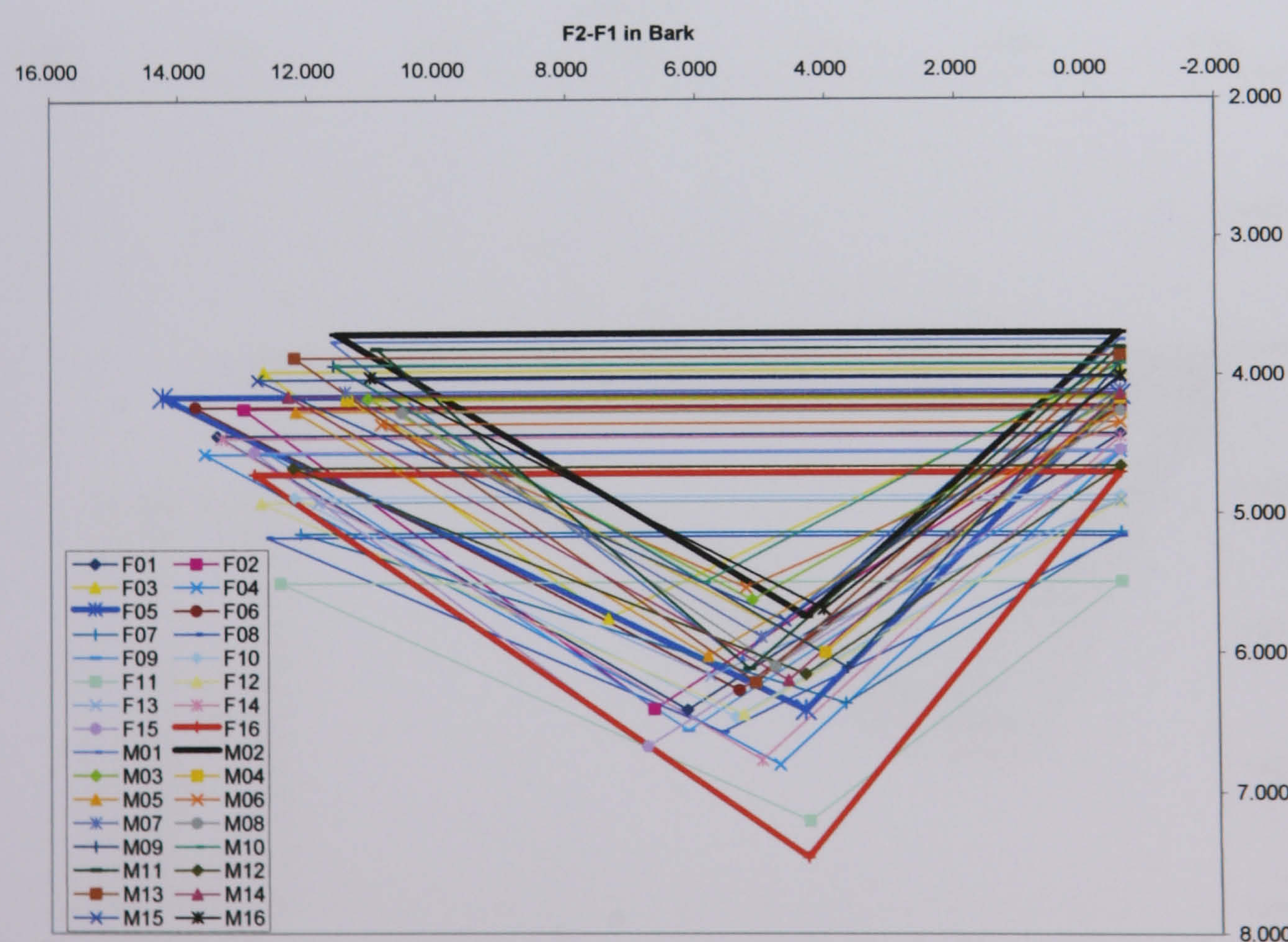


Figure 10 Comparison of KIT ~ START ~ uː vowel triangles for all speakers on Bark scale

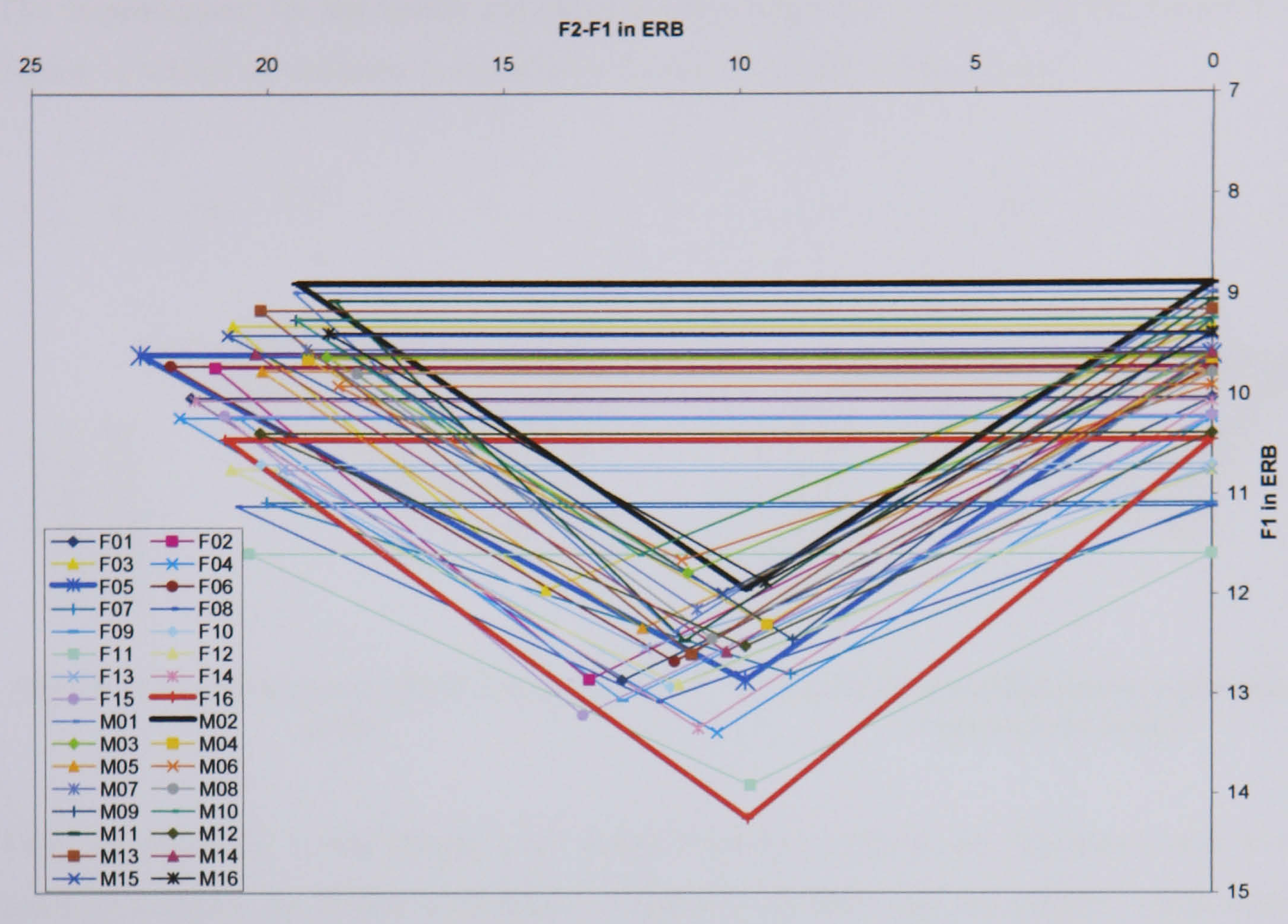


Figure 11 Comparison of KIT ~ START ~ uː vowel triangles for all speakers on ERB scale,

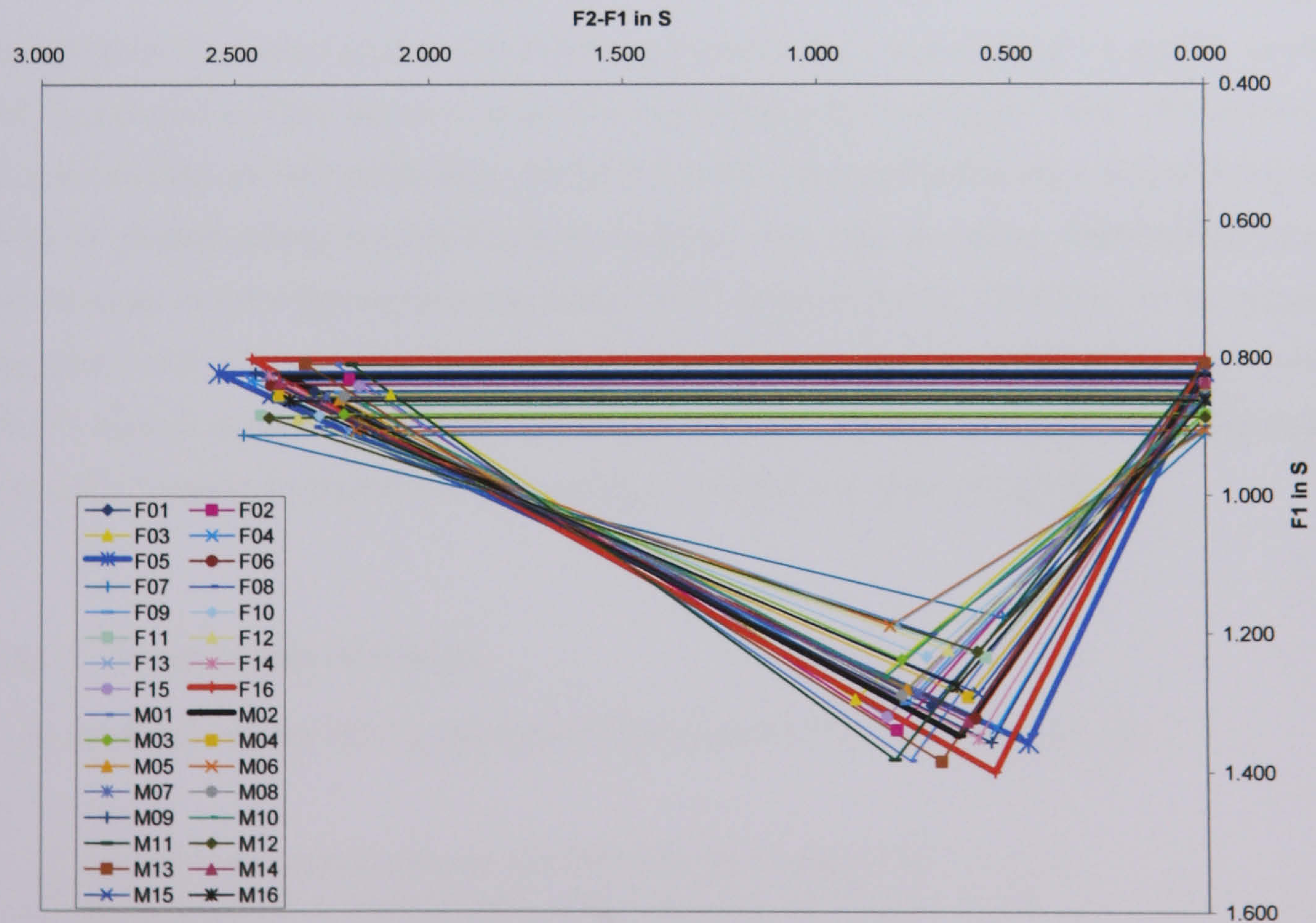


Figure 12 Comparison of KIT ~ START ~ uː vowel triangles for all speakers on *S*-transformed scale

The improvement for the match can be especially clear when comparing the Figure 9 and the Figure 12 which are redrawn to show sex difference in particular as below:

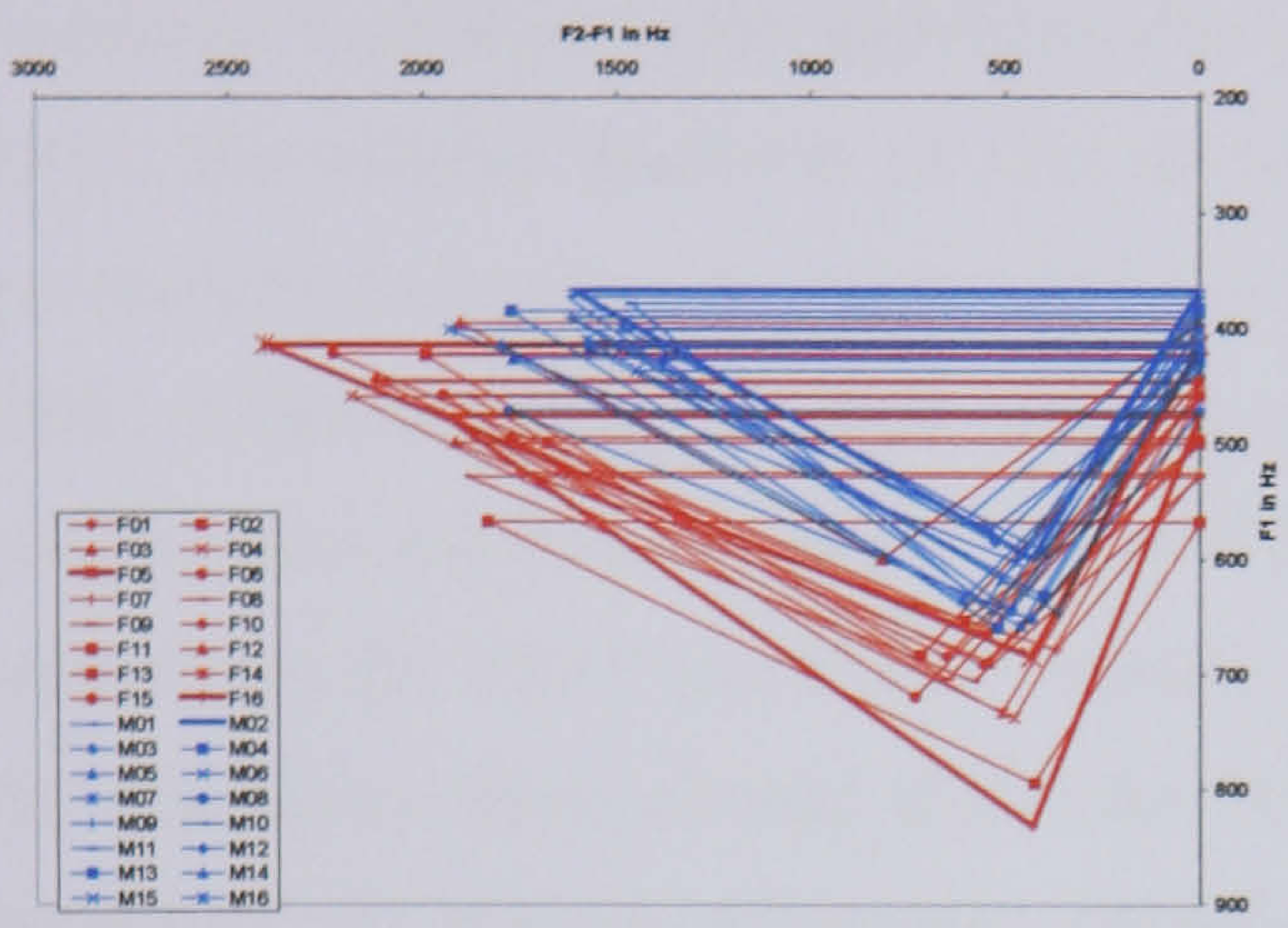


Figure 13 Sex difference in Fig13 (on linear Hz scale)

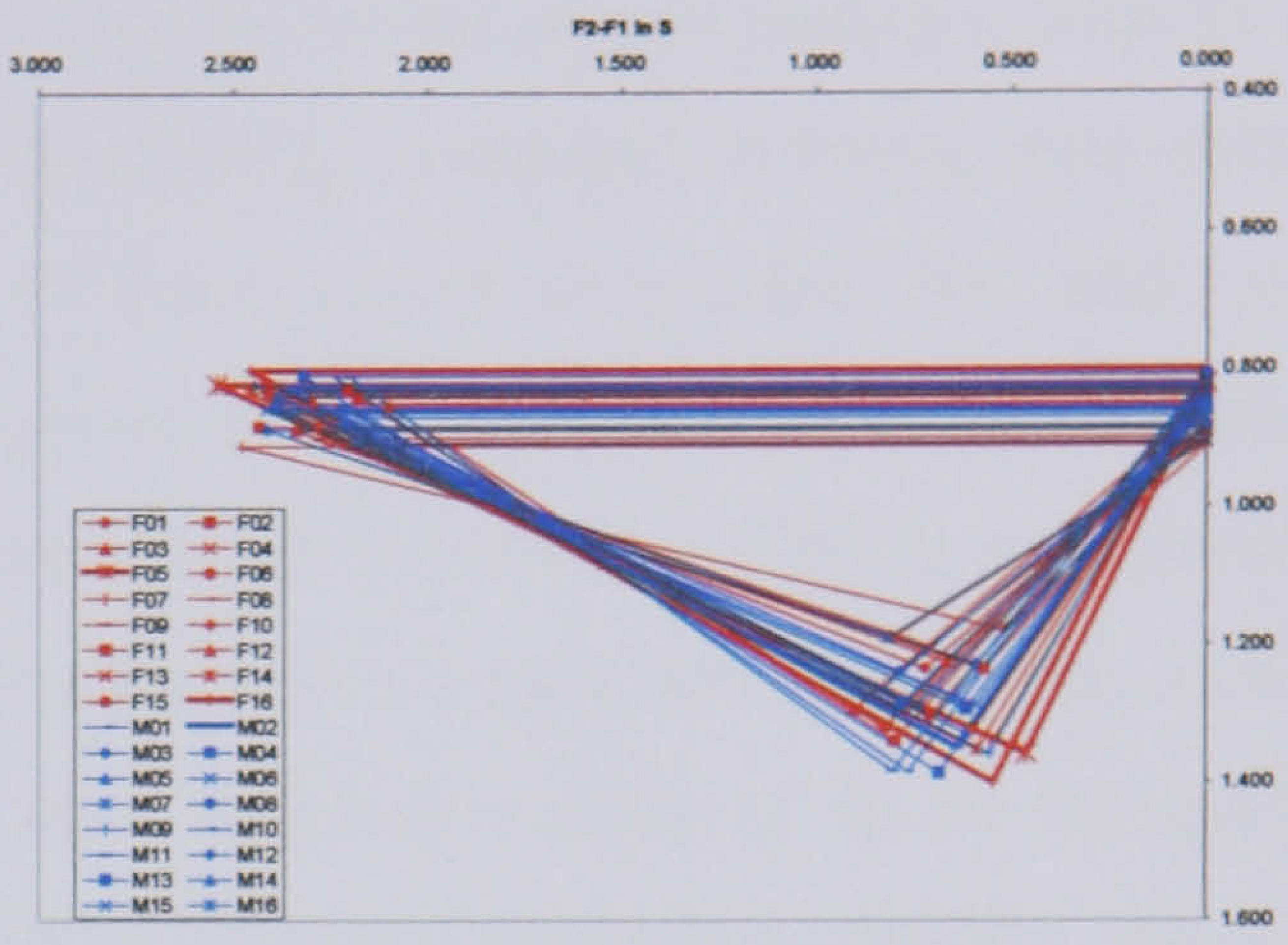


Figure 14 Sex difference in Fig16 (on S-transformed scale)

Thus, all speakers' vowel triangles are defined relative to *S*: we are, therefore, able to directly compare samples for different speakers – regardless of their age and gender – both statistically and visually (Watt & Fabricius 2002: 165).

Unlike Watt & Fabricius (2002), the current study employs vowel charts showing the *S*-transformed F1 plotted against the difference between the *S*-transformed F2 and F1 as shown in the figures above. This way of formant charts, according to Ladefoged (1993: 199), seems to give a more accurate picture particularly for back vowels compared to the other way of formant charts with F1 plotted simply against F2. It is, however, also true that those charts could possibly be problematic in case that there is any doubt on F1 measurements. Therefore, in the future study, the charts with F1 plotted against F2 should also be investigated. In this study, nevertheless, all the F1 measurements are believed to be accurate after any measurements both statistically and manually found to be doubtful were carefully corrected and removed (cf. §6.2).

5.2.7 Presentation of results

As mentioned earlier (§5.1), the data will be examined in three different steps:

1. a relative positional analysis for DRESS, TRAP and STRUT vowels
2. an apparent-time analysis of a relative position of DRESS, TRAP and STRUT vowels particularly in London WC and London UMC
2. an angle measurement analysis (Fabricius 2007) for TRAP and STRUT vowels.

In the first analysis, using normalised *S* values for F1 and F2-F1 (which we will call hereafter as SF1 and SF21 respectively), the relative position of the DRESS, TRAP and STRUT vowels – the SF1 as a marker for vowel height and the SF21 as a marker for vowel frontness – are statistically compared in relation to the social and phonological aspects. In the second analysis, with SF1 and SF21, the relative positions of the vowels are statistically compared between two different generations to investigate chronological changes of these vowels in London WC and London UMC respectively. In the third analysis, having given the results from the relative positional analysis showing the evidence of 'TRAP/STRUT rotation' as in Fabricius (2007), configurational analysis for the TRAP and STRUT vowels are conducted with a single measurement by means of the angle calculation method (Fabricius 2007) as described above (§4.6.1). In all the analyses, multi-factorial analyses of variance (ANOVAs) will be applied separately to the SF1 values and SF21 values of each vowel and the angle measurements. Detailed explanations for the procedure and statistical tests will be given in due course.

6 Results for Relative Positions

6.1 Main statistical tests

Statistical tests are conducted on mean formant values for one of the three vowels (i.e. DRESS, TRAP and STRUT) produced by each of 32 speakers in one of the three speech styles (i.e. IS, RPS and WLS). Appendix 7 provides all those raw mean values of the data which were the input into analysis of variance (ANOVA) programme. Then ANOVA transformed these mean values into Estimated Marginal Means which provide an estimate of the adjusted group means (i.e. the means after the covariate has been accounted for) (Field 2005: 369, SPSS technical support web: http://support.spss.com/). Therefore, the means from the raw mean data in the Appendix 7 may not be exactly the same as the estimated marginal means which were used for the calculation of ANOVAs and presented in this chapter.

The following ANOVA tests were conducted for each of SF1 and SF21 of each vowel:

TEST Set-1: multiple 2-way ANOVAs with social factors and speech style

Test-1-1 (T11): 2-way ANOVA with speech style x sex (for overall data)
Test-1-2 (T12): 2-way ANOVA with speech style x age (for overall data)
Test-1-3 (T13): 2-way ANOVA with speech style x social class (for overall data)
Test-1-4 (T14): 2-way ANOVA with speech style x social grouping (by sex x age x social class) (for overall data)

TEST Set-2: multiple 2-way ANOVAs with phonological factor and speech style

Test-2-1 (T21): 2-way ANOVA with phonetic environment x age (for WLS data only)
Test-2-2 (T22): 2-way ANOVA with phonetic environment x gender (for WLS data only)
Test-2-3 (T23): 2-way ANOVA with phonetic environment x class (for WLS data only)

Since there were two dependent variables (SF1 and SF21) for three vowels, these tests were repeated six times in total. The details of each test will be explained below.

The TEST Set-1 consists of four 2-way factorial ANOVAs (i.e. T11 to T14) comparing the speech style (as a within-subjects variable with three conditions) with one of the four social factors (i.e. sex, age, social class, or grouping by sex, age and social class) respectively (as a between-subject variable with two conditions for the first three factors and with eight conditions for the last factor). There were some reasons for choosing multiple 2-way ANOVAs rather than a single 4-way factorial ANOVA with all the social factors (i.e. speech style, sex, age, and social class) at one time. The first reason was because the results (especially interaction terms) from such a factorial ANOVA with more than three factors would be extremely difficult to interpret as many of the statistics textbooks warn and normally recommend us to limit the number of independent variables that we include to three or fewer for the sake of interpretation (Field 2005: 481, 519). The second reason was, more importantly, because much of the information from such a test (with all four social factors together) was more than I needed for the main objectives in this study, and it was found that all the information needed from that complex 4-way ANOVA could be obtained from these less-complex multiple 2-way ANOVAs, especially from the one with the last factor, grouping[48]. For these reasons, this set of multiple 2-way factorial ANOVAs was chosen. The main objectives from these tests, therefore, were to reveal (1) main effects of each of speech style and social factors (sex, age, and social class), (2) interaction effects between speech style and each social factor or a combination of all three social factors, and (3) effects of one factor for each condition of the other factor.

The TEST Set-2 consists of multiple 2-way factorial ANOVAs (i.e. T21 to T23), in which the phonological factor (phonetic environments: _LS, _VS, _N, _LF, or _VS, see footnote 13) was compared with one of the social factors (i.e. age, gender, or social class) respectively. As with the style variable, the phonetic environments variable was a repeated measure variable[49]. The tests were conducted on only word-list style (WLS) data. The main objectives from these tests, therefore, were to reveal (1) main effects of each factor (i.e. phonetic environments, sex, age, and social class), (2) interaction effects between phonetic environments and each social factor, and (3) effects of one factor for each condition of the other factor.

Following each of the tests explained above, the effects of those factors with more than two conditions (or levels) such as speech style and phonetic environments were further examined. The main effects of these factors were examined by *post hoc* tests using Fischer's Least Significant

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[48] Initially, there had been a good reason to consider conducting this 4-way 3 (speech style: IS, RPS and WLS) x 2 (sex; female and male) x 2 (age: young and old) x 2 (social class: WC and UMC) ANOVA on the data; I wanted to know the effects of the higher interactions (i.e. sex x age x social class, and speech style x sex x age x social class) to dependent variables to see overall patterns of the interactions, and found out that these could be obtained from planned contrasts and post hoc (simple main effects) analysis following this 4-way ANOVA. However, the problem for conducting the 4-way ANOVA was that it was not allowed to select only the interaction effects that were of our interest; instead, it was necessary to consider and report not only all four main effects but also all possible combinations of interactions (i.e. other 2-way, 3-way interactions) among those four factors, some of which were obviously not necessary for the purpose of this study. However, it was found out that the results at higher interactions (i.e. sex x age x social class, and speech style x sex x age x social class) that I wanted could be obtained selectively from our T14 (i.e. 2-way ANOVA comparing speech style with social group) and its subsequent comparisons; the results from this 2-way ANOVA were found to be the same as those obtained from 4-way ANOVA.

[49] 'Multiple' tests in TEST Set-1 were conducted on the same data, but strictly speaking these tests were conducted on different data sets, each of which had different sets of mean values due to the different factors involved. Similarly, 'multiple' tests in T21 to T23 were conducted on the same data, but again, these tests were conducted on different data sets, each of which had different sets of mean values due to the different factors involved. Therefore, these multiple ANOVAs should not inflate the Type I error.

Difference (LSD)[50] that were designed to compare all different combinations of the condition groups (Field 2005: 339), so that each condition of each of these factors could be compared one by one.

For the case of speech style, the data were also further examined using planned contrasts. This was done in the ANOVA programme so that those factors could be compared in groupings. Since three conditions of the speech style variable (i.e. IS, RPS, and WLS) could be categorised into two groups, 'spontaneous' (for IS speech) vs. 'non-spontaneous' (for RP speech vs. WLS speech), this variable was divided into 'IS' and the combination of 'RPS&WLS' by a planned contrast. Thus, the speech style factor was compared in these manners by the planned contrasts, as well as in one-to-one manner by the *post hoc* tests.

To break down the effects of any interaction, follow-up investigation proceeded with the computation of one or more sets of simple effects tests (also known as simple main effects tests). Simple effects tests reveal the degree to which one factor is differentially effective for each condition of the other factor. LSD method was used. Simple effects are usually looked at when there is a significant interaction, however, several sources (e.g., Howell, 2007: 403) state that an analysis of simple effects is sometimes warranted in the face of a non-significant interaction when the prime reason for this analysis is to detect the simple effects (cf. Fabricius 2000: 97, Stokes, Dritschel & Bekerian 2004: 1362). Since one of our main objectives is to detect the effects of one factor for overall data and for each condition of the other factor, it should be sensible to conduct simple effects tests not only on significant interactions, but also on non-significant interactions to see overall patterns of the interactions. Fabricius (2000) also looks at simple effects not only for her significant interactions, but also for her non-significant interactions to see overall patterns of the interactions. Therefore, in the current data, simple effects tests were also performed to break down all the interactions whether or not the interaction was significant, and this enabled us to see the full picture of the interactions.

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[50] The least significant difference (LSD) pairwise comparison makes no attempt to control the Type I error and is equivalent to performing multiple *t*-tests on the data. The other two available *post hoc* tests as pairwise comparisons for interaction terms in a current SPSS programme (version 14.0) are Bonferroni correction and Sidak correction. Both Bonferroni and Sidak corrections do control the Type I error rate. However, there is a trade-off for controlling the Type I error rate and that is a statistical power; this means that the probability of rejecting an effect that does actually exist is increased (a Type II error). By being more conservative in the Type I error rate for each comparison, we increase the chance that we will miss a genuine difference in the data (Field 2005: 339-340). In general, Bonferroni corrections are known to be too conservative when more than a few comparisons are made. Sidak, although it is said to be only slightly less conservative than Bonferroni, is also very conservative, hence has a lower statistical power than LSD. Considering the importance of statistical power and of controlling Type I error rate, LSD pairwise comparisons were used for our *post hoc* tests as recommended by the SPSS programme (SPSS technical support web: http://support.spss.com/).

Following Hudson (2001: 153) and many other studies in social sciences, an alpha value of probability of 0.05 was used as a significance threshold. That is, a difference with a probability below this figure was considered significant (*), while a difference with a probability above this was considered non-significant (ns). In addition, there were some cases in which a probability was lower than 0.01 or even lower than 0.001; a difference with such a particularly low probability indicated highly significant difference and very highly significant difference. In such cases, special remarks with signs ** for $p<0.01$ and *** for $p<0.001$ were made.

The significance level could have been stricter, so that all the statistical results would have become much sharper, and more prominent results would have been left. Such a stricter significance level, however, could have left out potentially important subtle differences. For this reason, the current study chose the threshold at 0.05, while displaying more detailed significance values for each statistical result.

6.2 Screening data, removing outliers and testing assumptions

Since outliers bias the mean and inflate the standard deviation, screening data is an important way to detect them (Field 2005: 67). To look for outliers, all the raw data of each F1 and F2-F1 were plotted in box plots group by group by SPSS. By doing this, SPSS statistically detected and visually showed significant and potential outliers indicated by asterisks and circles with measurement IDs in the graphs. To double-check those outliers, z-scores for each of F1 and F2-F1 values were also calculated[51]. All of the tokens detected as significant outliers had z-scores absolute values greater than 2.0, and most of the tokens detected as potential outliers had z-scores of absolute values greater than 1.0. All the measurements of the tokens detected as significant and potential outliers by SPSS were manually checked once again by the author. They were corrected if any mistake in measurement was found, or removed if there was a good reason to do so (e.g. such vowels which were obviously not representing the data set); otherwise, they were left unchanged. In the end, the formant values for 421 out of initial 5730 vowel tokens (i.e. 7.3%)

[51] Z-score is the value of an observation expressed in standard deviation units. It is calculated by taking the observation, subtracting from it the mean of all observations, and dividing the result by the standard deviation of all observations. (Field 2005: 750). Z-scores are particularly useful to know the nature of the data distribution. The first important value of z is 1.96 because this cuts off the top 2.5% of the distribution, and its counterpart at the opposite end (-1.96) cuts off the bottom 2.5% of the distribution. Therefore, 95% of z-scores lie between -1.96 and 1.96. The other two important benchmarks are ±2.58 and ±3.29; 99% of z-scores lie between -2.58 and 2.58, and 99.9% of them lie between -3.29 and 3.29 (Field 2005:13-14). Outliers could also be identified by using alternative methods such as Mahalanobis distance (cf. Field 2005: 165).

were carefully checked through, those for 132 tokens (i.e. 2.3%) were manually corrected, and those for 42 tokens (i.e. 0.7%) needed to be removed.

Since an ANOVA is a parametric test, it requires data to meet several assumptions. Firstly, the data should be measured at least at the interval level. Secondly, the data from different participants should be independent. The current data meet these two assumptions.

Thirdly, it is assumed that the data are from one or more normally distributed populations. This assumption of normality is the most important of all the other following assumptions (Field 2005: 65). The easiest way to check this assumption is to plot a histogram (i.e. also called frequency distribution, which shows how frequently each range of scores occur), look at the distribution of the sample data in groups which are compared, and see if it looks normal. This can also be tested statistically to see whether the sample data differ significantly from normal. All our data were screened prior to any test conducted. They were checked by combinations of an independent statistical test, Kolmorgorov-Smirnov test, and histograms conducted for each of the groups to be compared. As a result, the data were found to be generally normally distributed.

Fourthly, it is assumed that the variances between conditions of between-subjects variables should be the same throughout the data. This assumption was tested by the Levene's Tests of Equality of Error Variances in the process of each ANOVA together with variance ratio. The details are discussed in Appendix 8. In brief, 159 out of 162 conditions met this assumption, while the only 3 conditions did not. Those three conditions are RPS and WLS conditions in the T14 for the SF1 of TRAP and WLS condition in the T14 for the SF1 of STRUT. However, there does not seem to be a problem since the sample sizes were equal in both cases and ANOVA is said to be fairly robust especially when sample sizes are equal (Field 2005: 324). Therefore, it was considered to assume that the homogeneity assumption has been met for all the conditions.

The last assumption to be considered is 'sphericity' since the current data involve not only between-subjects variables (i.e. age, gender, class, and social grouping), but also a within-subjects variable (i.e. speech style and phonetic environments). According to Field (2005: 428), this sphericity assumption can be likened to the assumption of homogeneity of variance in between-subjects group. Sphericity is a more general condition of compound symmetry, which holds true when both the variances across conditions are equal (like variance homogeneity) and the covariances between pairs of conditions are equal. Sphericity refers to the equality of variances of the differences between treatment conditions. So if we were to take each pair of treatment conditions, and calculate the differences between each pair of scores, then it is necessary that these differences have equal variances. As such, we need at least three conditions for sphericity to be an issue. This assumption can be tested by the Mauchly's Test of Sphericity in the process of each ANOVA. The violation of this assumption is not fatal at all, because the assumption is a sufficient condition for ANOVA but not a necessary condition (Field 2005: 428). However, since the type of F-ratio that we refer to depended on the result of the Mauchly's Test of Sphericity, the results from this test in each ANOVA test were provided in Appendix 9.

Last but not least, it is particularly worth noting Fabricius' remarks about the moderate violation of the assumptions for ANOVA; 'computer simulations have shown that obtaining reliable results from an ANOVA is not dependent on meeting these assumptions completely, i.e. the test is robust even when the assumptions are violated moderately by data' (2000: 90).

6.3 Presentation of results

Figure 15 - Figure 22 provide an overview for relative positions of DRESS, TRAP and STRUT vowels. The plots represent mean frequencies of SF1 and SF21 from each of 32 speakers either in each of three speech styles or in each of five phonetic environments within WLS style, presented in traditional plots with SF1 (degree of openness) on the Y axis and SF21 (degree of frontness) on the X axis (Ladefoged 1993: 197):

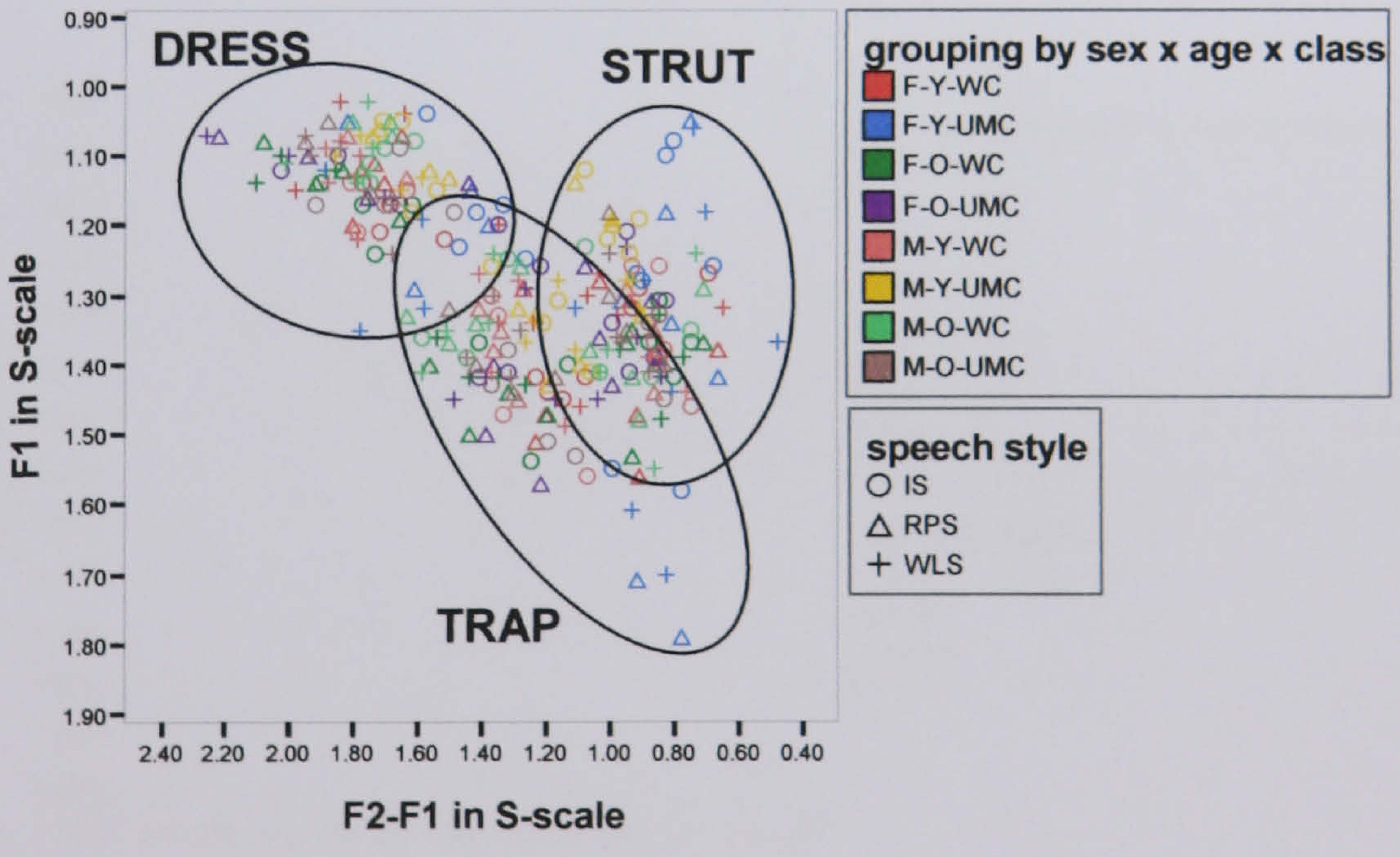


Figure 15 Mean distributions of DRESS, TRAP and STRUT for all 32 speakers in three speech styles

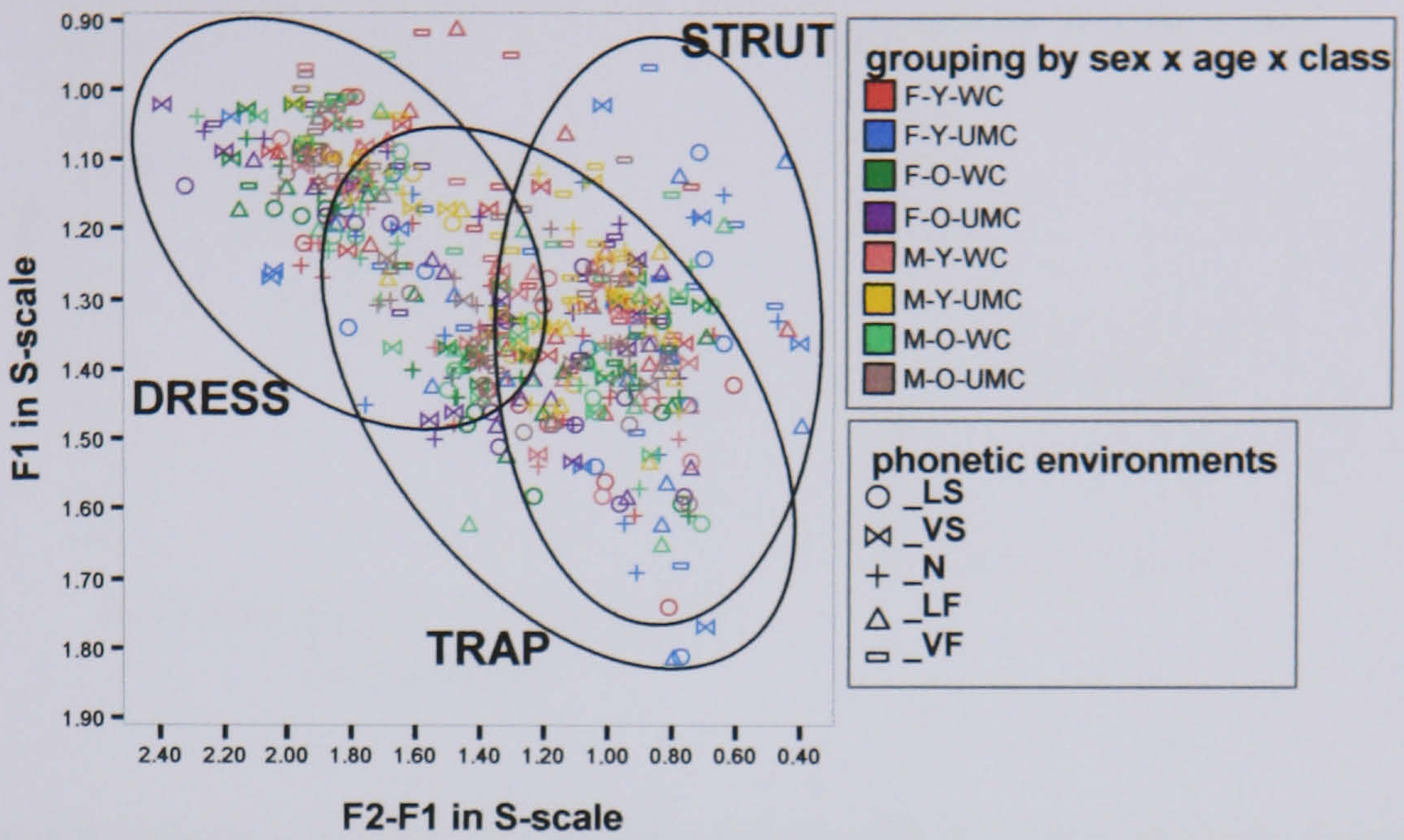


Figure 16 Mean distributions of DRESS, TRAP and STRUT for all 32 speakers in five phonetic environments

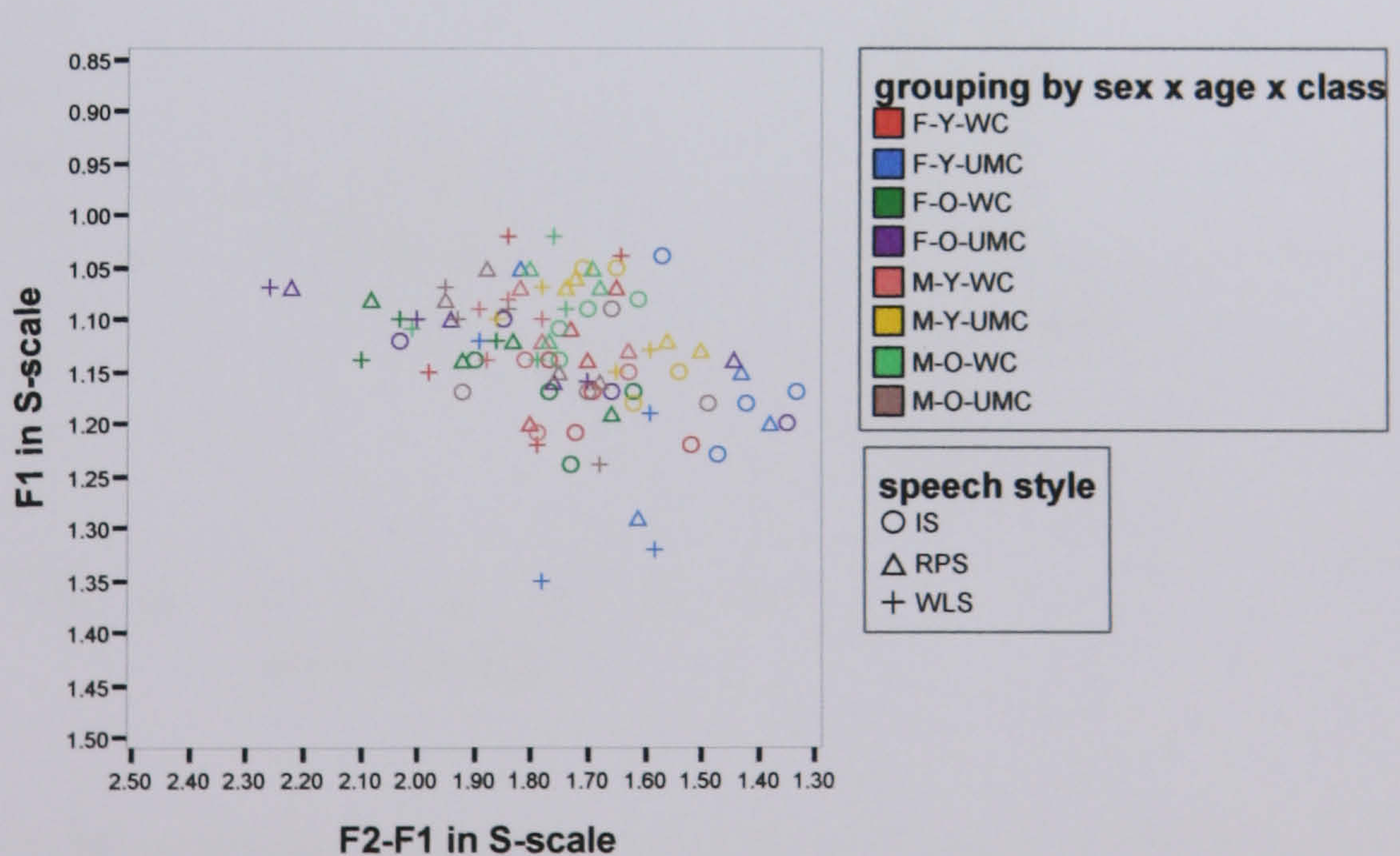


Figure 17 Mean distributions of DRESS vowels for all 32 speakers in three speech styles

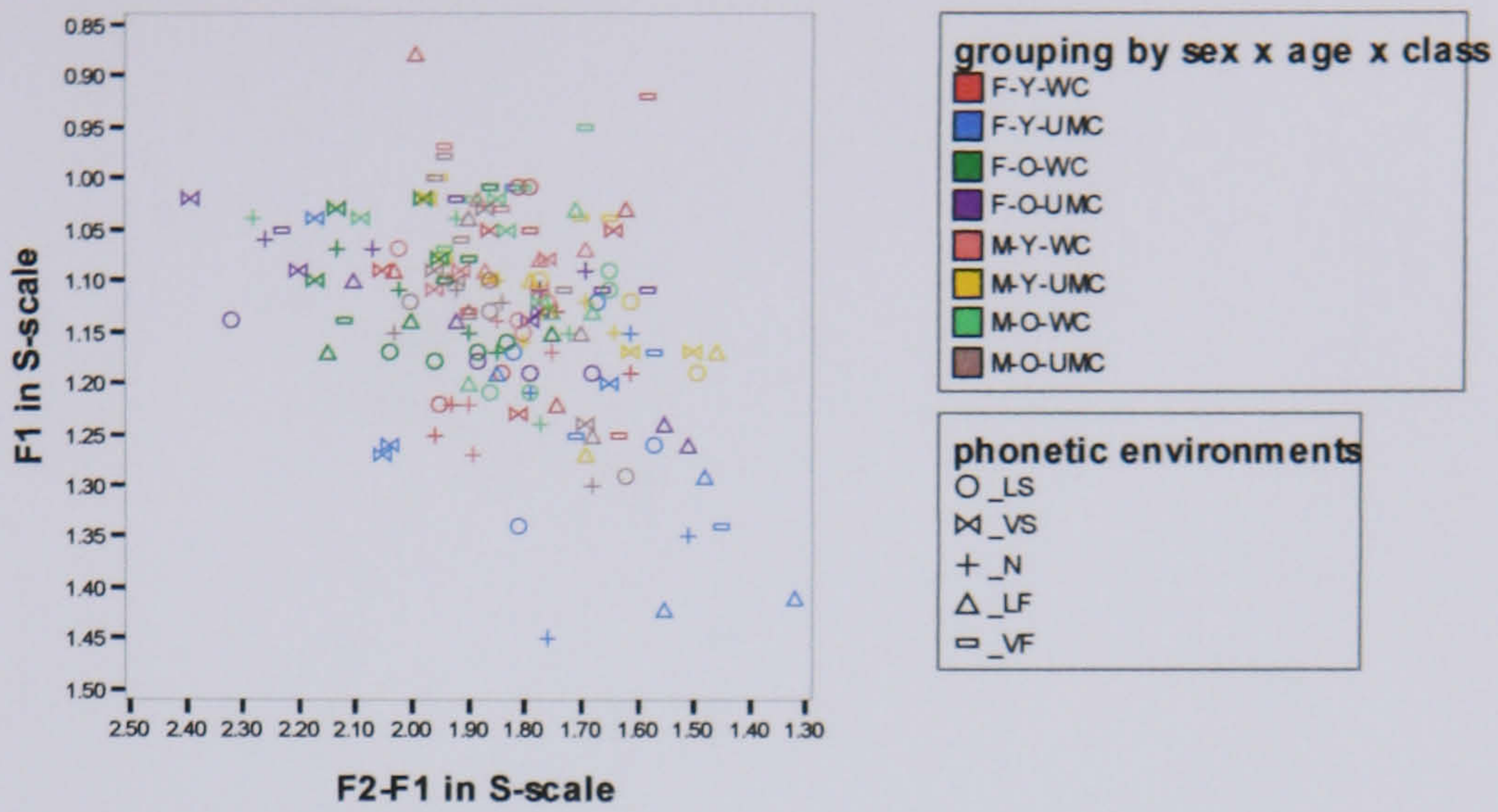


Figure 18 Mean distributions of DRESS vowels for all 32 speakers in five phonetic environments within WLS style

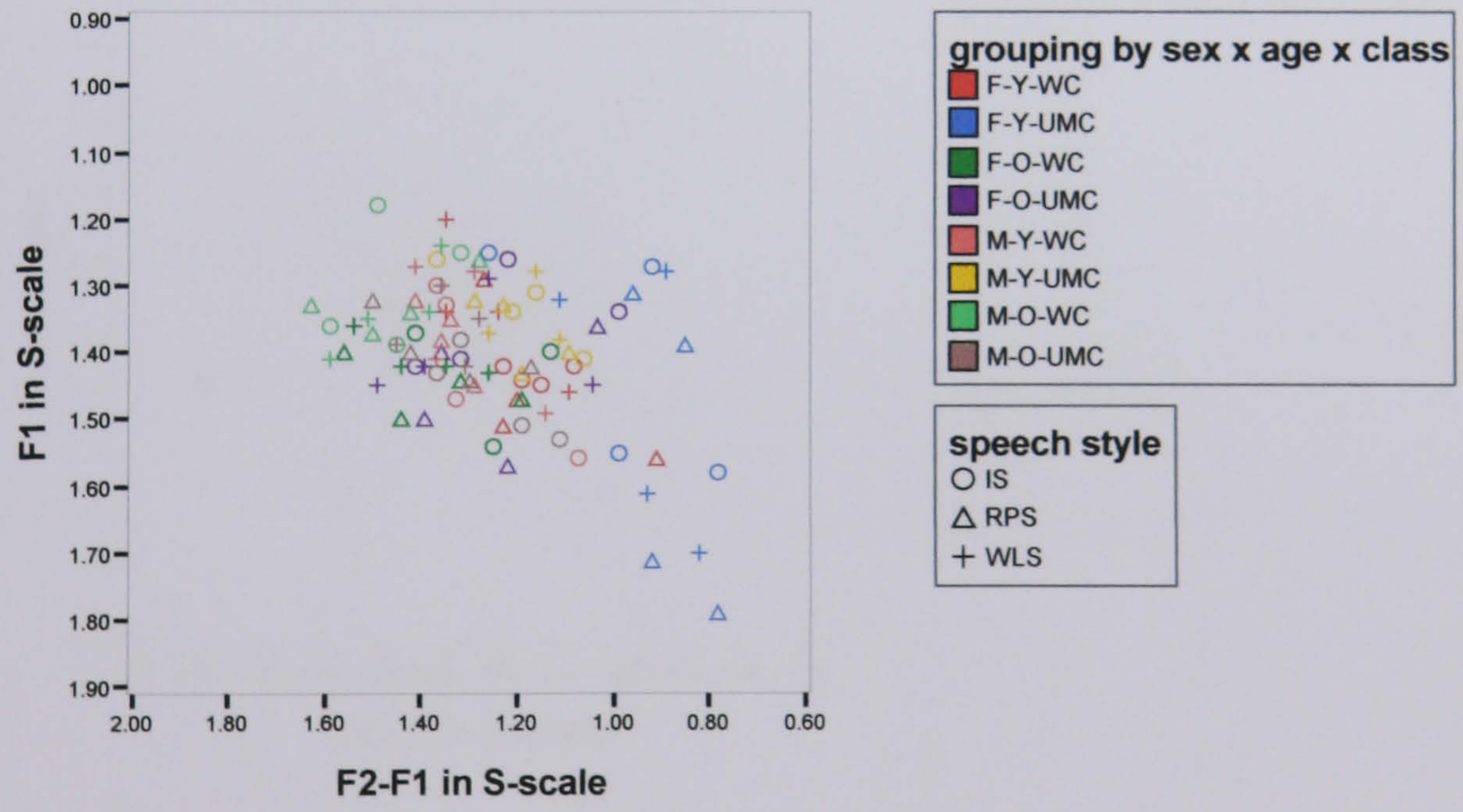


Figure 19 Mean distributions of TRAP vowels for all 32 speakers in three speech styles

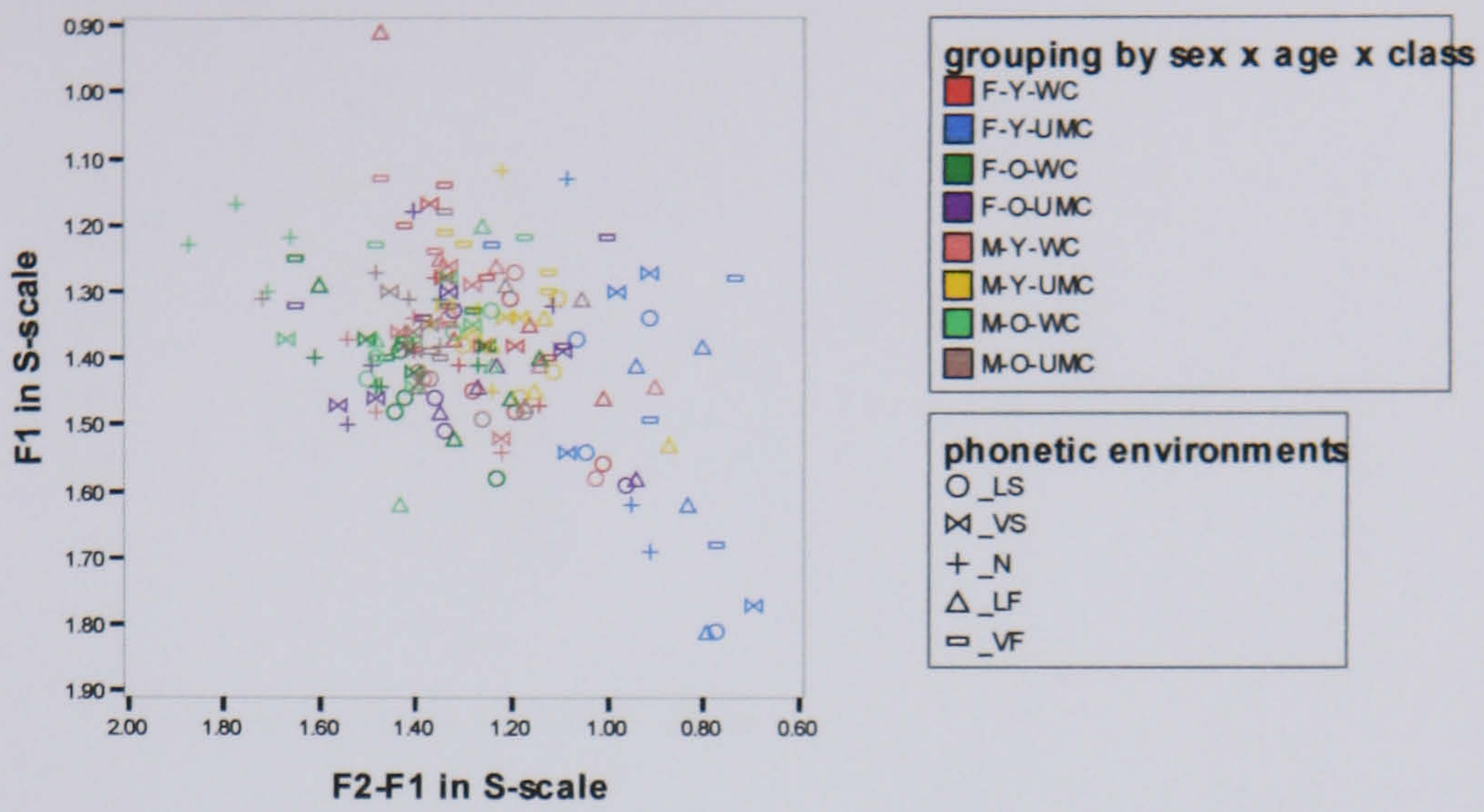


Figure 20 Mean distributions of TRAP vowels for all 32 speakers in five phonetic environments within WLS style

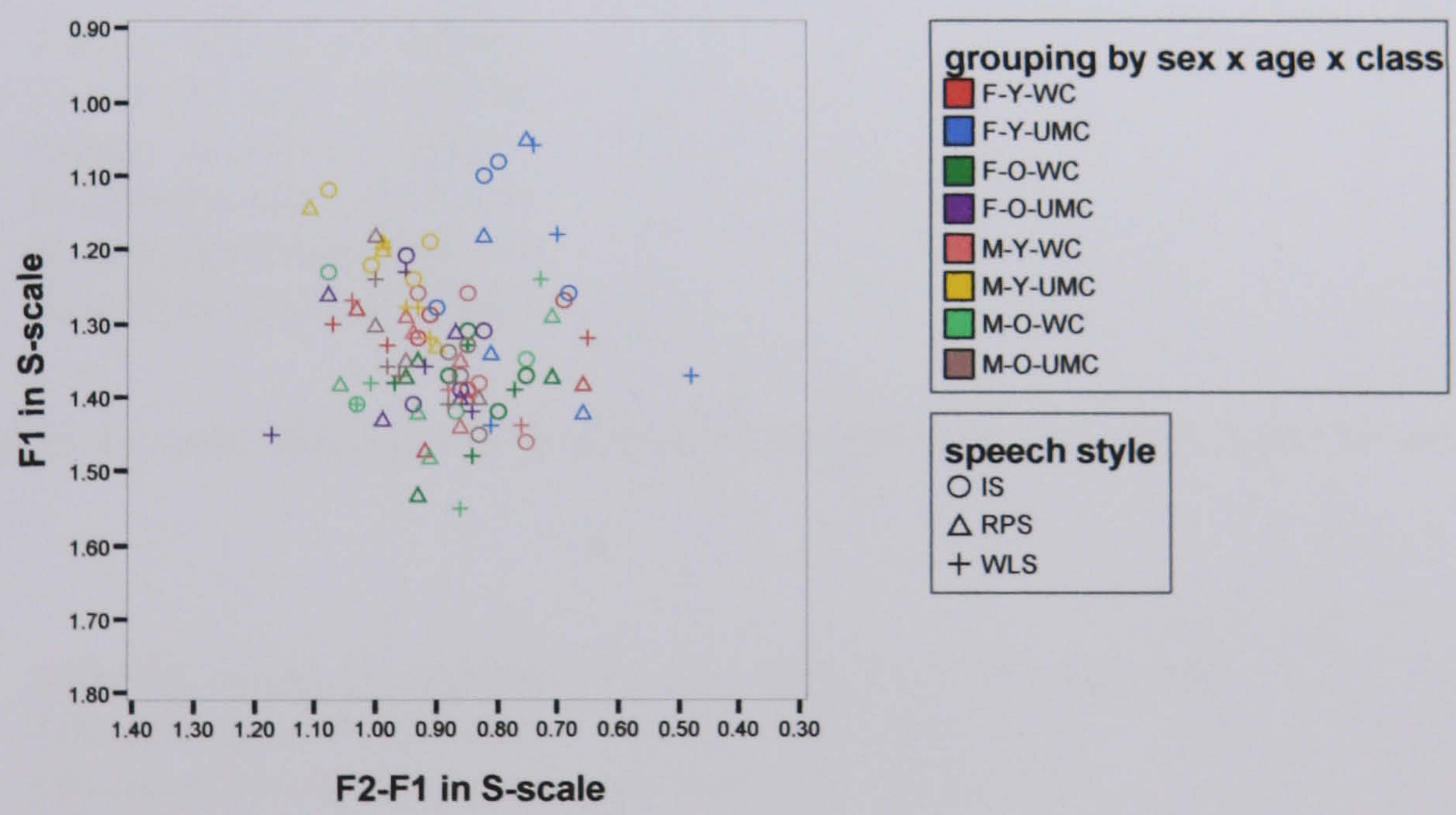


Figure 21 Mean distributions of STRUT vowels for all 32 speakers in three speech styles

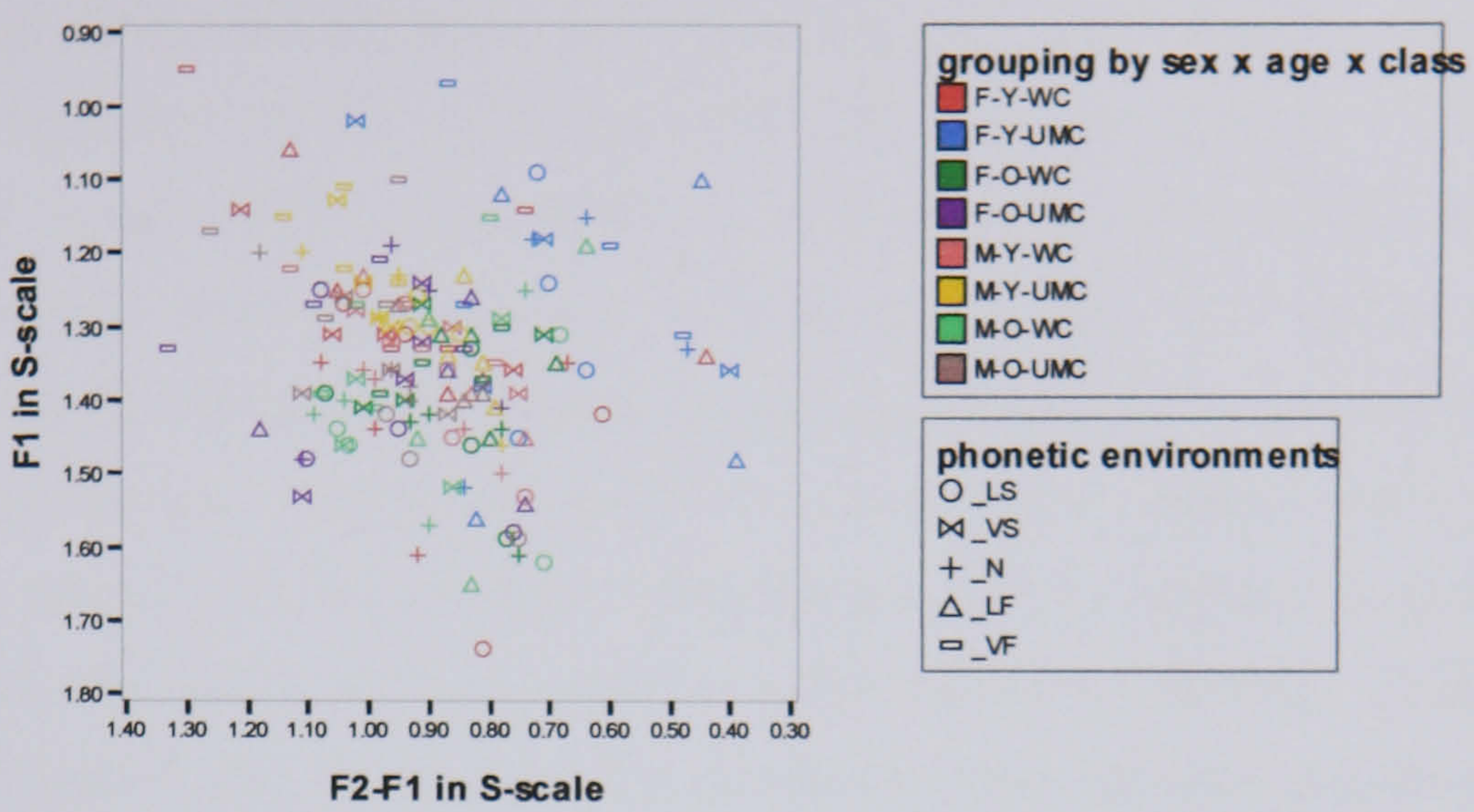


Figure 22 Mean distributions of STRUT vowels for all 32 speakers in five phonetic environments within WLS style

The results will be presented by each formant in the following order:

1. Results for SF1 of DRESS
2. Results for SF21 of DRESS
3. Results for SF1 of TRAP
4. Results for SF21 of TRAP
5. Results for SF1 of STRUT
6. Results for SF21 of STRUT

The results for each formant will be presented by each effect of each factor in the following way:

1. ANOVA results for all tests: T11, T12, T13, T14, T21, T22, T23
2. Effects of Speech style (from T11, T12, T13, T14)
3. Effects of Phonetic Environments (from T21, T22, T23)
4. Effects of Sex (from T11, T21)
5. Effects of Age (from T12, T22)
6. Effects of social class (from T13, T23)
7. Effects of social groupings (from T14)

First of all, ANOVA results for all the tests in which the given formant was involved will be shown in a table at once. Afterwards, those results will be decomposed focusing on each effect of all six factors (i.e. speech style, phonetic environments, sex, age, social class, and social groupings) one after another. In order to reveal the effects for each factor in detail, the results will have to be presented in a systematic way. Firstly, the results for the main effect of the given factor from all the ANOVA tests in which that particular factor was involved will be considered; the significant main effects for the factor with more than two conditions (i.e. speech style and phonetic environments) will be further examined by *post hoc* pairwise comparisons using Fischer's Least Significant Difference (LSD) in order to reveal difference between conditions. Thirdly, the results for all the interactions in which the factor was involved will be considered; the results, even if not significant, will be further analysed by simple effects tests to break down these interactions. Furthermore, significant simple effects for those factors with more than two conditions (i.e. speech style and phonetic environments) will be further examined by *post hoc* pairwise comparisons using LSD in order to reveal difference between conditions at each condition of the other factor. In this way, it is possible to reveal not only general patterns for the main effects of each factor, but also more detailed patterns for the simple effects of each factor for each condition of the other factor.

6.4 Statistical results

This section looks at statistical results of all the above-mentioned tests one after the other in great detail. Those who do not wish statistical details are advised to read only provisional summaries for each vowel (i.e. §6.4.3, §6.4.6 and §6.4.9) and move on to the overall summary and discussions (i.e. §6.5). Detailed means, standard deviations (SDs), maximum (Ma) and minimum (Mi) values and the difference between maximum and minimum values for each formant for each condition in each test are all provided in Appendix 10.

6.4.1 SF1 in DRESS

The results of the main effects and interaction effects for all the ANOVA tests in which the dependent variable was an SF1 value are provided in Table 13:

Table 13 ANOVA results for SF1 in DRESS: main effects and interaction effects

Test No.	Factor(s)	Type III Sum of Squares	df	Mean Square	F	Sig.	
1-1	**sstyle**	0.016	1.40, 42.10	0.012	5.302	0.017	***p*<0.05**
	sex	0.013	1, 30	0.013	5.558	0.025	***p*<0.05**
	sex x sstyle	0.000	1.40, 42.10	0.000	0.049	0.898	ns
1-2	**sstyle**	0.016	1.42, 42.64	0.012	5.463	0.015	***p*<0.05**

	age	0.002	1, 30	0.002	0.722	0.402	ns
	age x sstyle	0.003	1.42, 42.64	0.002	0.964	0.362	ns
1-3	**sstyle**	0.016	1.49, 44.76	0.011	6.289	0.008	***p*<0.01**
	social class	0.002	1, 30	0.002	0.762	0.390	ns
	social class x sstyle	0.015	1.492, 44.76	0.010	5.648	0.012	***p*<0.05**
1-4	**sstyle**	0.016	2, 48	0.008	7.219	0.002	***p*<0.01**
	groupings	0.026	7, 24	0.004	1.493	0.217	ns
	groupings x sstyle	0.038	14, 48	0.003	2.416	0.012	**p<0.05**
2-1	**PhonEn.**	0.214	4, 120	0.054	18.338	0.000	***p*<0.001**
	sex	0.064	1, 30	0.064	2.547	0.121	ns
	PhonEn x sex	0.024	4, 120	0.006	2.078	0.088	ns
2-2	**PhonEn.**	0.214	2.99, 89.68	0.072	19.786	0.000	***p*<0.001**
	age	0.033	1, 30	0.033	1.264	0.270	ns
	PhonEn x age	0.050	2.99, 89.68	0.017	4.610	0.005	***p*<0.01**
2-3	**PhonEn.**	0.214	4, 120	0.054	19.533	0.000	***p*<0.001**
	social class	0.084	1, 30	0.084	3.421	0.074	ns
	PhonEn x social class	0.046	4, 120	0.011	4.168	0.003	***p*<0.01**

This table will be referred to repeatedly as we discuss the effect of each factor one by one in the following sections.

6.4.1.1 SF1 in DRESS: speech style

Let us begin with the results for the effects of speech styles in the T11, T12, T13, and T14 in which speech style was compared with one of social factors (i.e. sex, age, social class, and social groupings) respectively. Figure 23 shows the means and their standard deviations (SDs) across three speech styles; in the middle of each of the three bars is a square that represents the mean of each group, while the vertical bar shows the SD around that mean.

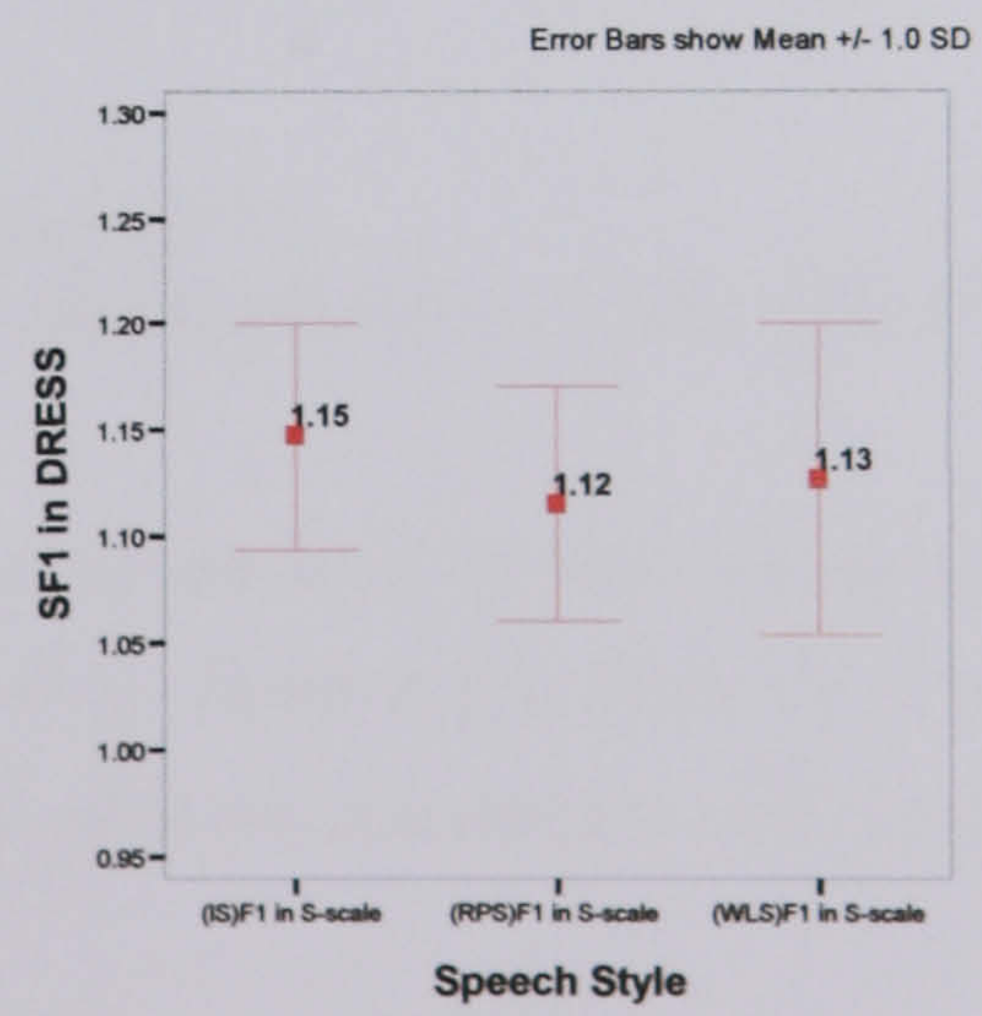


Figure 23 (SF1 in DRESS) Speech style: Means and SDs

The figure tells us that the mean of the SF1 values in IS is the highest followed by the mean in WLS and by the mean in RPS as the lowest, and that the SF1 values in WLS seem different from those in IS and RPS, in that the spread of the values is greater in the WLS than in the IS and RPS. Looking at the results for the main effect of speech style in Table 13, the difference between these means across speech style was found to be significant for all the tests 1-1, 1-2, 1-3, and 1-4. Therefore, in order to find out how these three means differ, the results were further examined by both planned contrasts and *post hoc* pairwise comparisons by LSD. Firstly let us look at the results of the planned contrasts shown in Table 14:

Table 14 SF1 in DRESS: Planned contrasts for the main effects of speech style

Test No.	Style contrasts	Type III Sum of Squares	df	Mean Square	F	Sig.	
Test-1-1	IS vs. RPS&WLS	0.022	1, 30	0.022	7.261	0.011	***p*<0.05**
	RPS vs. WLS	0.004	1, 30	0.004	1.820	0.187	ns
Test-1-2	IS vs. RPS&WLS	0.022	1, 30	0.022	7.525	0.010	***p*<0.05**
	RPS vs. WLS	0.004	1, 30	0.004	1.857	0.183	ns
Test-1-3	IS vs. RPS&WLS	0.022	1, 30	0.022	8.869	0.006	***p*<0.01**
	RPS vs. WLS	0.004	1, 30	0.004	2.055	0.162	ns
Test-1-4	IS vs. RPS&WLS	0.022	1, 24	0.022	10.494	0.003	***p*<0.01**
	RPS vs. WLS	0.004	1, 24	0.004	2.247	0.147	ns

The table tells us that, throughout analyses, SF1 values in spontaneous speech style were significantly higher than those in non-spontaneous speech styles. Within non-spontaneous speech, however, the values for RPS were not significantly different from those in WLS. This pattern for the effect of speech style on the SF1 values of DRESS by contrast is expressed in the following formulas:

(E-SF1: Style-contrast-pattern 1)***
Spontaneous speech (IS) > non-spontaneous speech (RPS&WLS)
RPS = WLS[52]

Similarly, the *post hoc* pairwise comparisons by the LSD also revealed the general pattern of SF1 values across three speech style as shown in the Table 15, in which an inequality sign indicates the significant result for each pairwise comparison with their significance level expressed by asterisks:

[52] Here I use '=' in a sense that there was no significant difference between the values in the environments of both sides.

Table 15 SF1 in DRESS: General patterns for the main effects of speech style by *post hoc* pairwise comparisons by LSD (ns: non-significant, *$p<0.05$, ** $p<0.01$, ***$p<0.001$)

Main effect of speech style in:	Pairwise comparisons by LSD		
	IS vs. RPS	IS vs. WLS	RPS vs. WLS
Test-1-1(by sex)***	>***	ns	ns
Test-1-2(by age)***	>***	ns	ns
Test-1-3(by class)***	>***	ns	ns
Test-1-4(by grouping)***	>***	ns	ns

Here, for all the analyses, the SF1 values in the IS were found to be significantly higher than in the RPS at the level of $p<0.001$ and $p<0.01$, while the SF1 values in the IS were no more significantly different from those in the WLS than those in RPS. These results suggest that, for the SF1 values of DRESS vowels, there was a significant style shift from IS to RPS, but there was no further style shift extended to WLS.

In summary, the general pattern for the effect of speech style on the SF1 values of DRESS by pairwise comparisons would be expressed in the following formulas:

(E-SF1: Style-pairwise-pattern 1) *** ** IS > RPS

We now turn to the results for the interaction effects between speech style and one of the social factors. The graphs in Figure 24 show the interaction graphs for all these interactions. Looking at the results for the interactions in Table 13, significant interactions were found between social class and speech style in T13, $F(1.492, 44.76)= 5.648$, $p<0.05$, and between social groupings and speech style in T14, $F(14, 48)= 2.416$, $p<0.05$, while non-significant interactions were found between sex and speech style in T11, $F(1.4, 42.1)= 0.049$, $p=0.898$, and between age and speech style in T12, $F(1.42, 42.64)= 0.964$, $p=0.362$. That is, the way in which the SF1 values were affected by speech style did differ for WC and UMC speakers and for speakers divided by social groupings, but did not differ for female and male speakers, and for young and old speakers. Planned contrasts also revealed significant interactions both when comparing WC and UMC values of SF1 in spontaneous speech style compared to non-spontaneous speech style, $F(1, 30)= 6.674$, $p<0.05$, and when comparing the values of social groupings in spontaneous speech style compared to non-spontaneous speech style, $F(7, 24)= 2.77$, $p<0.05$; this means that the profile of SF1 change between spontaneous speech and non-spontaneous speech and between RPS and WLS was significantly different between WC and UMC speakers and between social groupings. No other contrasts were significant ($p>0.05$).

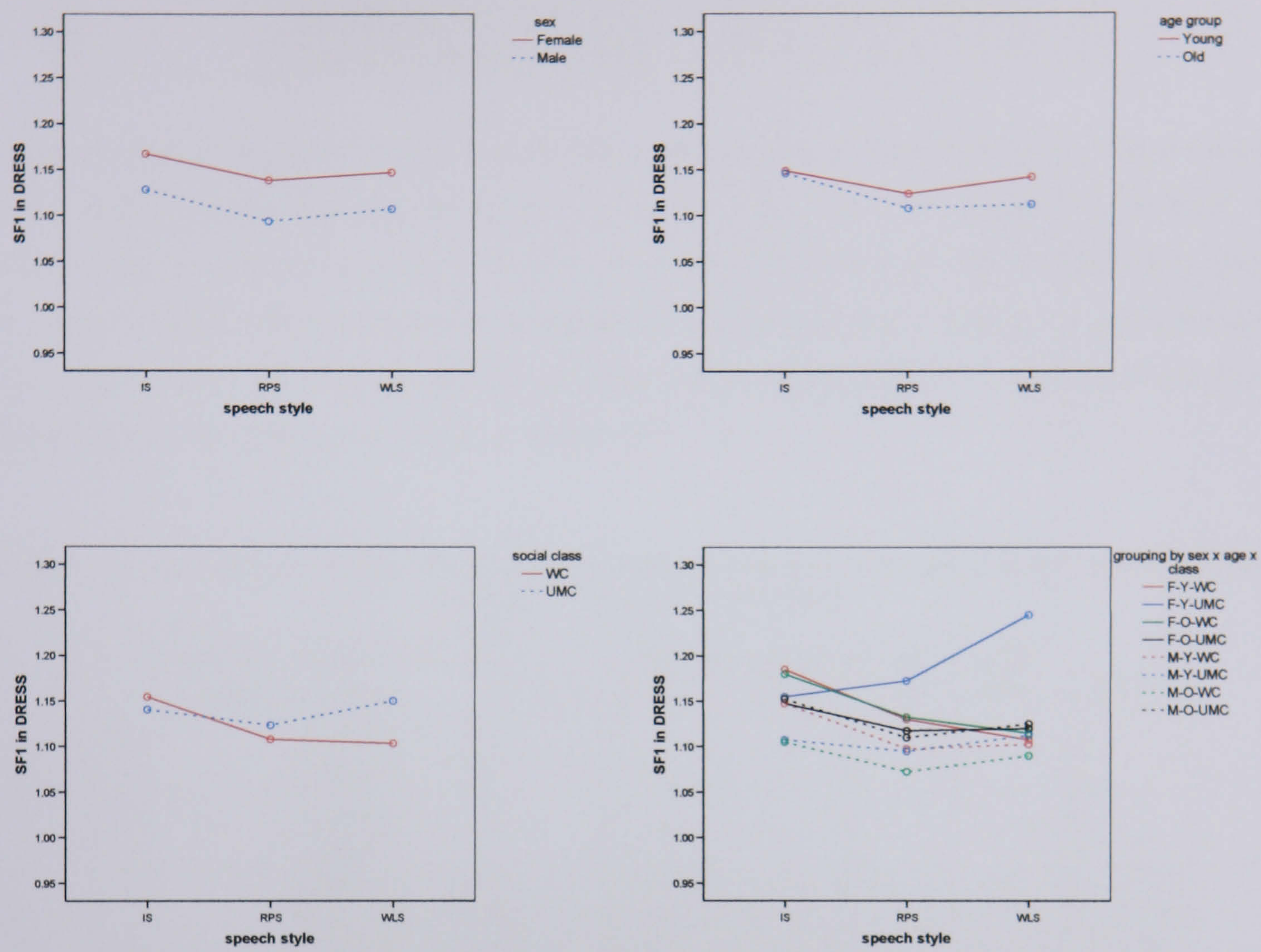


Figure 24 SF1 in DRESS: Interaction graphs for speech style x sex (top left), age (top right), social class (bottom-left), and social groupings (bottom-right)

To break down all these interactions in more detail, the data were further explored using simple effects tests; the results are shown in the Table 16:

Table 16 SF1 in DRESS: Simple effects of speech style for each condition of sex, age, social class, and social groupings

Test No.	Simple Effects	F	df	Sig.	
1-1 (sex)	Speech style at females	4.174	2, 29	0.026	***p*<0.05**
	Speech style at males	6.455	2, 29	0.005	***p*<0.01**
1-2 (age)	Speech style at Young	4.566	2, 29	0.019	***p*<0.05**
	Speech style at Old	6.469	2, 29	0.005	***p*<0.01**
1-3 (class)	Speech style at WC	9.602	2, 29	0.001	***p*<0.01**
	Speech style at UMC	4.606	2, 29	0.018	***p*<0.05**
1-4 (groupings)	Speech style at F-Y-WC	4.102	2, 23	0.03	***p*<0.05**
	Speech style at F-Y-UMC	6.235	2, 23	0.007	***p*<0.01**
	Speech style at F-O-WC	2.964	2, 23	0.072	ns
	Speech style at F-O-UMC	0.975	2, 23	0.392	ns

	Speech style at M-Y-WC	2.708	2, 23	0.088	ns
	Speech style at M-Y-UMC	0.455	2, 23	0.64	ns
	Speech style at M-O-WC	1.366	2, 23	0.275	ns
	Speech style at M-O-UMC	2.085	2, 23	0.147	ns

As can be seen in the Table 16, the simple effects of speech style were found to be significant for each condition of sex, age, and social class in the T11, T12, and T13; in the T14, however, the effects were significant only for F-Y-WC group and F-Y-UMC groups. Subsequently, these significant simple effects were further examined by *post hoc* pairwise comparisons using the LSD. The tests revealed the detailed patterns of difference in speech style for each condition of the other factor; those patterns are shown in Table 17:

Table 17 SF1 in DRESS: Simple effects of speech style in T11, T12, T13, and T14 (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

Patterns for simple effect of speech style at:		Pairwise comparisons by LSD		
		IS vs. RPS	IS vs. WLS	RPS vs. WLS
Sex	**Female ***	>*	ns	ns
	Male **	>**	ns	ns
Age	**Young ***	>*	ns	ns
	Old **	>**	ns	ns
Class	**WC ****	>***	>**	ns
	UMC *	ns	ns	<*
Groupings	**F-Y-WC***	>*	>*	ns
	F-Y-UMC**	ns	<**	<**
	F-O-WC^{ns}	–	–	–
	F-O-UMC^{ns}	–	–	–
	M-Y-WC^{ns}	–	–	–
	M-Y-UMC^{ns}	–	–	–
	M-O-WC^{ns}	–	–	–
	M-O-UMC^{ns}	–	–	–

For the interpretation of interaction effects, I referred to Field (2005). Comparing the significant interaction effects with relevant interaction graphs in Figure 24, the possible interacted patterns are shaded in grey in the three right rows, and significant interactions from the first planned contrast (i.e. IS vs. RPS&WLS) are also indicated by shades of the conditions of factors in the second left row. Those patterns significantly differ from each other – e.g. style pattern of WC vs. that of UMC – so that they may be reflected to significant interactions. Observing the relevant parts in the Figure 24, for the first interaction between social class and speech styles, the profile across three speech styles for the WC and that for the UMC are different; the SF1 values for the WC significantly decrease from spontaneous speech to non-spontaneous speech, whereas the SF1 values for the UMC are rather consistent from IS to RPS and even increase from RPS to WLS. For the second interaction between social groupings and speech styles, the profile for the F-Y-UMC is very different from those of others, particularly from that of the F-Y-WC; while the values for the F-Y-UMC decrease from spontaneous to non-spontaneous speech styles, those for the F-Y-WC and the others increase from less-formal speech styles to the most formal non-spontaneous speech styles.

As a whole, the patterns for the significant effects (i.e. main effects and simple effects) of speech style on the SF1 values of DRESS from these results are summarised as follows:

- Spontaneous (IS) > non-spontaneous (RPS&WLS), RPS = WLS: as the pattern from planned contrasts
- IS > RPS: as the general pattern, and as the patterns for the females, the males, the young, and the old
- IS > RPS = WLS: as the patterns for the WC and the F-Y-WC,
- RPS < WLS: as the pattern for the UMC,
- IS = RPS < WLS: as the pattern for the F-Y-UMC
- Interactions: '*class x IS-RPS-WLS', '*class x IS-RPS&WLS', '*grouping x IS-RPS-WLS', '*grouping x IS-RPS&WLS'.

6.4.1.2 SF1 in DRESS: phonetic environments

Let us now move on to the results for the effects of another within-subjects variable, phonological factor, in the T21, T22, and T23 in which phonetic environments were compared with one of the social factors (i.e. sex, age, and social class) respectively. Here, instead of comparing effects of all the five phonetic environments randomly, we consider the following three main points: (1) difference between SF1 values of DRESS vowels followed by voiced obstruents (i.e. _VS and _VF) and those followed by their voiceless counterparts (i.e. _LS and _LF) in the same manner of articulations, (2) difference between SF1 values of the vowels followed by stops (i.e. _VS and _LS) and those followed by fricatives (i.e. _VF and _LF) in the same voicing condition, and (3) difference between SF1 values of the vowels followed by stops (i.e. _VS and _LS), those followed by fricatives (i.e. _VF and _LF), and those followed by nasals (i.e. _N). Therefore, we will especially focus on comparisons for the following pairs in Table 18:

Table 18 Pairs of phonetic environments for pairwise comparisons

Pairs	(1) voiceless vs. voiced	(2) stops vs. fricatives	(3) nasals vs. stops / fricatives
1	_LS vs. _VS	_LS vs. _LF	_N vs. _LS
2	_LF vs. _VF	_VS vs. _VF	_N vs. _VS
3			_N vs. _LF
4			_N vs. _VF

Figure 25 shows the means and their SDs across five phonetic environments:

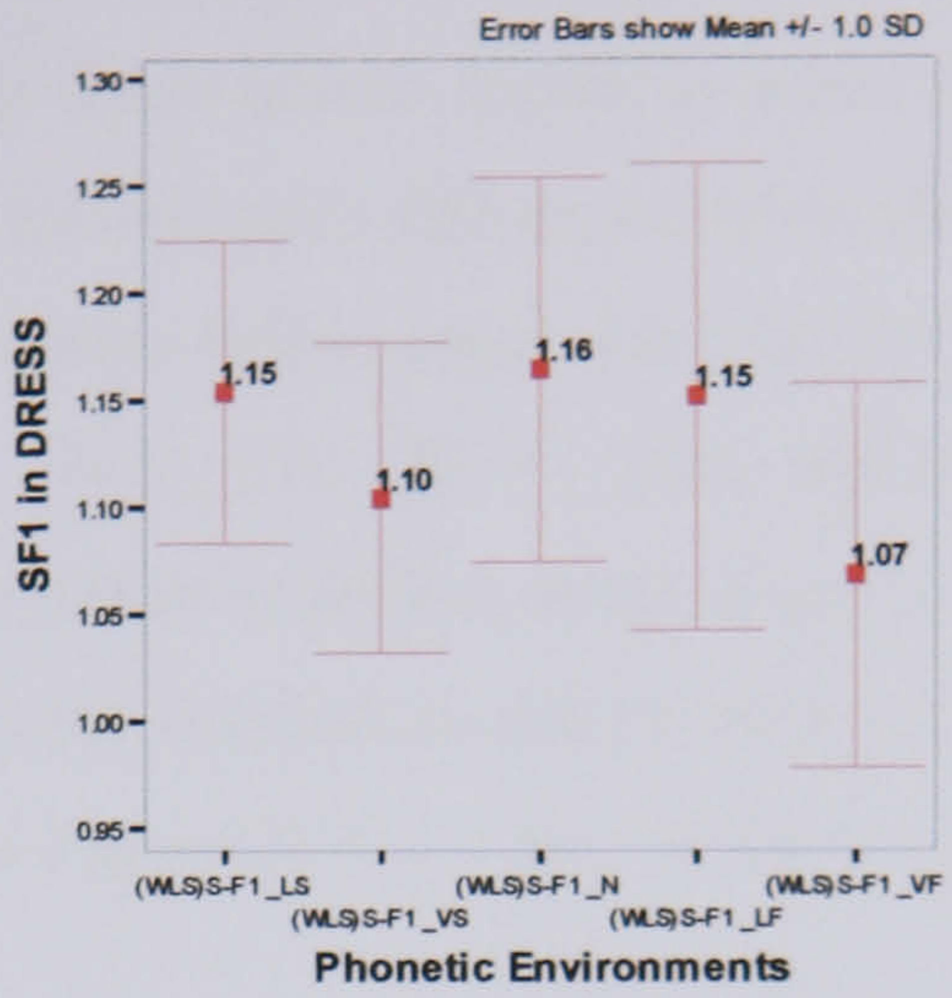


Figure 25 (SF1 in DRESS) Phonetic Environments: Means and SDs

The noticeable difference in the figure would be that the mean values of SF1 before voiced obstruents are lower than others among which the one before nasals is the highest and the one before voiceless fricatives has the greatest SD with the greatest range. Looking at the results for the main effect of speech style in Table 13, the difference between these means across phonetic environments was found out to be highly significant for all the tests 2-1, 2-2, and 2-3 at the level of $p<0.001$, so that phonetic environments proved to be a significant factor for the SF1 of DRESS vowels. In order to find out how the effects of these five phonetic environments differ, the results were further examined by *post hoc* pairwise comparisons; the comparisons revealed the following two general patterns for the effects of following segments on the SF1 values of DRESS vowels:

*(E-SF1: Phonetic environments-pairwise-pattern-1, Tests-2-1, 2-2, and 2-3)****
_VF < _VS < _LF = _LS = _N

Table 19 presents the detailed results of the pairwise comparisons, but only contains the results for the particular pairwise comparisons provided in Table 18 above:

Table 19 SF1 in DRESS: General patterns for the main effects of phonetic environments by *post hoc* pairwise comparisons by LSD (ns: non-significant, *$p<0.05$, ** $p<0.01$, ***$p<0.001$)

General patterns for:	(1)voiceless or voiced		(2)stops or fricatives		(3)nasals – stops – fricatives			
	_LS – _VS	_LF – _VF	_LS – _LF	_VS – _VF	_N – _LS	_N – _VS	_N – _LF	_N – _VF
Test-2-1(by sex)***	>***	>***	ns	>**	ns	>***	ns	>***
Test-2-2(by age)***	>***	>***	ns	>**	ns	>***	ns	>***
Test-2-3(by class)***	>***	>***	ns	>**	ns	>***	ns	>***

All the tests in the TEST Set-2 showed the same pattern. Firstly, DRESS vowels before voiceless obstruents had significantly higher SF1 values than those before their voiced obstruents (i.e. _LS

> _VS and _LF > _VF) in the same manner of articulation. Secondly, the vowels before stops had significantly higher values than those before fricatives when the following sounds were voiced (i.e. _VS > _VF), whilst there was no such difference when the following sounds were voiceless (i.e. _LS = _LF). Thirdly, the vowels before nasals had significantly higher SF1 values than those before voiced obstruents (i.e. _N >_VS, _N > _VF), whilst they did not have significantly different SF1 values from those before voiceless consonants (i.e. _N = _LS, _N = _LF).

Now we turn to the results for the interaction effects between phonetic environments and one of the social factors. The graphs in Figure 26 show the interaction graphs for all these interactions:

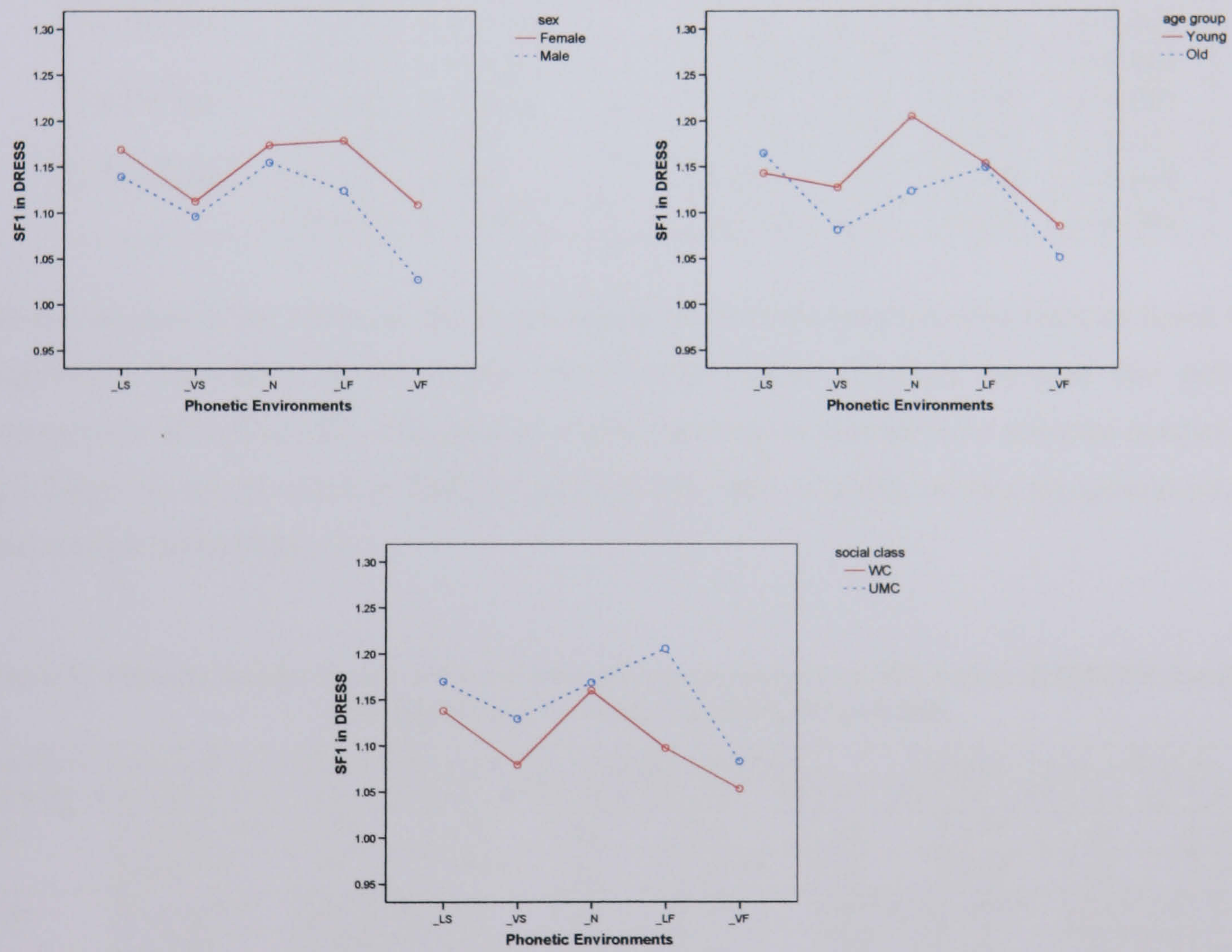


Figure 26 (SF1 in DRESS) Phonetic environments x sex (top left), age (top right), and social class (bottom)

Looking at the results for the interactions in Table 13, the interaction between phonetic environments and age and the interaction between phonetic environments and social class were significant: $F(2.99, 89.68)= 4.610$, $p<0.01$ for the former interaction $F(4, 120)= 4.168$, $p<0.01$ for the latter interaction. The former significant interaction indicates that the way in which SF1 values were affected by phonetic environments significantly differed for the young and the old.

The latter significant interaction indicates that the way in which SF1 values were affected by phonetic environments significantly differed for the WC and the UMC. The other non-significant interaction indicate that the way in which SF1 values were affected by phonetic environments did not significantly differ for the females and the males.

To break down both of these significant/non-significant interactions in more detail, the data were further explored using simple effects tests; the results are shown in the Table 20:

Table 20 SF1 in DRESS: Simple effects of phonetic environments for each condition of sex, age, and social class

Test No.	Simple Effects	F	df	Sig.	
2-1 (by sex)	PhonEn. at females	7.560	4, 27	0.000	***p*<0.001**
	PhonEn. at males	14.562	4, 27	0.000	***p*<0.001**
2-2 (by age)	PhonEn. at Young	9.382	4, 27	0.000	***p*<0.001**
	PhonEn. at Old	16.271	4, 27	0.000	***p*<0.001**
2-3 (by class)	PhonEn. at WC	8.854	4, 27	0.000	***p*<0.001**
	PhonEn. at UMC	13.729	4, 27	0.000	***p*<0.001**

As can be seen in the Table 20, the simple effects of phonetic environments were all found to be significant. Therefore, all the simple effects were further examined by *post hoc* pairwise comparisons using the LSD. The detailed results focusing on the particular pairwise comparisons (cf. Table 18) are provided in Table 21 which for the sake of clarity repeats the general patterns that we saw in the Table 19:

Table 21 Patterns for the simple effects of phonetic environments on SF1 values of DRESS vowels (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

Patterns for simple effects of Phonetic Environments at:		(1)voiceless or voiced		(2)stops or fricatives		(3)nasals – stops – fricatives			
		_LS – _VS	_LF – _VF	_LS – _LF	_VS – _VF	N – _LS	N – _VS	N – _LF	N – _VF
Sex	Female***	>**	>**	ns	ns	ns	>**	ns	>**
	Male***	>*	>***	ns	>***	ns	>**	ns	>***
Age	Young***	ns	>**	ns	>*	>***	>***	>*	>***
	Old***	>***	>***	ns	ns	<*	>*	ns	>**
Class	WC***	>**	>*	>*	ns	ns	>***	>*	>***
	UMC***	>*	>***	<*	>**	ns	>*	ns	>**
General patterns for:									
T21, T22, T23***		>***	>***	ns	>**	ns	>***	ns	>***

Comparing the significant interaction effects with relevant interaction graphs in Figure 26, the possible interacted patterns are shaded in grey; that is, those patterns significantly differ from each other so that they may be reflected to significant interactions. Observing the relevant parts in the Figure 26, for the first interaction between age and phonological environments, the profile of the

SF1 values between _N and voiceless obstruents (_LS or _LF) is apparently quite different for the young and the old; while the values for the young are higher before nasals than before voiceless obstruents, the values for the old are lower before nasals than before voiceless obstruents. For the second interaction between social class and phonological environments, the profile of the SF1 values from _LF to either _N or _LS looks different for the WC and the UMC; while the values for the WC increase from _LF to either _N or _LS, those for the UMC decrease from _LF to either _N or _LS.

As a whole, all the patterns for the significant effects (i.e. main effects and simple effects) of phonetic environments on the SF1 values of DRESS from these results are summarised as follows:

- (1)_LS > _VS, _LF > _VF: as the general pattern, and as the patterns for the females, the males, the old, the WC, and the UMC,
- (1)_LS = _VS, _LF > _VF: as the pattern for the young,
- (2)_LS = _LF, _VS > _VF: as the general pattern, and as the patterns for the males, and the young,
- (2)_LS > _LF, _VS = _VF: as the pattern for the WC
- (2)_LS < _LF, _VS > _VF: as the pattern for the UMC
- (2)_LS = _LF, _VS = _VF: as the patterns for the females, and the old,
- (3)_N = _LS, _N > _VS, _N = _LF, _N > _VF: as the general pattern, and as the patterns for the females, the males, and the UMC,
- (3)_N > _LS, _N > _VS, _N > _LF, _N > _VF: as the pattern for the young,
- (3) _N < _LS, _N > _VS, _N = _LF, _N > _VF: as the pattern for the old,
- (3) _N = _LS, _N > _VS, _N > _LF, _N > _VF: as the patterns for the WC.
- Interactions: '**age x _N-_LS, _N-_LF', '**class x _LS-_LF, _N-_LF'

6.4.1.3 SF1 in DRESS: sex

Now we turn to the results for the effects of sex in the T11 and T21 in which sex was compared with speech style and phonetic environments respectively. Let us firstly begin with the main effect of sex both in the T11 in which sex was compared with speech style in whole data and in the T21 in which sex was compared with phonetic environments within WLS data. The distributions of the SF1 values by sex are shown in Figure 27 below in which their means and SDs are displayed:

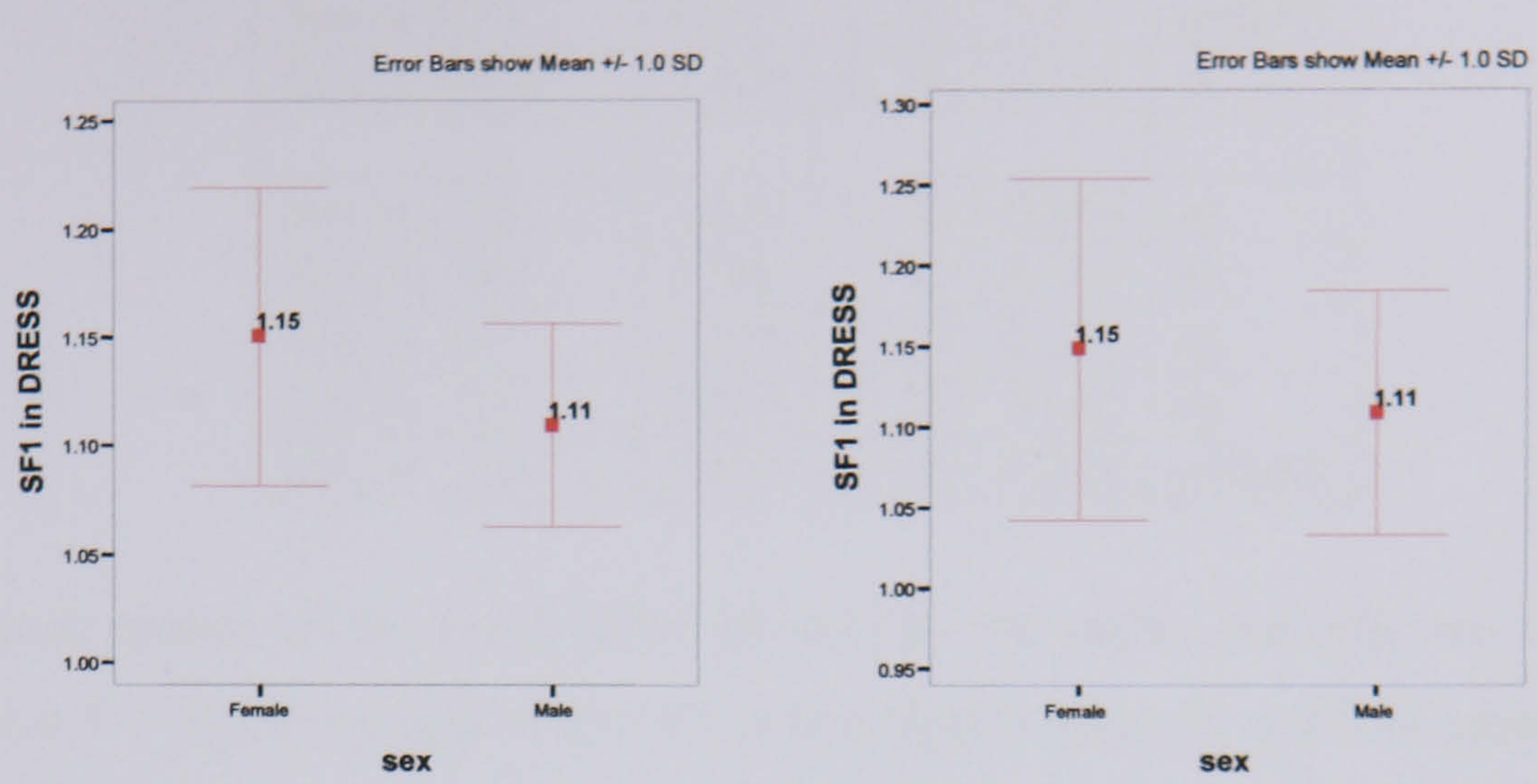


Figure 27 (SF1 in DRESS) Sex: Means and SDs in all speech styles in all speech styles for T11 (left) and in WLS for T21 (right)

For both T11 and T21, the mean of the SF1 values is higher for the females than for the males. Moreover, the SD and the range between maximum and minimum values for the females (see Appendix 10) were much greater for the females than for the males especially in T21. Looking at the Table 13, the main effect of sex was shown to be significant in T11, F(1, 30)=5.558, $p<0.05$, but non-significant in T21, F(1, 30)=2.547, $p=0.121$; the latter non-significance result may be due to the greater SD for the females than for the males. These results indicate that there was a significant effect of sex on the SF1 values of DRESS vowels for entire data in general, whilst there was no such effect for WLS in particular. Therefore, the following general pattern for the effect of sex on the SF1 values of DRESS vowels can be obtained:

(E-SF1: Sex-pattern-1, for entire data) Female > Male
(E-SF1: Sex-pattern-2, for WLS data) Female = Male

As discussed in §6.4.1.1 and §6.4.1.2, there was no significant interaction effect either between sex and speech styles or between sex and phonetic environments, indicating that the way in which the SF1 values were affected by sex did not significantly differ either across speech styles or across phonetic environments (cf. Figure 24 and Figure 26).

To break down these non-significant interactions, the simple effects tests were further performed; the results from the tests are shown in Table 22:

Table 22 SF1 in DRESS: Simple effects of sex for each condition of speech style and phonetic environments

Simple Effects	F	df	Sig.	
Sex at IS	4.768	1, 30	0.037	***p*<0.05**

Sex at RPS	6.011	1, 30	0.020	***p*<0.05**
Sex at WLS	2.409	1, 30	0.131	ns
Sex at _LS	1.410	1, 30	0.244	ns
Sex at _VS	0.390	1, 30	0.537	ns
Sex at _N	0.338	1, 30	0.565	ns
Sex at _LF	2.044	1, 30	0.163	ns
Sex at _VF	7.991	1, 30	0.008	***p*<0.01**

As the general pattern of the main effect of sex for the entire data that we saw above was significant (i.e. F > M), the simple effect of sex was significant in IS and RPS speech styles, i.e. F > M. Similarly, as we saw the general pattern of the main effect of sex for the WLS was F = M, the simple effect of sex was not significant in WLS speech style, i.e. F = M. This was also true for most of the conditions of the phonetic environments. Only significant was the simple effect of sex when the vowels were followed by voiced fricatives; in this environment, the SF1 values for female speakers were significantly higher than those for male speakers (i.e. F > M), as with the general pattern in the entire data.

Thus, for the sex factor, the general effect of sex on the SF1 values of DRESS vowels was F > M in less formal speech styles; that is, the SF1 values were higher for the females than for the males. This pattern was also true even in the most formal speech style only when the vowels were followed by voiced fricatives; otherwise, there was no such effect of sex in the most formal speech style. These results are summarised as follows:

- F > M: as the general pattern (for entire data), and as the patterns for IS, RPS and _VF,
- F = M: as the general pattern (for WLS data), and as the patterns for WLS, _LS, _VS, _N and _LF.

6.4.1.4 SF1 in DRESS: age

We turn now to the results for the effects of age in the T12 and T22 in which age was compared with speech style in whole data and with phonetic environments in WLS data respectively. Let us begin with the main effect of age both in the T12 and in the T22. The distributions of the SF1 values by age are shown in Figure 28 which displays their means and SDs:

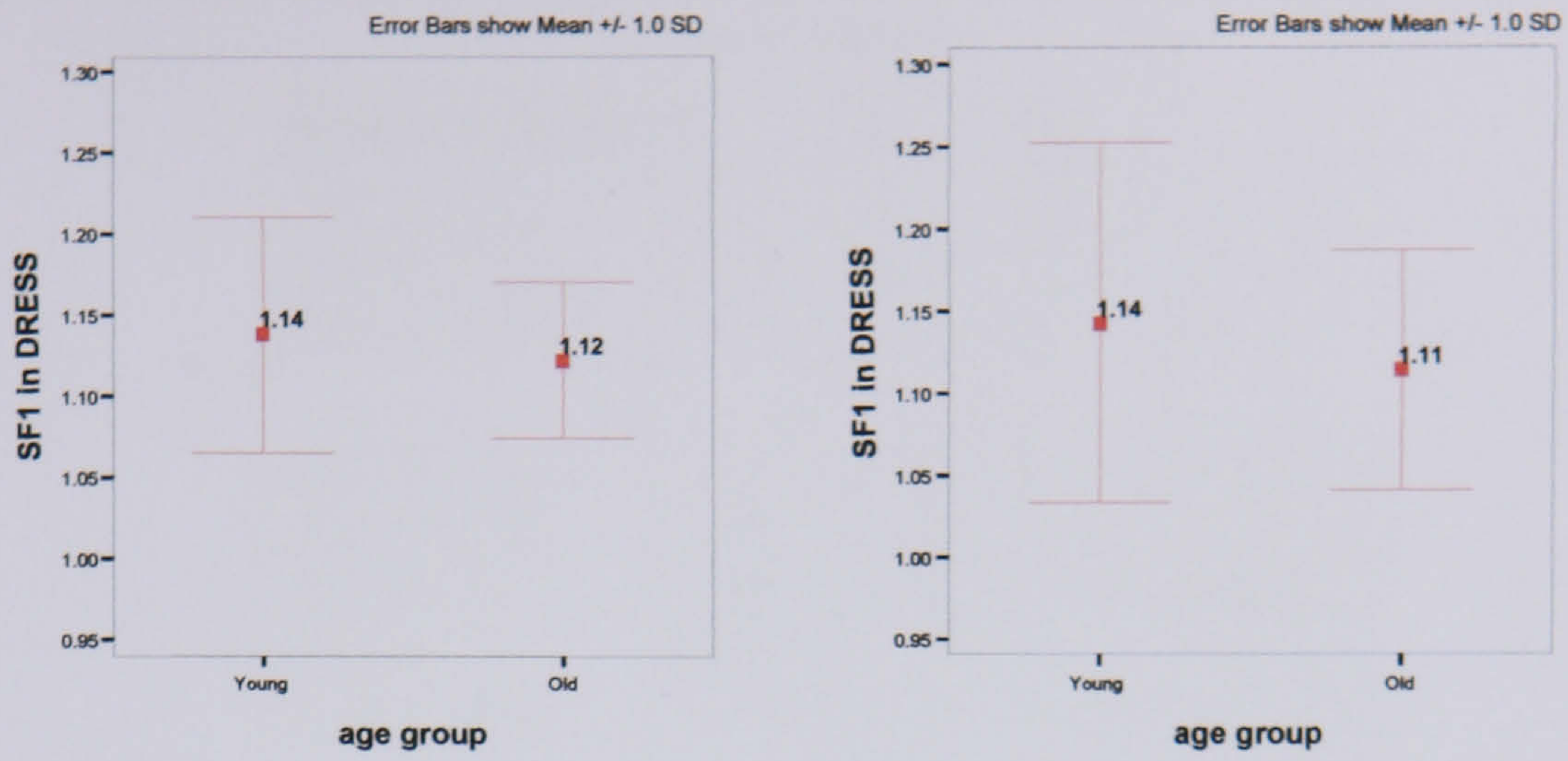


Figure 28 (SF1 in DRESS) Age: Means and SDs in all speech styles for T12 (left) and in WLS for T22 (right)

For both T12 and T22, the means of the SF1 values are higher for young speakers than for old speakers. The SDs are also greater for the young than for the old. Looking at the ANOVA table in Table 13, the main effects of age in T12 and T22 were both shown to be non-significant: $F(1, 30)= 0.722$, $p=0.402$ in T12 and $F(1, 30)= 1.264$, $p=0.27$ in T22. These results indicate that there was no significant effect of age on the SF1 values of DRESS vowels for entire data in general and for WLS in particular as well. Therefore, the following general pattern for the effect of age on the SF1 of DRESS vowels can be obtained:

(E-SF1: Age-pattern-1) Young = OLD

As discussed in §6.4.1.1 and §6.4.1.2, while there was no significant interaction effect between age and speech style, there was a highly significant interaction effect between age and phonetic environment: $F(2.99, 89.68)= 4.610$, $p<0.01$. The result was interpreted in §6.4.1.2 that the way in which SF1 values were affected by phonetic environments significantly differed for the young and the old, and, as indicated in Table 21, it seems particularly so when comparing the environments, _N vs. _LS, or _N vs. _LF. This significant interaction can in fact also be interpreted as follows: the way in which SF1 values were affected by age significantly differed in different phonetic environments.

To break down this significant interaction as well as the other non-significant interaction, the simple effects tests were further performed; the results from the tests are shown in Table 23:

Table 23 SF1 in DRESS: Simple effects of age for each condition of speech style and phonetic environments

Simple Effects	F	df	Sig.	
Age at IS	0.017	1, 30	0.897	ns
Age at RPS	0.634	1, 30	0.432	ns
Age at WLS	1.295	1, 30	0.264	ns
Age at _LS	0.766	1, 30	0.388	ns
Age at _VS	3.481	1, 30	0.072	ns
Age at _N	7.931	1, 30	0.009	***p*<0.01**
Age at _LF	0.012	1, 30	0.912	ns
Age at _VF	1.130	1, 30	0.296	ns

Possible interacted patterns are shaded in the table. Similar to the general pattern for the non-significant main effect of age that we saw above (i.e. Y=O), the effects of age in all speech styles and in most of the phonetic environments were found to be non-significant, i.e. Y=O. Only significant was the effect of age when the vowels were followed by nasals; in this environment, the SF1 values for young speakers were significantly higher than those for old speakers, i.e. Y>O. This difference in age effect in different phonetic environment may be reflected to significant interactions with speech style.

Thus, for the age factor, in addition to a non-significant main effect, we see non-significant results for the effect of age for all speech styles; when the simple effects analyses were tested for age at each phonetic environment within WLS data, however, the effect of age did exist (i.e. Y>O) only when the vowels were followed by nasals. The results are summarised as follows:

- Y = O: as the general pattern (for entire data, and for WLS), and as the patterns for all speech styles, _LS, _VS, _LF and _VF,
- Y > O: as the pattern for _N.
- Interaction: '**age x _N-others'

6.4.1.5 SF1 in DRESS: social class

We turn now to the results for the effects of social class in the T13 and T23 in which social class was compared with speech style in whole data and with phonetic environments in WLS data respectively. Let us begin with the main effect of social class both in the T13 and in the T23. The distributions of the SF1 values by social class are provided in Figure 29 which shows their means and SDs:

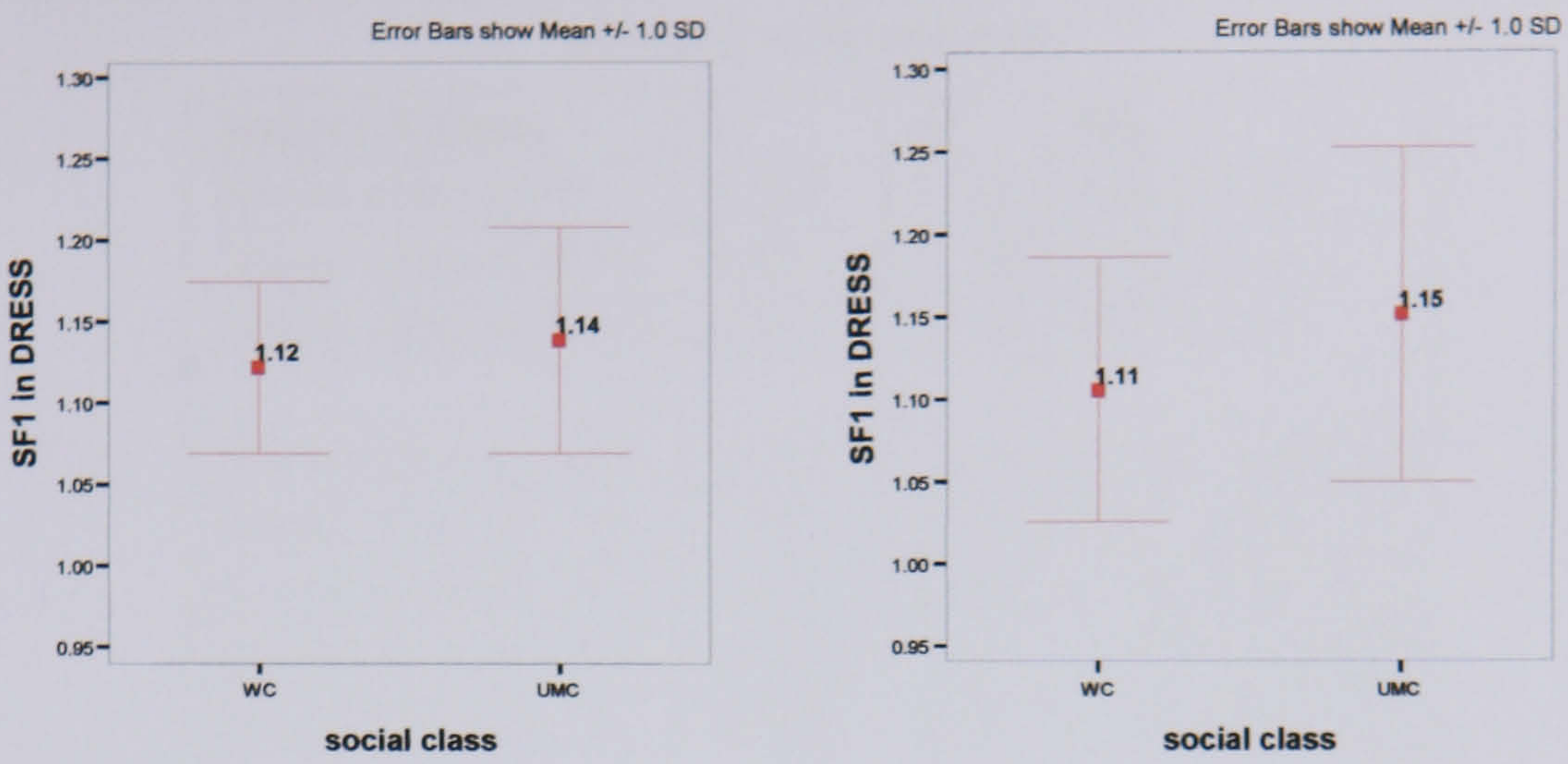


Figure 29 (SF1 in DRESS) Social class: Means and SDs in all speech styles for T13 (left) and in WLS for T23 (right)

For both T13 and T23, the means of the SF1 values were higher for UMC speakers than for WC speakers. The greater SDs and wider range between maximum and minimum values for the UMC (cf. Appendix 10) indicate that the SF1 values for the UMC were more varied than for the WC. Looking at the ANOVA table in Table 13, the main effects of social class in T13 and T23 were both non-significant: $F(1, 30)= 0.762$, $p=0.39$ in T13 and $F(1, 30)= 3.421$, $p=0.074$ in T23. These results indicate that there was no significant effect of social class on the SF1 values of DRESS vowels for entire data in general and for WLS in particular as well. Therefore, the following general pattern for the effect of social class on the SF1 of DRESS vowels can be obtained:

(E-SF1: Social class-pattern-1) WC = UMC

As discussed in §6.4.1.1 and §6.4.1.2, there were significant interaction effects both between social class and speech styles (i.e. IS vs. RPS vs. WLS, and IS vs. RPS&WLS) and between social class and phonetic environments. The results were interpreted in §6.4.1.1 and §6.4.1.2 that the way in which SF1 values were affected by speech styles or phonetic environments significantly differed for the WC and the UMC. In the case of the interaction with phonetic environments, as indicated in Table 21, it seems particularly so when comparing the environments, _LS vs. _LF or _N vs. _LF. These significant interactions can also be interpreted as follows: the way in which SF1 values were affected by social class significantly differed in different speech styles or in different phonetic environments.

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 24:

Table 24 (SF1 in DRESS) Simple effects of social class for each condition of speech styles and phonetic environments

Simple Effects	F	df	Sig.	
Social class at IS	0.527	1, 30	0.473	ns
Social class at RPS	0.634	1, 30	0.432	ns
Social class at WLS	3.533	1, 30	0.070	ns
Social class at _LS	0.674	1, 30	0.206	ns
Social class at _VS	4.150	1, 30	0.051	ns
Social class at _N	0.073	1, 30	0.789	ns
Social class at _LF	10.119	1, 30	0.003	***p*<0.01**
Social class at _VF	0.886	1, 30	0.354	ns

Possible interacted patterns are shaded in the table. Similar to the general pattern for the non-significant main effect of social class that we saw above (i.e. WC=UMC), the effect of social class in all speech styles and in most of the phonetic environments were found to be non-significant, i.e. WC=UMC. Only significant was the effect of social class when the vowels were followed by voiceless fricatives; in this environment, the SF1 values for the UMC were significantly higher than those for the WC, i.e. WC<UMC. This difference in social class effect for different phonetic environments may be reflected to significant interactions with phonetic environments, whereas no difference in social class across speech styles may confirm that the interaction between social class and speech styles is due to the difference in profiles of WC and UMC speakers across speech styles.

Thus, for the social class factor, in addition to a non-significant main effect, we see non-significant results for the effect of social class for all speech styles; when the simple effects analyses were tested for social class at each phonetic environment within WLS data, however, the effect of social class did exist (i.e. WC<UMC) only when the vowels were followed by voiceless fricatives. The results are summarised as follows:

- WC = UMC: as the general pattern (for entire data, and for WLS), and as the patterns for all speech styles, _LS, _VS, _N and _VF,
- WC < UMC: as the pattern for _LF
- Interactions: '*class x IS-RPS-WLS', '*class x IS-RPS&WLS', '**class x _LF-others'.

6.4.1.6 SF1 in DRESS: social grouping (by sex, age and social class)

Before we move on to the results in SF1 values of DRESS for different social grouping (i.e. grouping by sex, age and social class), there is one point to make with regard to the T14. Unlike the other three tests in TEST Set-1, the main objective for this T14 was not to see the effect of the factor (i.e. social grouping) itself; instead, this social grouping factor was especially elaborated to be able to make comparisons between particular pairs of groups which differed in only one social factor. By focusing on only the difference in one particular social factor, we can make three different types of comparisons between socially correlated groups of people due to their sex, age, and social class: i.e. sex comparisons, age comparisons, and social class comparisons. That is, for the sex comparisons, I compared four pairs of groups; groups in each pair belonged to the same age and social class group, but differed in sex. In the same way, for the age comparisons, I compared four pairs of groups; groups in each pair belonged to the same sex and social class, but differed in age. Finally for the social class comparisons, I compared four pairs of groups; groups in each pair belonged to the same sex and age group, but differed in social class. All the pairs of groups for each of three comparisons are summarised in the Table 25 below:

Table 25 Pairs of groups for sex, age, social class comparisons

Pairs	Sex Comparisons		Age Comparisons		Social Class Comparisons	
	Female	*Male*	*Young*	*Old*	*WC*	*UMC*
1	*F*-Y-WC	vs. *M*-Y-WC	F-*Y*-WC	vs. F-*O*-WC	F-Y-*WC*	vs. F-Y-*UMC*
2	*F*-Y-UMC	vs. *M*-Y-UMC	F-*Y*-UMC	vs. F-*O*-UMC	F-O-*WC*	vs. F-O-*UMC*
3	*F*-O-WC	vs. *M*-O-WC	M-*Y*-WC	vs. M-*O*-WC	M-Y-*WC*	vs. M-Y-*UMC*
4	*F*-O-UMC	vs. *M*-O-UMC	M-*Y*-UMC	vs. M-*O*-UMC	M-O-*WC*	vs. M-O-*UMC*

For example, the first sex comparison was made between F-Y-WC (i.e. female-young-working class) group and M-Y-WC (i.e. male-young-working class) group, since these two groups were both from Y-WC group but different from each other in terms of their sex only so that we could expect difference in these groups was mainly due to their sex difference. With the results in the previous three sections for the effects of each social factor (i.e. sex, age, social class) and their interaction effects with speech style factor or phonetic environment factor, these three additional comparisons enabled us to examine overall picture of the data in more detail[53].

Let us now look at the results for the effects of social groupings in the T14 in which social grouping factor was compared with speech style in whole data. Let us begin with the main effect of social grouping. The distributions of the SF1 values by social grouping are provided in Figure 30 which shows their means and SDs:

[53] These comparisons were possible only when the main ANOVA results were significant since the pairwise comparisons by LSD for these comparisons required the overall ANOVA to be significant (Field 2005: 340).

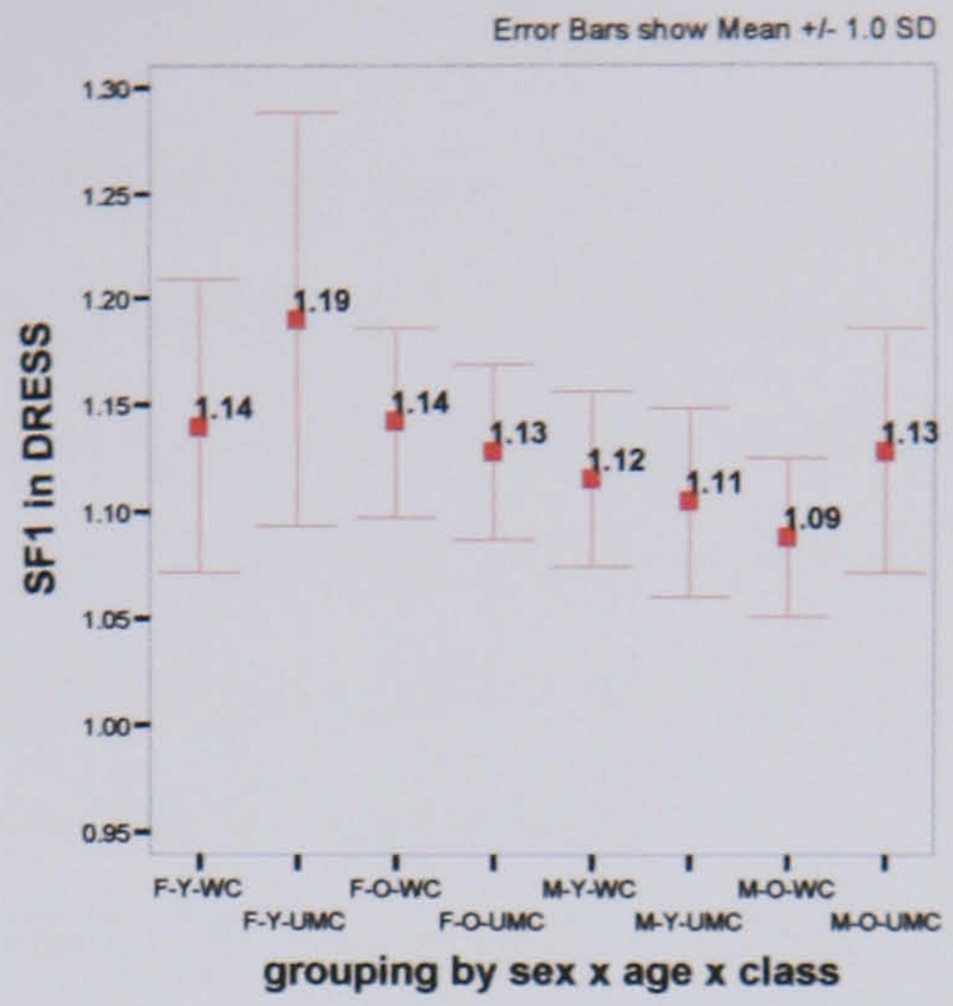


Figure 30 (SF1 in DRESS) Social grouping: Means and SDs in all speech styles for T14

The remarkable difference that we can see from the figure would be that the SF1 values for F-Y-UMC are higher than any other groups, with the greatest SD and the widest range between maximum and minimum (cf. Appendix 10); this indicates that the SF1 values are more varied for F-Y-UMC speakers than for the other speakers. Another thing is that most of the SF1 values for females are higher than those for males. Looking at the ANOVA results in Table 13, however, the main effect of social grouping in the T14 was not significant, $F(7, 24) = 1.493$, $p=0.217$. This result indicates that there was no significant effect of social grouping on the SF1 values of DRESS vowels. Therefore, the data could not be further examined the difference between these groupings.

As discussed in §6.4.1.1, there were significant interaction effects between social groupings and speech styles (i.e. IS vs. RPS vs. WLS, and IS vs. RPS&WLS). The significant result was interpreted that the way in which SF1 values were affected by speech styles significantly differed for different groupings, and in particular, the pattern for the F-Y-UMC seems to be very different from that for the F-Y-WC as well as others, as can be seen in the Figure 24. This, however, can also be interpreted as follows: the way in which SF1 values were affected by social groupings significantly differed in different speech styles.

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 26:

Table 26 (SF1 in DRESS) Simple effects of social grouping at each speech style

Simple Effects	F	df	Sig.	
grouping at IS	1.279	7, 24	0.302	ns
grouping at RPS	1.269	7, 24	0.307	ns

grouping at WLS	2.285	7, 24	0.062	ns

Similar to the non-significant main effect, the effect of social grouping in all speech styles were found to be non-significant (i.e. $p>0.05$). No difference in social groupings across speech styles may confirm that the interaction between groupings and speech styles is simply due to the difference in profiles of different social groupings across speech styles. These non-significant results, therefore, prevented me from performing *post hoc* pairwise comparisons by LSD to see more detailed internal difference between groupings.

The result for the social grouping effect on the SF`1 values of DRESS is summarised as follows:

- Interactions: '*grouping x IS-RPS-WLS', '*grouping x IS-RPS&WLS'.

6.4.2 SF21 in DRESS

The results of the main effects and interaction effects for all the ANOVA tests in which the dependent variable was an SF21 value are provided in Table 27:

Table 27 ANOVA results for SF21 in DRESS: main effects and interaction effects

Test No.	Factor(s)	Type III Sum of Squares	df	Mean Square	F	Sig.	
1-1	sstyle	0.406	2, 60	0.203	52.322	0.000	$p<0.001$
	sex	0.000	1, 30	0.000	0.003	0.956	ns
	sex x sstyle	0.024	2, 60	0.012	3.084	0.053	ns
1-2	sstyle	0.406	2, 60	0.203	49.518	0.000	$p<0.001$
	age	0.113	1, 30	0.113	5.327	0.028	$p<0.05$
	age x sstyle	0.011	2, 60	0.005	1.311	0.277	ns
1-3	sstyle	0.406	2, 60	0.203	48.329	0.000	$p<0.001$
	social class	0.043	1, 30	0.043	1.835	0.186	ns
	social class x sstyle	0.005	2, 60	0.002	0.560	0.574	ns
1-4	sstyle	0.406	2, 48	0.203	50.179	0.000	$p<0.001$
	groupings	0.24	7, 24	0.034	1.609	0.181	ns
	groupings x sstyle	0.063	14, 48	0.004	1.104	0.378	ns
2-1	PhonEn.	0.346	4, 120	0.086	10.146	0.000	$p<0.001$
	sex	0.056	1, 30	0.056	0.454	0.505	ns
	PhonEn x sex	0.173	4, 120	0.043	5.060	0.001	$p<0.01$
2-2	PhonEn.	0.346	4, 120	0.086	8.949	0.000	$p<0.001$
	age	0.515	1, 30	0.515	4.749	0.037	$p<0.05$
	PhonEn x age	0.036	4, 120	0.009	0.923	0.453	ns
2-3	PhonEn.	0.346	4, 120	0.086	9.217	0.000	$p<0.001$
	social class	0.18	1, 30	0.18	1.5	0.23	ns
	PhonEn x social class	0.069	4, 120	0.017	1.851	0.124	ns

This table will be referred to repeatedly as we discuss the effect of each factor one by one in the following sections.

6.4.2.1 SF21 in DRESS: speech style

Let us begin with the results for the effects of speech styles in the T11, T12, T13, and T14 in which speech style was compared with one of social factors (i.e. sex, age, social class, and social groupings) respectively. Figure 31 shows the means and their SDs across speech styles:

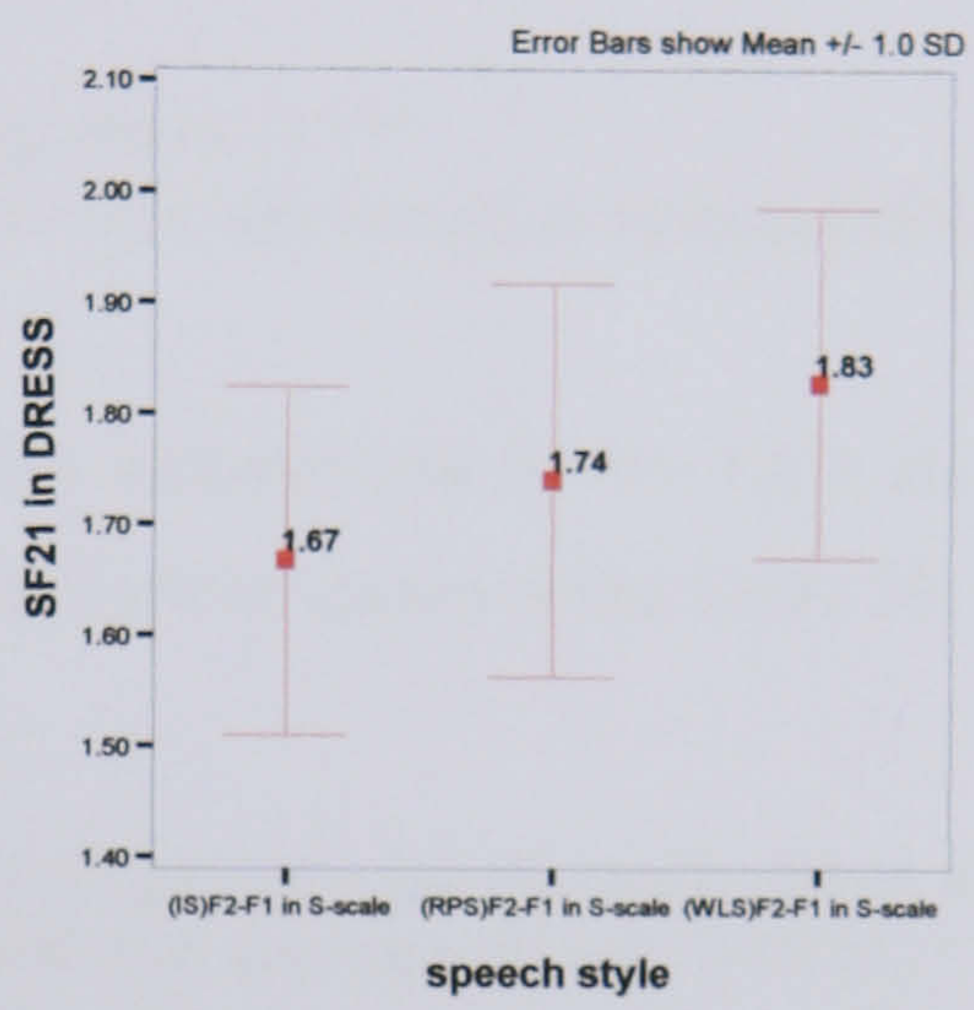


Figure 31 (SF21 in DRESS) Speech style: Means and SDs

The figure tells us that the mean of the SF21 values in WLS is the highest followed by the mean in RPS and by the mean in IS as the lowest. Looking at the results for the main effect of speech style in Table 27, the difference between these means across speech style was found to be highly significant for all the tests 1-1, 1-2, 1-3 and 1-4. Therefore, in order to find out how these three means differ, the results were further examined by both planned contrasts and *post hoc* pairwise comparisons by LSD. Firstly let us look at the results of the planned comparisons shown in Table 28:

Table 28 SF21 in DRESS: Planned contrasts for the main effects of speech style

Test No.	Style contrasts	Type III Sum of Squares	df	Mean Square	F	Sig.	
Test-1-1	IS vs. RPS&WLS	0.428	1, 30	0.428	76.406	0.000	p**<0.001**
	RPS vs. WLS	0.242	1, 30	0.242	29.992	0.000	p**<0.001**
Test-1-2	IS vs. RPS&WLS	0.428	1, 30	0.428	66.947	0.000	p**<0.001**
	RPS vs. WLS	0.242	1, 30	0.242	30.663	0.000	p**<0.001**
Test-1-3	IS vs. RPS&WLS	0.428	1, 30	0.428	66.299	0.000	p**<0.001**

	RPS vs. WLS	0.242	1, 30	0.242	29.466	0.000	**p<0.001**
Test-1-4	IS vs. RPS&WLS	0.428	1, 24	0.428	79.786	0.000	**p<0.001**
	RPS vs. WLS	0.242	1, 24	0.242	26.742	0.000	**p<0.001**

The table tells us that, throughout analyses, SF21 values in spontaneous speech style were significantly lower than those in non-spontaneous speech styles at the level of p<0.001; moreover, within non-spontaneous speech, the values for RPS were significantly lower than those in WLS. This pattern for the effect of speech style on the SF21 values of DRESS by contrast is expressed in the following formulas:

*(E-SF21: Style-contrast-pattern 1)****
Spontaneous speech (IS) < non-spontaneous speech (RPS&WLS)
RPS < WLS

Similarly, the *post hoc* pairwise comparisons by the LSD also revealed the general pattern of SF21 values across three speech style as shown in the Table 29:

Table 29 SF21 in DRESS: General patterns for the main effects of speech style by *post hoc* pairwise comparisons by LSD (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

Main effect of speech style in:	Pairwise comparisons by LSD		
	IS vs. RPS	IS vs. WLS	RPS vs. WLS
Test-1-1(by sex)***	<***	<***	<***
Test-1-2(by age)***	<***	<***	<***
Test-1-3(by class)***	<***	<***	<***
Test-1-4(by grouping)***	<***	<***	<***

All the pairwise comparisons were found out to be very highly significant for all the analyses, indicating that the SF21 values were significantly lower in the IS than in the RPS, and those were significantly lower in the RPS than in the WLS. These results suggest that, there was the following style shifting; the more formal the speech style is, the higher the SF21 value is. Therefore, the general pattern for the effect of speech style on the SF21 values of DRESS by pairwise comparisons would be expressed in the following formulas:

*(E-SF21: Style-pairwise-pattern 1)**** IS < RPS < WLS

Now we turn to the results for the interaction effects between speech style and one of the social factors. The graphs in Figure 32 show the interaction graphs for all these interactions:

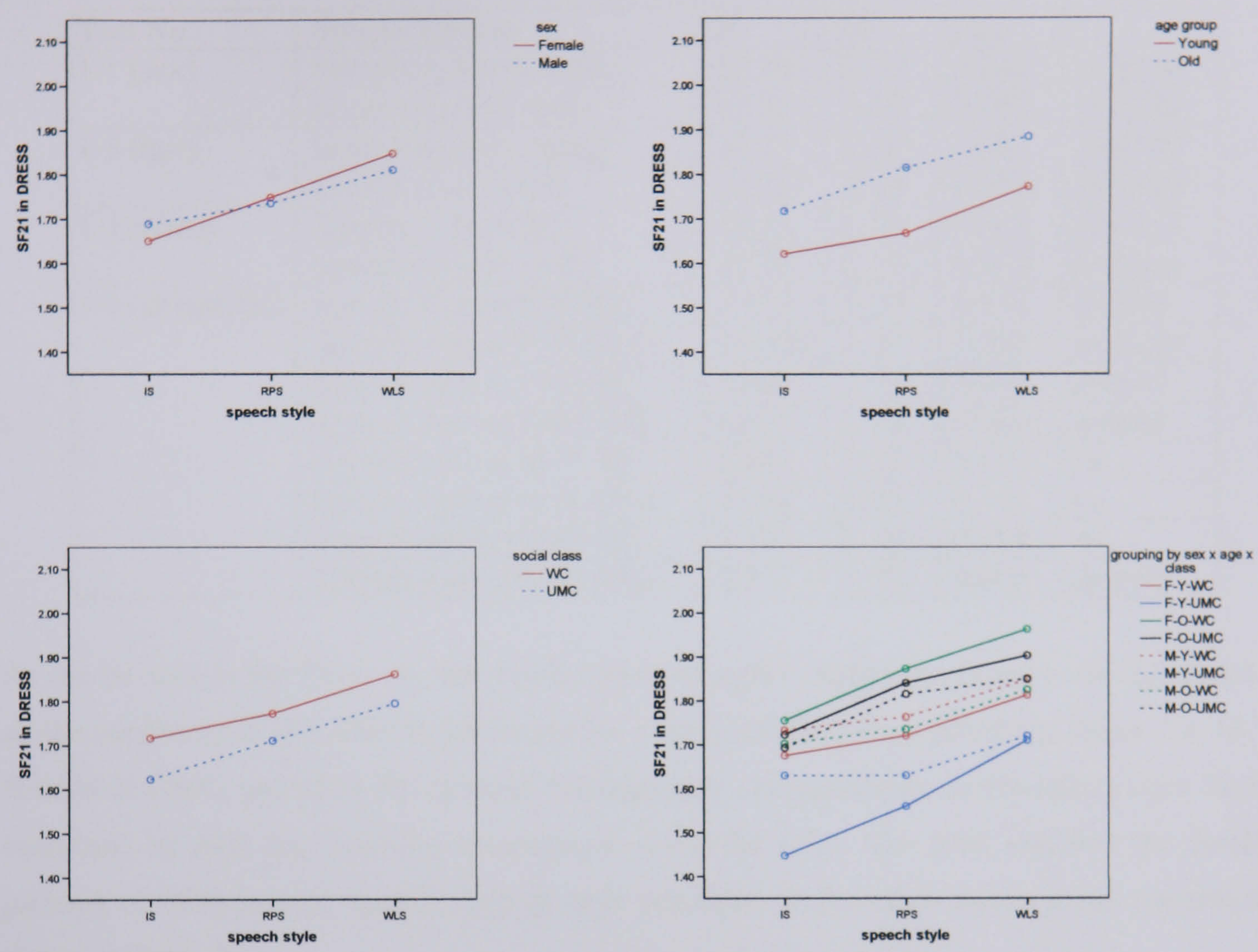


Figure 32 SF21 in DRESS: Interaction graphs for speech style x sex (top left), age (top right), social class (bottom-left), and social groupings (bottom-right)

Looking at the results for the interactions in Table 27, none of the interactions of speech style and another factor was significant: F(2, 60)= 3.084, *p*=0.053 (for sex and speech style in T11), F(2, 60)= 1.311, *p*=0.277 (for age and speech style in T12), F(2, 60)= 0.56, *p*=0.574 (for social class and speech style in T13), and F(14, 48)= 1.104, *p*=0.378 (for groupings and speech style in T14). This means that the way in which the SF21 values were affected by speech style did not differ for male and female speakers, for young and old speakers, for WC and UMC speakers, and for eight social groupings. Planned contrasts, however, revealed one significant interaction when comparing male and female values of SF21 in spontaneous speech style compared to non-spontaneous speech styles, F(1, 30)= 5.807, *p*=0.022, *p*<0.05; this means that the decrease of SF21 from non-spontaneous to spontaneous speech was greater for the female speakers than for the male speakers. No other contrasts were significant (*p*>0.05).

To break down these interactions in more detail, the data were further explored using simple effects tests; the results are shown in the Table 30:

Table 30 SF21 in DRESS: Simple effects of speech style at each condition of sex, age, social class, and social groupings

Test No.	**Simple Effects**	**F**	**df**	**Sig.**	
1-1 (sex)	Speech style at females	35.16	2. 29	0.000	***p*<0.001**
	Speech style at males	13.21	2, 29	0.000	***p*<0.001**
1-2 (age)	Speech style at Young	18.17	2, 29	0.000	***p*<0.001**
	Speech style at Old	22.331	2, 29	0.000	***p*<0.001**
1-3 (class)	Speech style at WC	16.57	2, 29	0.000	***p*<0.001**
	Speech style at UMC	23.32	2, 29	0.000	***p*<0.001**
1-4 (groupings)	Speech style at F-Y-WC	4.020	2, 23	0.032	***p*<0.05**
	Speech style at F-Y-UMC	14.825	2, 23	0.000	***p*<0.001**
	Speech style at F-O-WC	9.940	2, 23	0.001	***p*<0.01**
	Speech style at F-O-UMC	8.033	2, 23	0.002	***p*<0.01**
	Speech style at M-Y-WC	2.844	2, 23	0.079	ns
	Speech style at M-Y-UMC	2.078	2, 23	0.148	ns
	Speech style at M-O-WC	3.223	2, 23	0.058	ns
	Speech style at M-O-UMC	7.007	2, 23	0.004	***p*<0.01**

As can be seen in the Table 30, the simple effects of speech style were found to be significant at all the conditions of the other factor except for a few conditions from groupings factor (i.e. M-Y-WC, M-Y-UMC, and M-O-WC groups). Subsequently, the significant simple effects were further examined by *post hoc* pairwise comparisons using the LSD. The tests revealed the detailed patterns of difference in speech style at each condition of the other factor; those patterns are shown in Table 31:

Table 31 SF21 in DRESS: Simple effects of speech style in T11, T12, T13, and T14 (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

Patterns for simple effect of speech style at:		Pairwise comparisons by LSD		
		IS vs. RPS	IS vs. WLS	RPS vs. WLS
Sex	**Female *** **	<***	<***	<***
	Male * **	<*	<***	<**
Age	**Young *** **	<*	<***	<***
	Old * **	<***	<***	<**
Class	**WC *** **	<*	<***	<***
	UMC * **	<***	<***	<**
Groupings	**F-Y-WC***	ns	<**	ns
	F-Y-UMC***	<**	<***	<**
	F-O-WC**	<**	<***	ns
	F-O-UMC**	<**	<**	ns
	M-Y-WC^{ns}	–	–	–
	M-Y-UMC^{ns}	–	–	–
	M-O-WC^{ns}	–	–	–
	M-O-UMC**	<**	<**	ns

Possible interacted patterns are shaded in grey in the three right rows, while significant interactions from the first planned contrast (i.e. IS vs. RPS&WLS) are indicated by shades of the conditions of factors in the second left row. Observing the relevant parts in the Figure 32 and the Table 31, both female and male speakers have increasing SF21 values as the formality increases; the only difference between them is that the degree of increasing is slightly greater for the females than the males. This difference may be reflected to the significant interaction effect. For all the other conditions, the tendency is very similar; the more formal the speech style is, the higher the SF21 value is.

As a whole, the patterns for the significant effects (i.e. main effects and simple effects) of speech style on the SF1 values of TRAP from these results are summarised as follows:

- Spontaneous (IS) < non-spontaneous (RPS&WLS), RPS < WLS: as the pattern from planned contrasts
- IS < RPS < WLS: as the general pattern, as the patterns for the females, the males, the young, the old, the WC, the UMC, and the F-Y-UMC,
- RPS < WLS: as the pattern for the F-Y-WC
- IS < RPS = WLS: as the patterns for the F-O-WC, F-O-UMC and the M-O-UMC,
- Interaction: '*sex x IS-RPS&WLS'.

6.4.2.2 SF21 in DRESS: phonetic environments

Let us now move on to the results for the effects of another within-subjects variable, phonological factor , in the T21, T22, and T23 in which phonetic environments were compared with one of the social factors (i.e. sex, age, and social class) respectively. Figure 33 shows the means and their SDs across five phonetic environments:

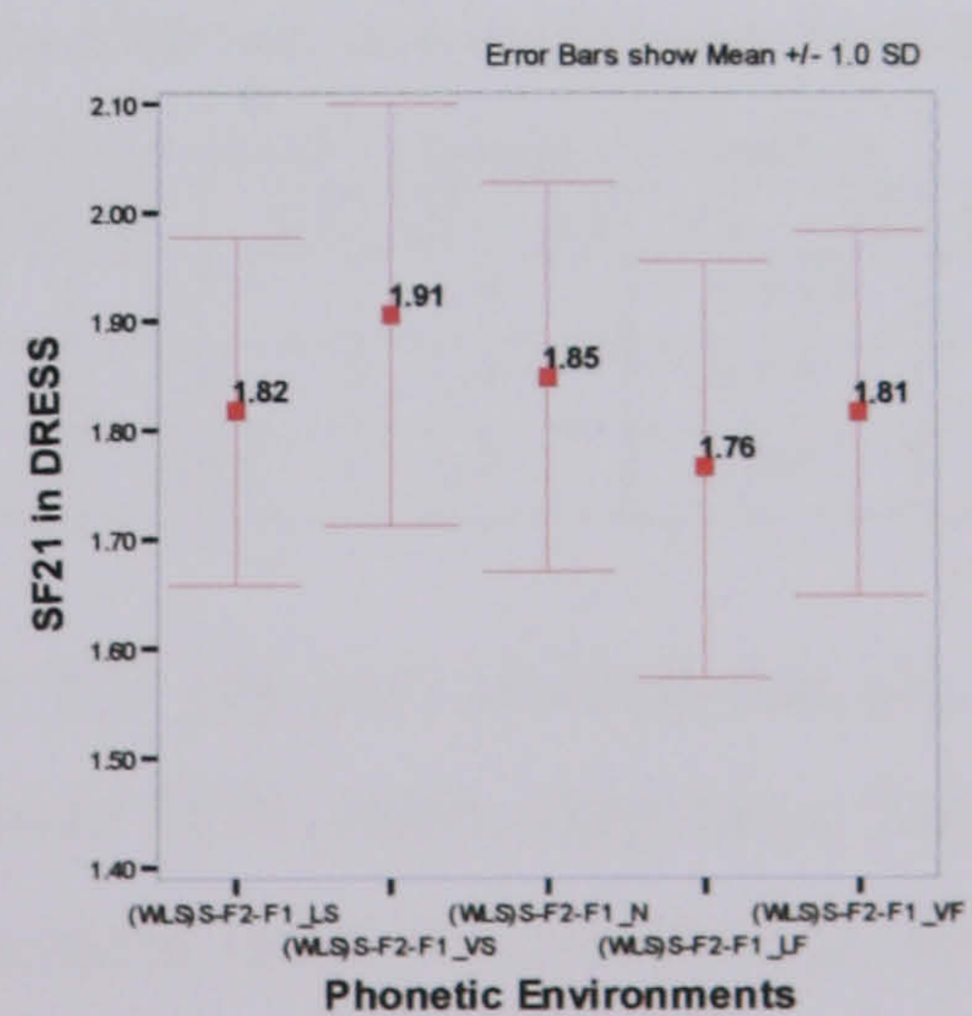


Figure 33 (SF21 in DRESS) Phonetic Environments: Means and SDs

Apparent differences in mean from the Figure 33 and Appendix 10 would be firstly that the mean SF21 values of DRESS vowels are higher in the environments of preceding voiced obstruents (i.e. _VS and _VF) compared to the environments of preceding their voiceless counterparts (i.e. _LS and _LF), and secondly that they are higher in the environments of preceding stops (i.e. _VS and _LS) compared to the environments of preceding fricatives (i.e. _VF and _LF). Looking at the results for the main effect of speech style in Table 27, the difference between these means across phonetic environments was found to be highly significant for all the tests 2-1, 2-2, and 2-3 and at the level of $p<0.001$, so that phonetic environments proved to be a significant factor for the SF21 of DRESS vowels. In order to find out how the effects of these five phonetic environments differ, the results were further examined by *post hoc* pairwise comparisons; the comparisons revealed the following two general patterns for the effects of following segments on the SF21 values of DRESS vowels:

*(E-SF21: Phonetic environments-pairwise-pattern-1, Test-2-1)****
_LF < _VF = _LS = _N < _VS
*(E-SF21: Phonetic environments-pairwise-pattern-2, Test-2-2 & Test-2-3)****
_LF < _VF = _LS < _VS
_LF< _N

These two patterns are, in fact, identical except for one difference; that is, the DRESS vowels before nasals were not significantly lower than those before voiced stops for the T22 and T23. Table 32 presents the detailed results of the pairwise comparisons, but only contains the results for the particular pairwise comparisons provided in Table 18 above:

Table 32 SF21 in DRESS: General patterns for the main effects of phonetic environments by post hoc pairwise comparisons by LSD (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

General patterns for:	(1)voiceless or voiced		(2)stops or fricatives		(3)nasals – stops – fricatives			
	LS – VS	LF – VF	LS – LF	VS – VF	N – LS	N – VS	N – LF	N – VF
Test-2-1(by sex)***	<**	<**	>*	>***	ns	<*	>**	ns
Test-2-2(by age)***	<**	<*	>*	>**	ns	ns	>**	ns
Test-2-3(by class)***	<**	<**	>*	>**	ns	ns	>**	ns

The first pattern found in the T21 (by sex) showed that (1) DRESS vowels before voiceless obstruents had significantly lower SF21 values than those before their voiced counterparts (i.e. _LS < _VS, _LF < _VF) in the same manner of articulation, that (2) the vowels before stops had significantly higher values than those before fricatives (i.e. _LS > _LF, _VS > _VF) in the same voicing condition, and (3) the vowels before nasals had significantly lower values than those before voiced stops (i.e. _N < _VS), significantly higher values than those before voiceless fricatives (i.e. _N > _LF), but did not have any significantly different values from those before voiceless stops and voiced fricatives (i.e. _N = _VS, _N = _VF). The second pattern found in the T22 (by age) and T23 (by social class) was the same as the first one except for the fact that the vowels before nasals did not have significantly different values from those before voiced stops (i.e. _N = _VS).

We turn now to the results for the interaction effects between phonetic environments and one of the social factors. The graphs in Figure 34 show the interaction graphs for all these interactions:

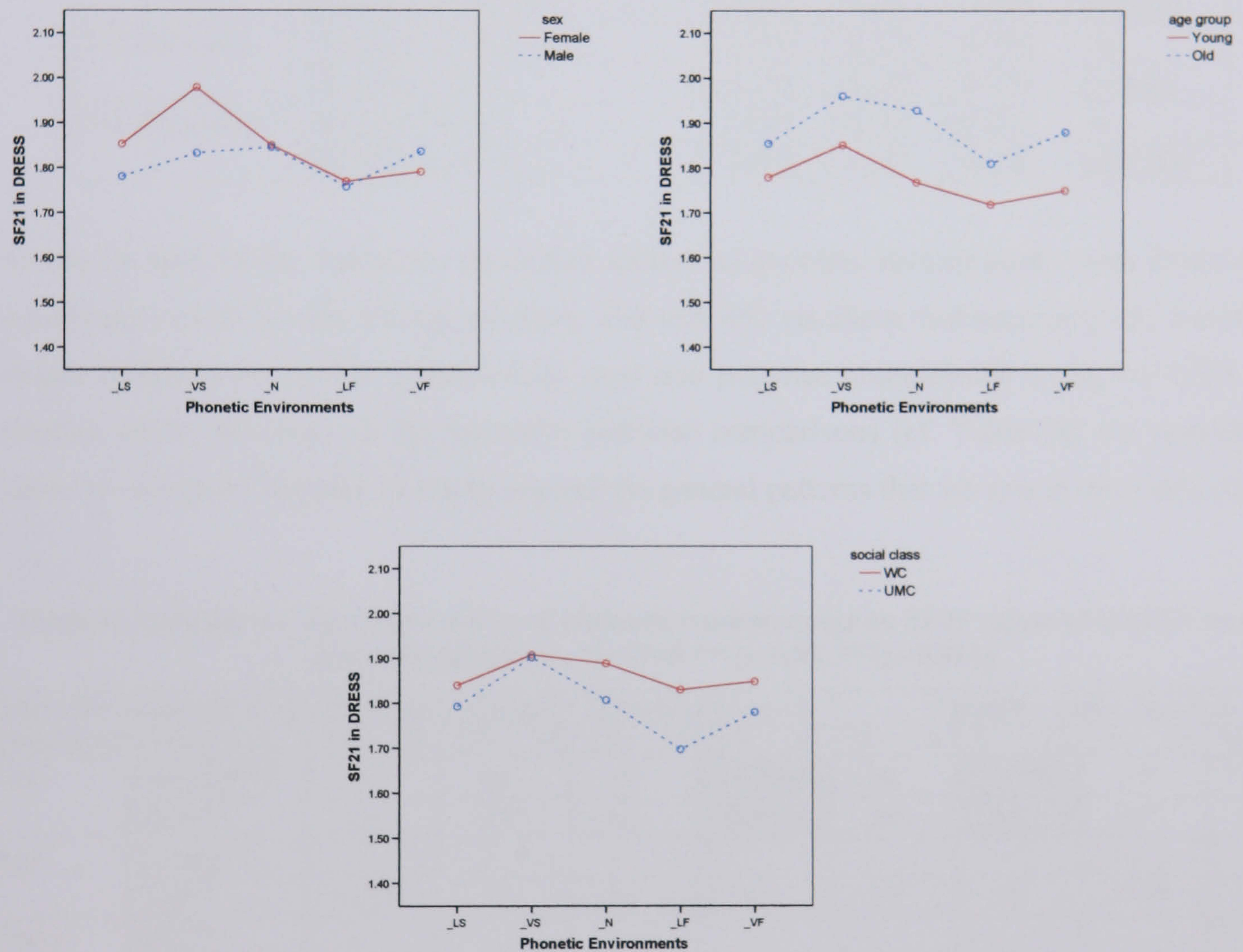


Figure 34 (SF21 in DRESS) Phonetic environments x sex (top left), age (top right), social class (bottom)

Looking at the results for the interactions in Table 27, one interaction between phonetic environments and sex was highly significant, $F(4, 120) = 5.06$, $p=0.001$, $p<0.01$, indicating that the way in which SF21 values were affected by phonetic environments significantly differed for the females and the males. The other interactions were not significant, meaning that the way in which SF21 values were affected by phonetic environments did not significantly differ for the young and the old, and for the WC and the UMC.

To break down both of these significant/non-significant interactions in more detail, the data were further explored using simple effects tests; the results are displayed in the Table 33:

Table 33 SF21 in DRESS: Simple effects of phonetic environments for each condition of sex, age, and social class

Test No.	Simple Effects	F	df	Sig.	
2-1 (by sex)	PhonEn. at females	8.741	4, 27	0.000	***p*<0.001**
	PhonEn. at males	4.162	4, 27	0.009	***p*<0.01**
2-2 (by age)	PhonEn. at Young	2.218	4, 27	0.094	ns
	PhonEn. at Old	5.257	4, 27	0.003	***p*<0.01**
2-3 (by class)	PhonEn. at WC	1.400	4, 27	0.261	ns
	PhonEn. at UMC	7.203	4, 27	0.000	***p*<0.001**

As can be seen in the Table 33, the simple effects of phonetic environments were found to be significant except for the young speakers, and the WC speakers. Subsequently the significant simple effects were further examined by *post hoc* pairwise comparisons using the LSD. The detailed results focusing on the particular pairwise comparisons (cf. Table 18) are provided in Table 34 which for the sake of clarity repeats the general patterns that we saw in the Table 32:

Table 34 Patterns for the simple effects of phonetic environments on SF21 values of DRESS vowels (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

Patterns for simple effects of Phonetic Environments at:		(1)voiceless or voiced		(2)stops or fricatives		(3)nasals – stops – fricatives			
		_LS – _VS	_LF – _VF	_LS – _LF	_VS – _VF	_N – _LS	_N – _VS	_N – _LF	_N – _VF
Sex	Female***	<**	ns	>*	>***	ns	<**	>*	ns
	Male**	ns	<**	ns	ns	ns	ns	>*	ns
Age	Young^{ns}	–	–	–	–	–	–	–	–
	Old**	<**	<*	ns	ns	>*	ns	>**	ns
Class	WC ^{ns}	–	–	–	–	–	–	–	–
	UMC***	<**	<**	>**	>**	ns	<*	>**	ns
General patterns for:									
T31***		<**	<**	>*	>***	ns	<*	>**	ns
T32***		<**	<*	>*	>**	ns	ns	>**	ns
T33***		<**	<**	>*	>**	ns	ns	>**	ns

Comparing the significant interaction effects with relevant interaction graphs in Figure 34, the possible interacted patterns are shaded in grey; that is, those patterns significantly differ from each other so that they may be reflected to significant interactions. Observing the relevant parts in the Figure 34, the profile of the SF21 values from _VS to either _N or _VF apparently looks different for the females and the males; that is, while the values for the females are higher before voiced stops than before nasals or voiced fricatives, the values for the males are rather constant before nasals, voiced obstruents (i.e. _VS, _VF). These differences in profiles between two sexes may be reflected to the significant interaction.

As a whole, the patterns for all the significant effects (i.e. main effects and simple effects) of phonetic environments on the SF21 values of DRESS from these results are summarised as follows:

- (1) _LS < _VS, _LF < _VF: as the general pattern, and as the patterns for the old, and the UMC,
- (1) _LS < _VS, _LF = _VF: as the pattern for the females,
- (1) _LS = _VS, _LF < _VF: as the pattern for the males,
- (2) _LS > _LF, _VS > _VF: as the general pattern, and as the patterns for the females, and the UMC,
- (2) _LS = _LF, _VS = _VF: as the patterns for the males and the old,
- (3) _N = _LS, _N < _VS, _N > _LF, _N = _VF: as the general pattern (in T21), as the patterns for the females and the UMC,
- (3) _N = _LS, _N = _VS, _N > _LF, _N = _VF: as the general pattern (in T22 and T23), as the pattern for the males,
- (3) _N > _LS, _N = _VS, _N > _LF, _N = _VF: as the pattern for the old,
- Interaction: '**sex x _VS-_VF, _N-_VS'.

6.4.2.3 SF21 in DRESS: sex

Now we turn to the results for the effects of sex in the T11 and T21 in which sex was compared with speech style in whole data and with phonetic environments in WLS data respectively. Let us firstly begin with the main effect of sex both in the T11 and in the T21. The distributions of the SF21 values by sex are shown in Figure 35 below in which their means and SDs are displayed:

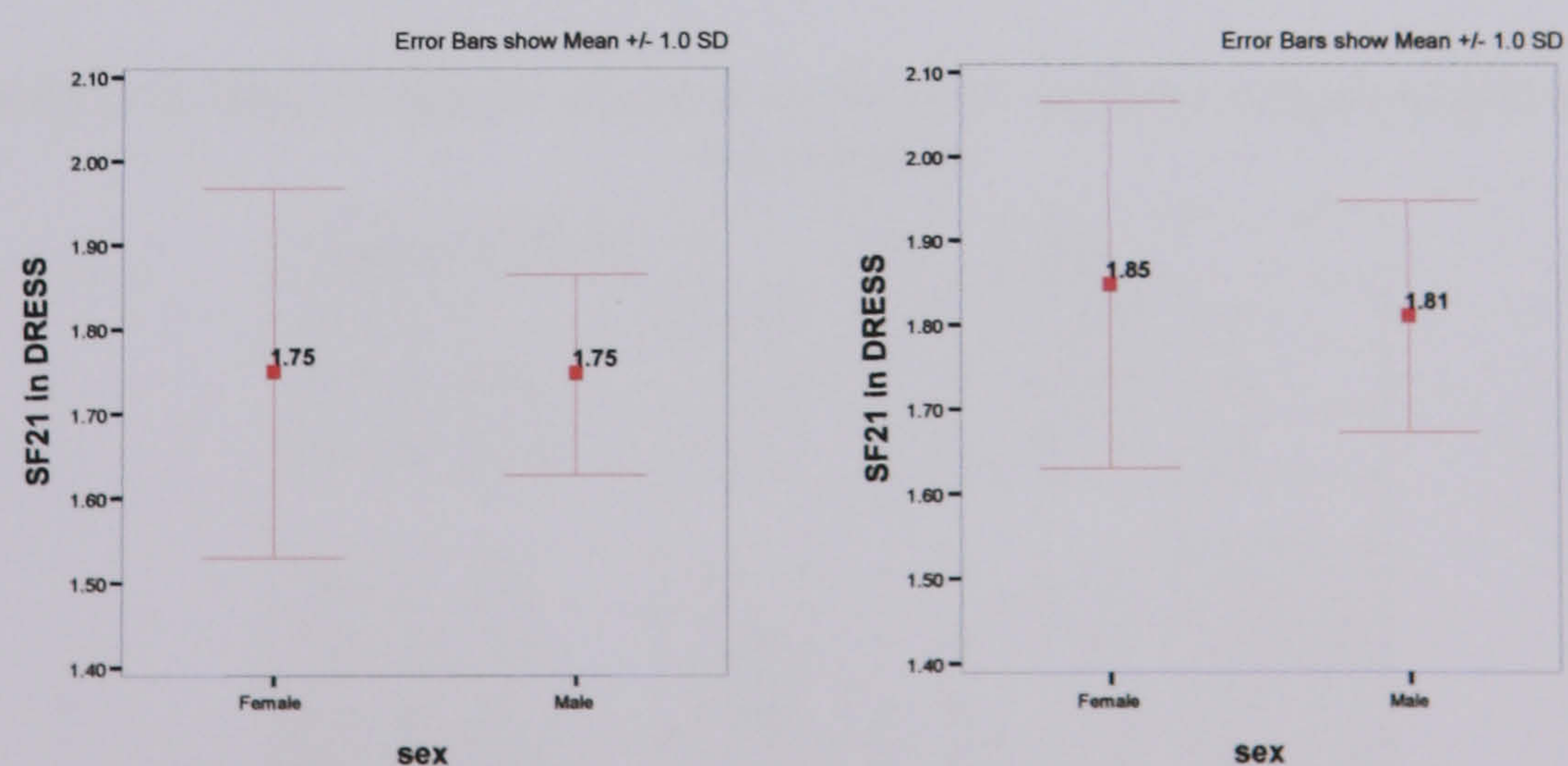


Figure 35 (SF21 in DRESS) Sex: Means and SDs in all speech styles in all speech styles for T11 (left) and in WLS for T21 (right)

Firstly for the T11, the mean of the SF21 values for both female and male speakers are almost the same; however, the SD and the range between maximum and minimum values for the females in Appendix 10 were nearly twice as great as those for the males, indicating that the SF21 values for the females were more varied than for the males. This is also true for the T21, although the mean of the SF21 values is slightly higher for the females than for the males. Looking at the Table 27, the main effects of sex in T11 and T21 were both shown to be non-significant: $F(1, 30) = 0.003$, $p=0.956$ in T11, and $F(1, 30) = 0.454$, $p= 0.505$ in T21. These results indicate that there was no significant effect of sex on the SF21 values of DRESS vowels for entire data in general and for WLS in particular as well. Therefore, the following general pattern for the effect of sex on the SF21 of DRESS vowels can be obtained:

(E-SF21: Sex-pattern-1) Female = Male

As discussed in §6.4.2.1 and §6.4.2.2, there were significant interaction effects both between sex and speech styles (i.e. IS vs. RPS&WLS) and between sex and phonetic environments. The results were interpreted in §6.4.2.1 and §6.4.2.2 that the way in which SF21 values were affected by speech styles/phonetic environments significantly differed for the females and the males. In the case of the interaction with phonetic environments, as indicated in Table 34, it seems particularly so when comparing the environments, _VS vs. _VF or _N vs. _VS. These significant interactions, however, can also be interpreted as follows: the way in which SF21 values were affected by sex significantly differed between IS and RPS&WLS or in different phonetic environments.

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 35:

Table 35 SF21 in DRESS: Simple effects of sex for each condition of speech style and phonetic environments

Simple Effects	F	df	Sig.	
Sex at IS	0.492	1, 30	0.488	ns
Sex at RPS	0.038	1, 30	0.846	ns
Sex at WLS	0.421	1, 30	0.522	ns
Sex at _LS	1.637	1, 30	0.211	ns
Sex at _VS	5.086	1, 30	0.032	***p*<0.05**
Sex at _N	0.005	1, 30	0.946	ns
Sex at _LF	0.027	1, 30	0.871	ns
Sex at _VF	0.587	1, 30	0.450	ns

Possible interacted patterns are shaded in the table. Similar to the general pattern for the non-significant main effect of sex that we saw above (i.e. F=M), the effect of sex at all speech styles and in most of the phonetic environments were found to be non-significant, i.e. F=M. Only significant was the effect of sex when the vowels were followed by voiced stops; in this environment, the SF21 values for female speakers were significantly higher than those for male speakers, i.e. F>M. This difference in sex effect in different phonetic environments may be reflected to the significant interaction with phonetic environments. No difference in sex across speech styles, on the other hand, may confirm that the interaction between sex and speech styles is due to the difference in profiles of the females and the males between spontaneous and non-spontaneous speech.

Thus, for the sex factor, in addition to a non-significant main effect, we see non-significant results for the effect of sex in all speech styles; when the simple effects analyses were tested for sex at each phonetic environment within WLS data, however, the effect of sex did exist (i.e. F>M) only when the vowels were followed by voiced stops. These results are summarised as follows:

- F = M: as the general pattern (for entire data and WLS data), and as the patterns for IS, RPS, WLS, _LS, _N, _LF and _VF,
- F > M: as the pattern for _VS
- Interactions: '*sex x IS-RPS&WLS', '**sex x _VS-others'.

6.4.2.4 SF21 in DRESS: age

We turn now to the results for the effects of age in the T12 and T22 in which age was compared with speech style in whole data and with phonetic environments in WLS data respectively. Let us begin with the main effect of age both in the T12 and in the T22. The distributions of the SF21 values by age are shown in Figure 36 which displays their means and SDs:

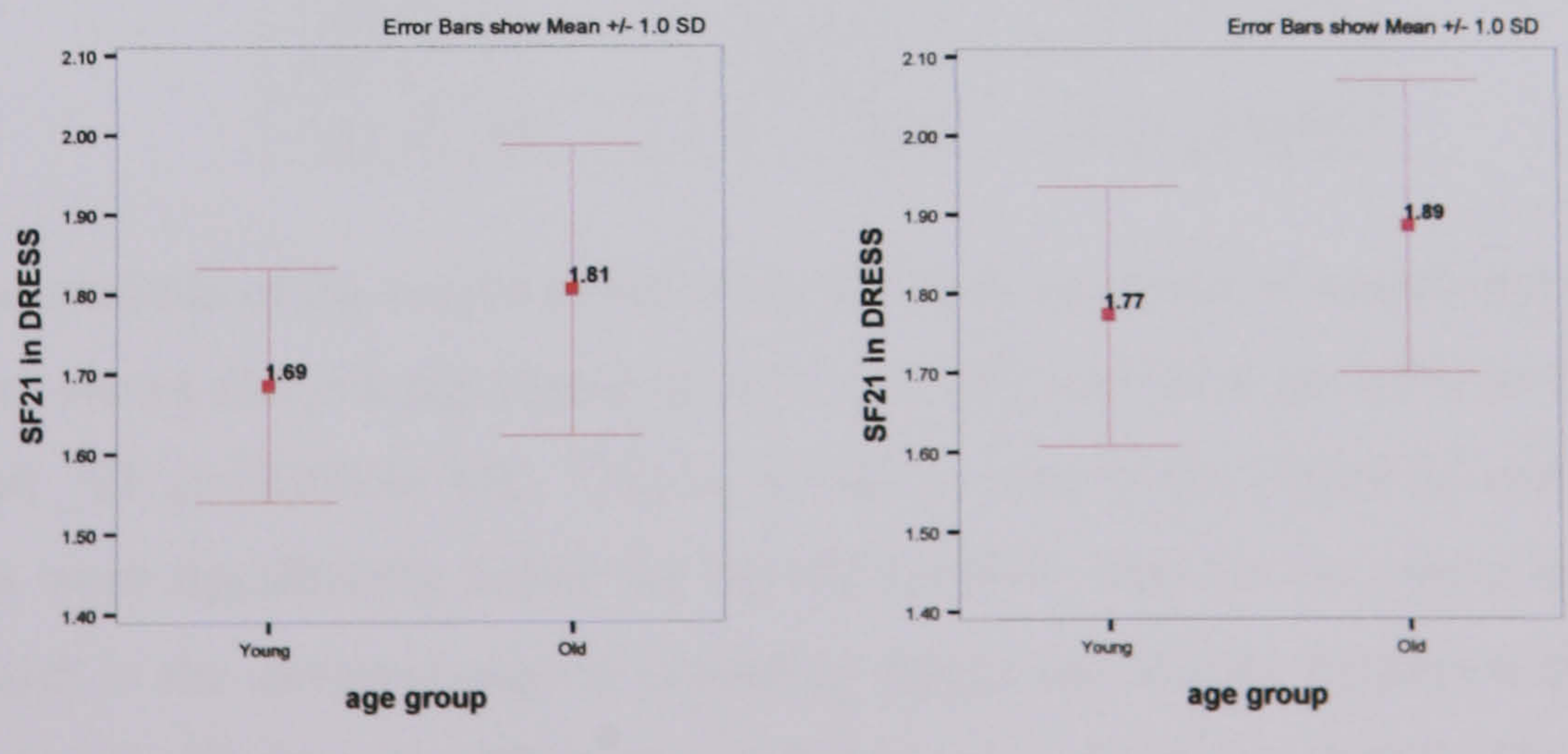


Figure 36 (SF21 in DRESS) Age: Means and SDs in all speech styles for T12 (left) and in WLS for T22 (right)

For both T12 and T22, the means of the SF21 values are higher for old speakers than for young speakers. The SDs are slightly greater for the old than for the young (cf. Appendix 10). Looking at the ANOVA table in Table 27, the main effects of age in T12 and T22 were both shown to be significant: $F(1, 30)= 5.327$, $p<0.05$ in T12 and $F(1, 30)= 4.749$, $p<0.05$ in T22. These results indicate that the mean difference between young and old speakers was significant for entire data in general and for WLS in particular as well; that is, the SF2 values were higher for the old than for the young. Therefore, the following general pattern for the effect of age on the SF21 of DRESS vowels can be obtained:

(E-SF21: Age-pattern-1) Young < OLD

As discussed in §6.4.2.1 and §6.4.2.2, there was no significant interaction effect either between age and speech styles or between age and phonetic environments, indicating that the way in which the SF21 values were affected by age did not significantly differ either across speech styles or across phonetic environments (cf. Figure 32 and Figure 34).

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 36:

Table 36 SF21 in DRESS: Simple effects of age for each condition of speech style and phonetic environments

Simple Effects	F	df	Sig.	
Age at IS	3.25	1, 30	0.081	ns
Age at RPS	6.475	1, 30	0.016	***p*<0.05**
Age at WLS	4.609	1, 30	0.04	***p*<0.05**
Age at _LS	1.823	1, 30	0.187	ns
Age at _VS	2.672	1, 30	0.113	ns
Age at _N	7.833	1, 30	0.009	***p*<0.01**
Age at _LF	1.875	1, 30	0.181	ns
Age at _VF	5.6	1, 30	0.025	***p*<0.05**

This detailed analysis of the simple effect of age for each condition of speech styles and phonetic environments shows that p is significant for RPS ($p<0.05$) and WLS ($p<0.05$) in T12, and for _N ($p<0.01$) and _VF ($p<0.05$) in T22. That is, as can be seen in the Figure 32 and Figure 34, the SF21 values were significantly higher for the old speakers than for the young speakers in RPS and WLS, and in the environments of preceding nasals and voiced fricatives; this is the same pattern for the significant main effect of age that we saw above (i.e. Y<O). The tests revealed, however, that the effect of age was not significant for other conditions, i.e. IS, _LS, _VS, and _LF,

although the mean of SF21 values between the young and old speakers were on the lines of the general tendency, Y<O.

Thus, the main effect of age on the SF21 values was Y<O; the values were higher for the old than for the young. This pattern was also true when the vowels were produced in non-spontaneous speech and when they occur before voiced continuant (i.e. _N and _VF). These results are summarised as follows:

- Y < O: as the general pattern (for entire data and for WLS data), and as the patterns for RPS, WLS, _N and _VF,
- Y = O: as the patterns for IS, _LS, _VS and _LF.

6.4.2.5 SF21 in DRESS: social class

We turn now to the results for the effects of social class in the T13 and T23 in which social class was compared with speech style in whole data and with phonetic environments in WLS data respectively. Let us begin with the main effect of social class both in the T13 and in the T23. The distributions of the SF21 values by social class are provided in Figure 37 which shows their means and SDs:

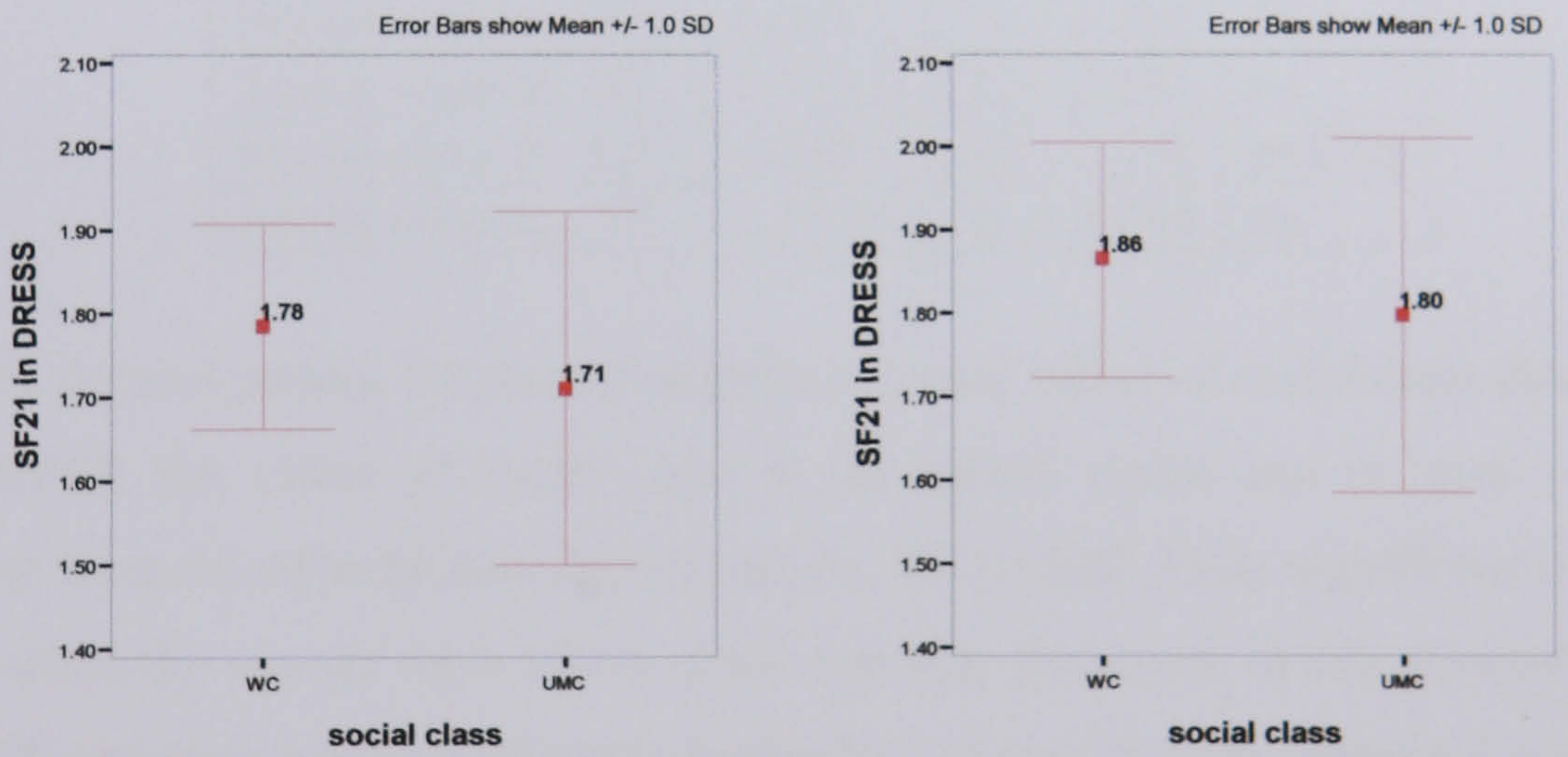


Figure 37 (SF21 in DRESS) Social class: Means and SDs in all speech styles for T13 (left) and in WLS for T23 (right)

For both T13 and T23, the means of the SF21 values are higher for WC speakers than for UMC speakers. The greater SDs and wider range between maximum and minimum values for the UMC (cf. Appendix 10) indicate that the SF21 values for the UMC were more varied than for the WC. Looking at the ANOVA table in Table 27, the main effects of social class in T13 and T23 were both non-significant: $F(1, 30)=1.853$, $p=0.186$ in T13 and $F(1, 30)=1.5$, $p=0.23$ in T23. These results indicate that there was no significant effect of social class on the SF21 values of DRESS vowels for entire data in general and for WLS in particular as well. Therefore, the following general pattern for the effect of social class on the SF21 of DRESS vowels can be obtained:

(E-SF21: Social class-pattern-1) WC = UMC

As discussed in §6.4.2.1 and §6.4.2.2, there was no significant interaction effect either between social class and speech styles or between social class and phonetic environments, indicating that the way in which the SF21 values were affected by social class did not significantly differ either across speech styles or across phonetic environments (cf. Figure 32 and Figure 34).

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 37:

Table 37 (SF21 in DRESS) Simple effects of social class for each condition of speech styles and phonetic environments

Simple Effects	F	df	Sig.	
Social class at IS	2.979	1, 30	0.095	ns
Social class at RPS	0.947	1, 30	0.338	ns
Social class at WLS	1.452	1, 30	0.238	ns
Social class at _LS	0.675	1, 30	0.418	ns
Social class at _VS	0.006	1, 30	0.936	ns
Social class at _N	1.706	1, 30	0.201	ns
Social class at _LF	4.248	1, 30	0.048	$p<0.05$
Social class at _VF	1.341	1, 30	0.256	ns

Similar to the general pattern for the non-significant main effect of social class that we saw above (i.e. WC=UMC), the effect of social class in all speech styles and in most of the phonetic environments were found to be non-significant, i.e. WC=UMC. Only significant was the effect of social class when the vowels were followed by voiceless fricatives; in this environment, the SF21 values for WC speakers were significantly higher than those for UMC speakers, i.e. WC>UMC.

Thus, for the social class factor, in addition to a non-significant main effect, we see non-significant results for the effect of social class in all speech styles; when the simple effects analyses were tested for social class at each phonetic environment within WLS data, however, the effect of social class did exist (i.e. WC>UMC) only when the vowels were followed by voiceless fricatives. These results are summarised as follows:

- WC = UMC: as the general pattern (for entire data and for WLS data), and as the patterns for IS, RPS, WLS, _LS, _VS, _N and _VF
- WC > UMC: as the pattern for _LF.

6.4.2.6 SF21 in DRESS: social grouping (by sex, age and social class)

Let us now look at the results for the effects of social groupings in the T14 in which social grouping factor was compared with speech style in whole data. Let us begin with the main effect of social grouping. The distribution of the SF21 values by social grouping is provided in Figure 38 which shows their means and SDs:

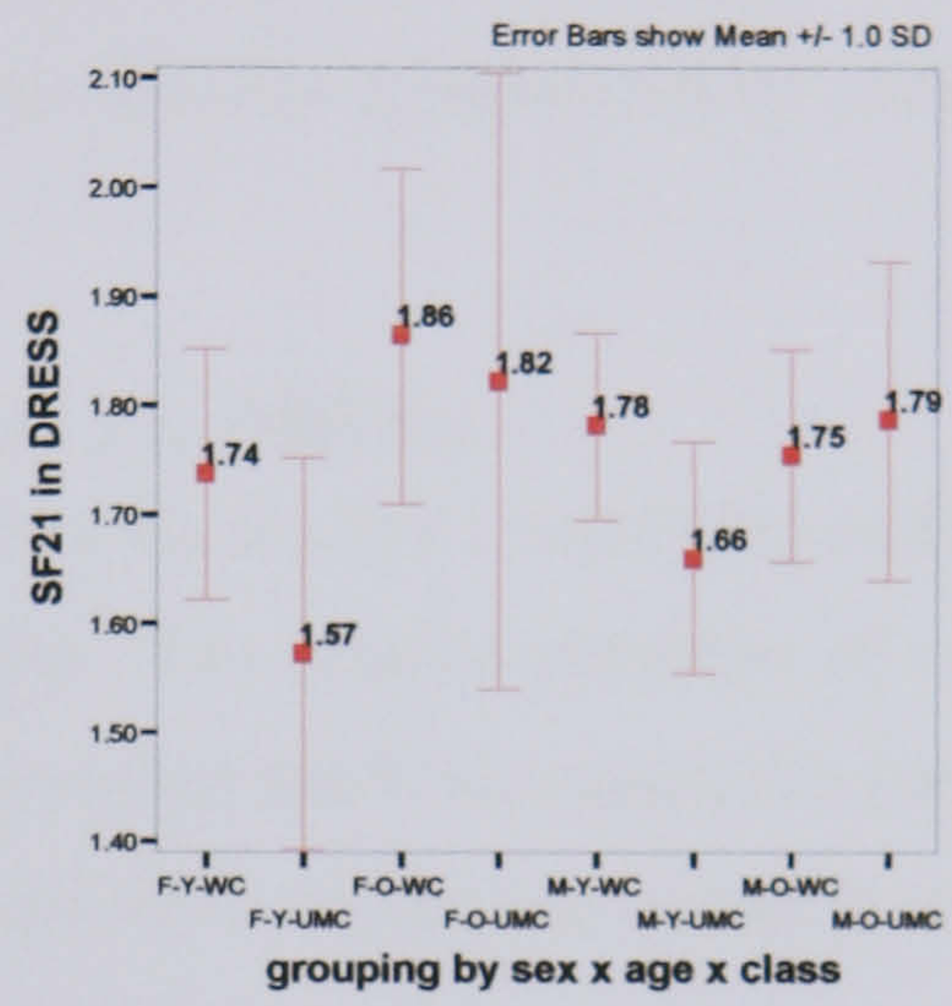


Figure 38 (SF21 in DRESS) Social grouping: Means and SDs in all speech styles for T14

There are a few remarkable differences that we can see from Figure 38 and Appendix 10. Firstly, the SF21 values for female old speakers are higher than any other groups. Secondly, the values for the F-Y-UMC are much lower than any other groups. Thirdly, the SDs and the ranges between maximum and minimum values for female UMC speakers look greater and wider than those for other groups of speakers; this indicates that the SF21 values are more varied for the F-UMC speakers than the other speakers. Looking at the ANOVA results in Table 27, the main effect of social grouping in the T14 was not significant, $F(7, 24)= 1.609$, $p=0.181$. This result indicates that there was no significant effect of social grouping on the SF21 values of DRESS vowels. Therefore, the data could not be further examined the difference between these groupings.

As discussed in §6.4.2.1, there was no significant interaction effect between social groupings and speech styles, indicating that the way in which the SF21 values were affected by social groupings did not significantly differ across speech styles (cf. Figure 32).

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 38:

Table 38 (SF21 in DRESS) Simple effects of social grouping for each speech style

Simple Effects	F	df	Sig.	
grouping at IS	1.82	7, 24	0.130	ns
grouping at RPS	1.618	7, 24	0.178	ns
grouping at WLS	1.235	7, 24	0.323	ns

Similar to the non-significant main effect, the effect of social grouping in all speech styles were found to be non-significant (i.e. $p>0.05$). These non-significant results, therefore, prevented us from performing further *post hoc* pairwise comparisons by LSD.

6.4.3 Provisional Summary for DRESS

In this section, both dependent variables (SF1 and SF21) will be considered together on a vowel space for a provisional summary. The relative positions of vowels are presented in traditional plots with SF1 (degree of openness) on the Y axis and SF21 (degree of frontness) on the X axis as in §6.3; therefore, all the SF1 and SF21 will be considered in terms of vowel openness and vowel frontness respectively.

The following sections provide provisional summaries in relation to each factor. Each section presents, as a summary of the statistical results in the previous sections, schematic graphs in order to visually show the effects of the factor both in general and for each condition of the other factor. All the SF1 and SF21 values that we saw in the previous sections will be considered in terms of vowel openness and vowel frontness respectively. An inequality sign will, therefore, be interpreted as 'more open > closer' for the results of SF1 and as 'more front > more back' for the results of SF21 in terms of articulation (i.e. relative position of tongue) rather than 'higher > lower' in terms of acoustics (i.e. formant measurements). Overall summary and discussions of DRESS in relation to TRAP and STRUT will be left for a later section, §6.5.

6.4.3.1 DRESS and speech style

Speech style proved to be a significant factor both for the SF1 and SF21 of DRESS vowels not only in general, but also for many of the sub groups. The statistical results are summarised in the following schematic graphs in which an arrow indicates each significant pairwise result in terms of openness (by a vertical arrow), frontness (by a horizontal arrow), and combination of both (by a diagonal arrow). Namely, a vertical arrow pointing up/down (↑↓) indicates the vowels are realised closer/opener from one condition to another, a horizontal arrow pointing left/right with its pointed end on the left/right (←→) indicates the vowels are realised more front/back from one condition to another, and a diagonal arrow pointing top-left/top-right/bottom-left/bottom-right (↖↗↙↘) indicates the vowels are realised more close-front/close-back/open-front/open-back from one condition to another. For consistency, each arrow always points from less formal speech style to more formal speech style:

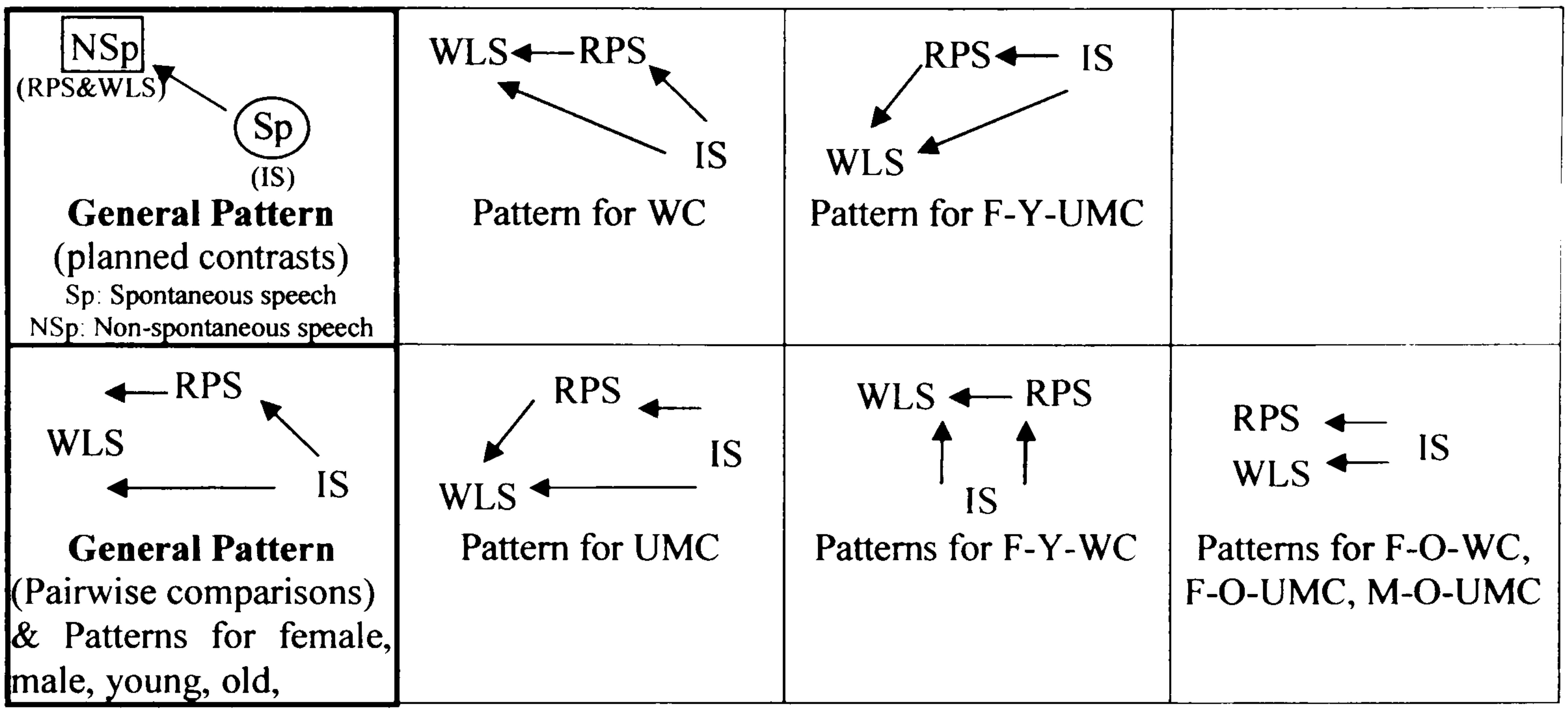
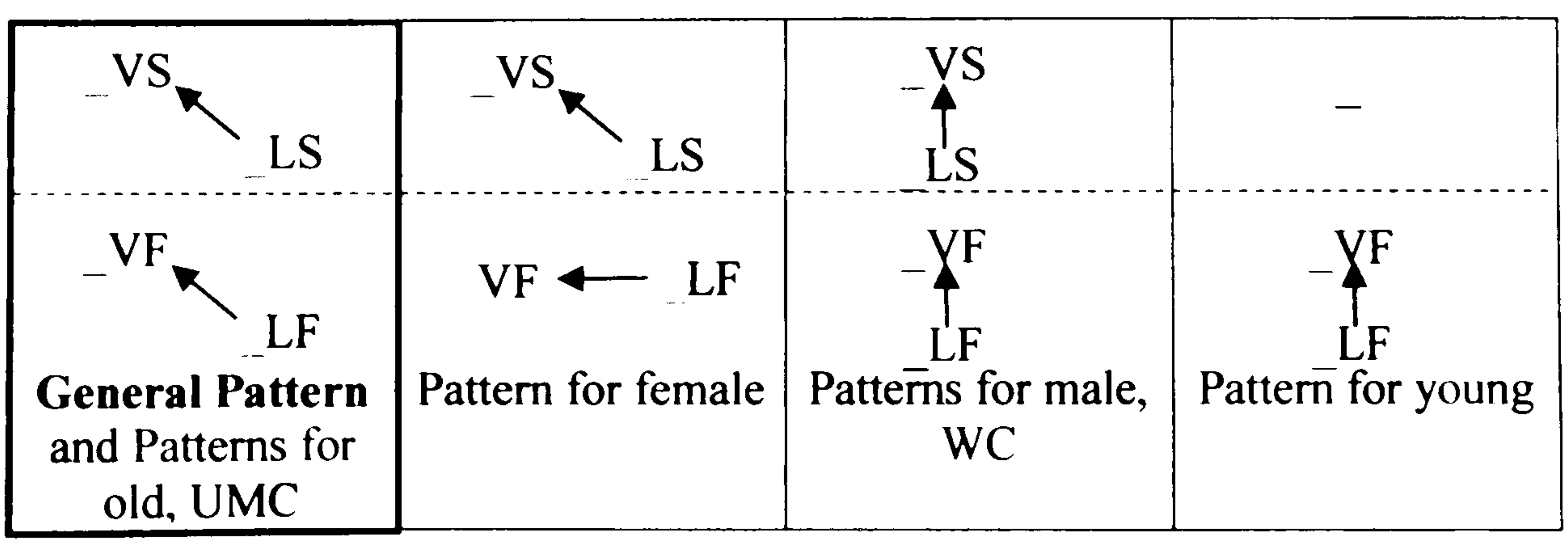


Figure 39 DRESS by speech style: schematic patterns

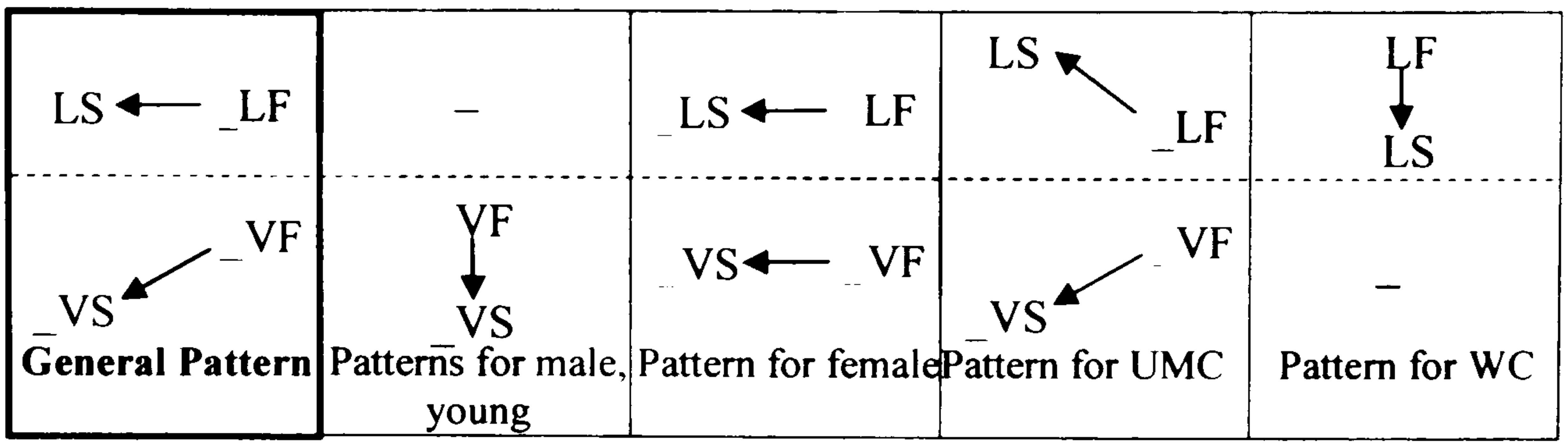
6.4.3.2 DRESS and phonetic environments

Phonetic environments proved to be a very highly significant factor both for the SF1 and SF21 of DRESS vowels not only in general, but also for many sub groups. Comparison focussed on: (1) before voiceless or voiced obstruents, (2) before stop or fricative, and (3) before nasal or obstruent. The statistical results are summarised in the following schematic graphs, in which, for consistency, each arrow always points (1) from a voiceless obstruent to a voiced obstruent, (2) from a fricative to a stop, and (3) from an obstruent to a nasal:

(1) before voiceless or voiced obstruents – _LS vs. _VS, _LF vs. _VF



(2) before stops or fricatives – _LS vs. _LF, _VS vs. _VF



(3) before nasals, stops or fricatives – _N vs. _LS, _N vs. _VS, _N vs. _LF, _N vs. _VF

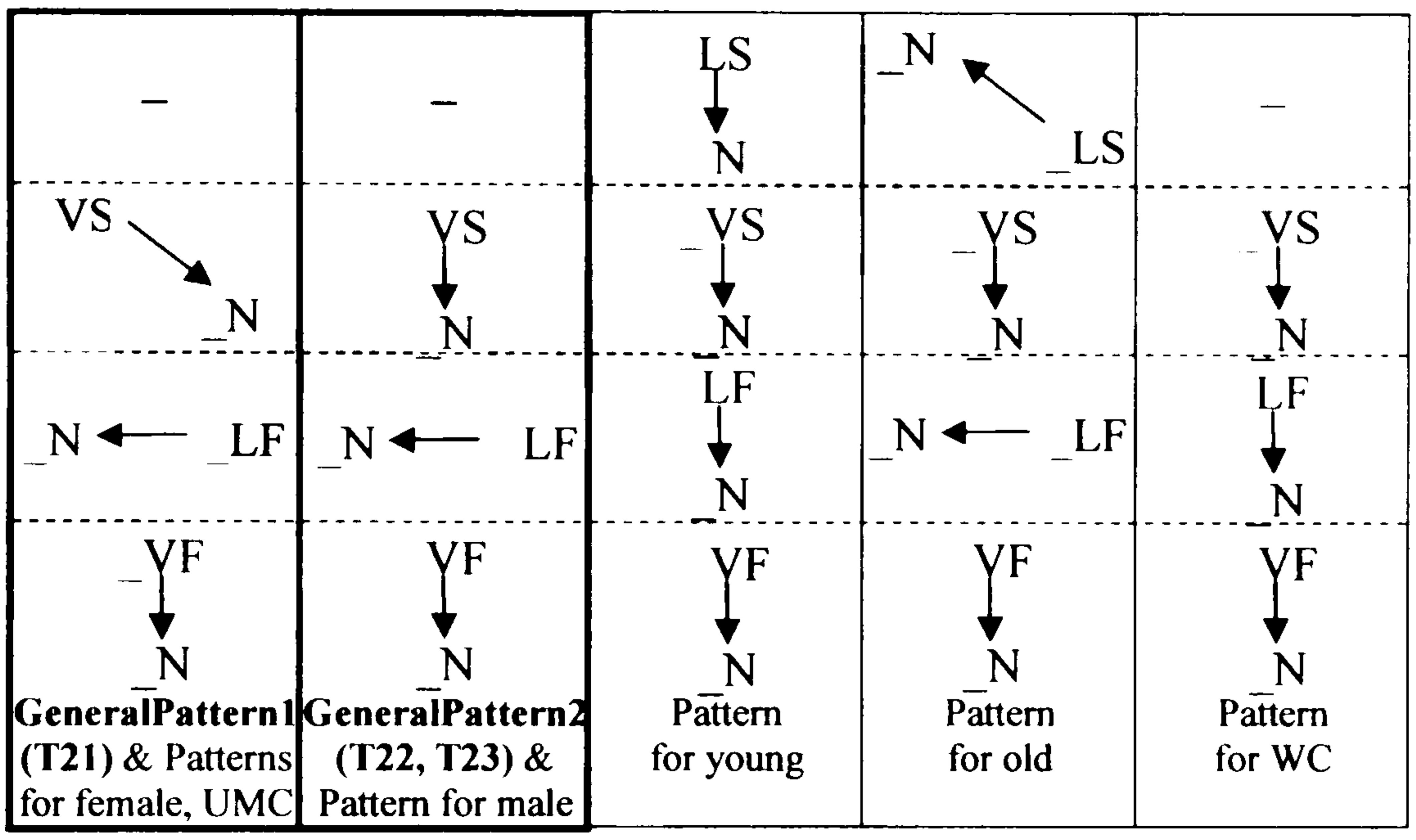


Figure 40 DRESS by phonetic environments: schematic patterns

6.4.3.3 DRESS and sex

The general relationship between sex and vowel openness was F > M in less formal speech style (IS or RPS), while it was F = M in the most formal speech (WLS). Even within WLS, however, the relationship F > M was found before voiced fricatives.

The general relationship between sex and vowel frontness was F = M. The effect of sex was equally non-significant for all the conditions but one, before voiced stops. In this environment, the relationship between sex and frontness was F > M.

These results are summarised in the following schematic graphs, in which, for consistency, each arrow always points from the females to the males:

M ↑ F **General Pattern** (for entire data), IS, RPS, _VF	– **General Pattern** (for WLS data), WLS, _LS, _N, _LF	F ⟶ M Pattern for _VS

Figure 41 DRESS by sex: schematic patterns

6.4.3.4 DRESS and age

The general relationship between age and vowel openness was Y = O. The effect of age was equally non-significant in all the conditions but one, before nasals. In this environment, the relationship between age and openness was Y > O.

The general relationship between age and vowel frontness was O > Y. The same relationship was also found when the vowels were uttered in more formal non-spontaneous speech styles, and when the vowels were followed by a voiced continuant in the WLS.

These results are summarised in the following schematic graphs, in which, for consistency, each arrow always points from the old to the young:

O ⟶ Y **General Pattern** (for entire & WLS data), RPS, WLS, _VF	– Patterns for IS, _LS, _VS, _LF	O ↘ Y Pattern for _N

Figure 42 DRESS by age: schematic patterns

6.4.3.5 DRESS and social class

The relationship between social class and vowel openness was WC = UMC. This was equally true at all conditions but one, before voiceless fricatives. In this environment, the relationship was UMC > WC.

The relationship between social class and vowel frontness was also WC = UMC. This was also true at all the conditions but one, before voiceless fricatives. In this environment, the relationship was WC > UMC.

These results are summarised in the following schematic graphs, in which, for consistency, each arrow points from the UMC to the WC:

– General Pattern (for entire & WLS data), IS, RPS, WLS, _LS, _VS, _N, _VF	WC ↖ UMC Pattern for _LF

Figure 43 DRESS by social class: schematic patterns

6.4.3.6 DRESS and social groupings

The noticeable difference between social groupings is that the vowels are more centralised for the F-Y-UMC than for any other groups. Statistical results, however, indicated that there was no significant difference across social grouping regarding the openness and the frontness of the DRESS vowels.

6.4.4 SF1 in TRAP

The results of the main effects and interaction effects for all the ANOVA tests in which the dependent variable was an SF1 value are provided in Table 39:

Table 39 ANOVA results for SF1 in TRAP: main effects and interaction effects

Test No.	Factor(s)	Type III Sum of Squares	df	Mean Square	F	Sig.	
1-1	**sstyle**	0.033	2, 60	0.017	5.207	0.008	**$p<0.01$**
	sex	0.035	1, 30	0.035	4.308	0.047	**$p<0.05$**
	sex x sstyle	0.029	2, 60	0.014	4.554	0.014	**$p<0.05$**
1-2	**sstyle**	0.033	2, 60	0.017	4.588	0.014	**$p<0.05$**
	age	0.002	1, 30	0.002	0.208	0.652	ns
	age x sstyle	0.003	2, 60	0.002	0.447	0.642	ns
1-3	**sstyle**	0.033	2, 60	0.017	4.701	0.013	**$p<0.05$**
	social class	0.005	1, 30	0.005	0.591	0.448	ns
	social class x sstyle	0.008	2, 60	0.004	1.198	0.309	ns
1-4	**sstyle**	0.033	2, 48	0.017	6.378	0.003	**$p<0.01$**
	groupings	0.067	7, 24	0.01	1.108	0.39	ns
	groupings x sstyle	0.095	14, 48	0.007	2.618	0.007	**$p<0.01$**
2-1	**PhonEn.**	0.322	2.89, 86.79	0.111	13.082	0.000	**$p<0.001$**
	sex	0.121	1, 30	0.121	2.49	0.125	ns
	PhonEn x sex	0.010	2.89, 86.79	0.003	0.392	0.752	ns
2-2	**PhonEn.**	0.322	2.91, 87.26	0.111	13.593	0.000	**$p<0.001$**
	age	0	1, 30	0	0.002	0.962	ns
	PhonEn x age	0.037	2.91, 87.26	0.013	1.580	0.201	ns

2-3	**PhonEn.**	0.322	3.04, 91.20	0.106	13.905	0.000	***p*<0.001**
	social class	0.059	1, 30	0.059	1.17	0.288	ns
	PhonEn x social class	0.053	3.04, 91.20	0.018	2.305	0.081	ns

This table will be referred to repeatedly as we discuss the effect of each factor one by one in the following sections.

6.4.4.1 SF1 in TRAP: speech style

Let us begin with the results for the effects of speech styles in the T11, T12, T13, and T14 in which speech style was compared with one of social factors (i.e. sex, age, social class, and social groupings). Figure 44 shows the means and their SDs across speech styles:

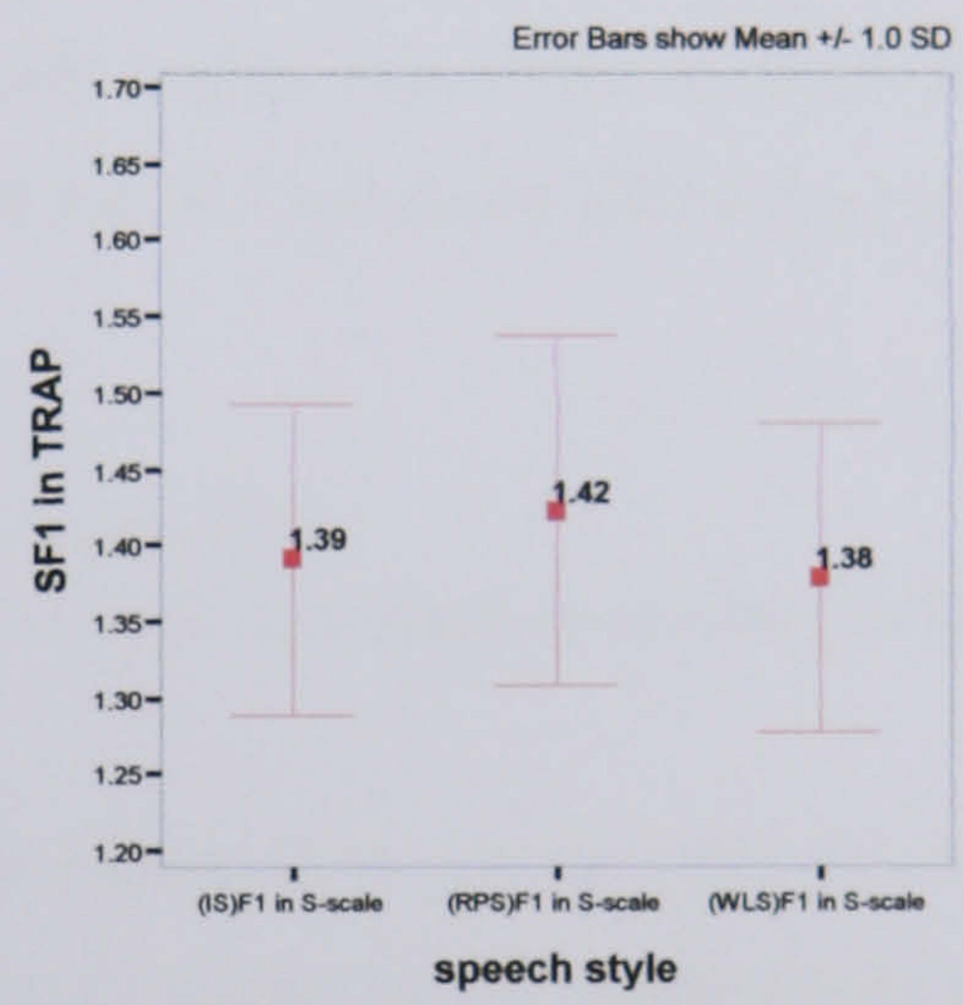


Figure 44 (SF1 in TRAP) Speech style: Means and SDs

The figure tells us that the mean of the SF1 values in RPS is the highest followed by the mean in IS and by the mean in WLS as the lowest. A slightly higher SD for the RPS compared to those for the IS and WLS (cf. Appendix 10) indicates the greater spread of the values. Looking at the results for the main effect of speech style in Table 39, the difference between these means across speech style was found to be significant at $p<0.01$ in the T11 and T14 and at $p<0.05$ in the T12 and T13. Therefore, in order to find out how these three means differ, the results were further examined by both planned contrasts and *post hoc* pairwise comparisons by LSD. Firstly let us look at the results of the planned contrasts shown in Table 40:

Table 40 SF1 in TRAP: Planned contrasts for the main effects of speech style

Test No.	Style contrasts	Type III Sum of Squares	df	Mean Square	F	Sig.	
Test-1-1	IS vs. RPS&WLS	0.003	1	0.003	0.534	0.471	ns
	RPS vs. WLS	0.062	1	0.062	12.478	0.001	***p*<0.01**
Test-1-2	IS vs. RPS&WLS	0.003	1	0.003	0.473	0.497	ns
	RPS vs. WLS	0.062	1	0.062	10.884	0.003	***p*<0.01**
Test-1-3	IS vs. RPS&WLS	0.003	1	0.003	0.505	0.483	ns
	RPS vs. WLS	0.062	1	0.062	10.501	0.003	***p*<0.01**
Test-1-4	IS vs. RPS&WLS	0.003	1	0.003	0.841	0.368	ns
	RPS vs. WLS	0.062	1	0.062	11.354	0.003	***p*<0.01**

The table tells us that, throughout analyses, there was no significant difference between spontaneous speech and non-spontaneous speech. Within non-spontaneous speech, however, the values for RPS were significantly higher than those in WLS at the level of p<0.01. This pattern for the effect of speech style on the SF1 values of TRAP by contrast is expressed in the following formulas:

*(A-SF1: Style-contrast-pattern 1)***
Spontaneous speech (IS) = non-spontaneous speech (RPS&WLS)
RPS > WLS

Similarly, the *post hoc* pairwise comparisons by the LSD also revealed the general pattern of SF1 values across three speech style as shown in the Table 41, in which an inequality sign indicates the significant result for each pairwise comparison with their significance level expressed by asterisks:

Table 41 SF1 in TRAP: General patterns for the main effects of speech style by post hoc pairwise comparisons by LSD (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

Main effect of speech style in:	Pairwise comparisons by LSD		
	IS vs. RPS	IS vs. WLS	RPS vs. WLS
Test-1-1(by sex)**	<*	ns	>**
Test-1-2(by age)*	ns	ns	>**
Test-1-3(by class)*	ns	ns	>**
Test-1-4(by grouping)**	<*	ns	>**

For all the analyses, as we saw in the planned contrasts, the SF1 values in the RPS were found to be significantly higher than in the WLS at the level of p<0.01. Similarly, the SF1 values in the RPS were significantly higher than in the IS at the level of p<0.05 in the T11 and T14, however, this was not the case in the T12 and T13. The difference between values in IS and those in WLS was non-significant in any test. These results, therefore, suggest that, for the SF1 values of TRAP vowels, there was a significant style shift between RPS and WLS, and sometimes between RPS and IS, but there was no such shift between IS and WLS.

In summary, the general pattern for the effect of speech style on the SF1 values of TRAP by pairwise comparisons would be expressed in the following formulas:

*(E-SF1: Style-pairwise-pattern 1)***
RPS > WLS (= IS)

We now turn to the results for the interaction effects between speech style and one of the social factors. The graphs in Figure 45 show the interaction graphs for all these interactions:

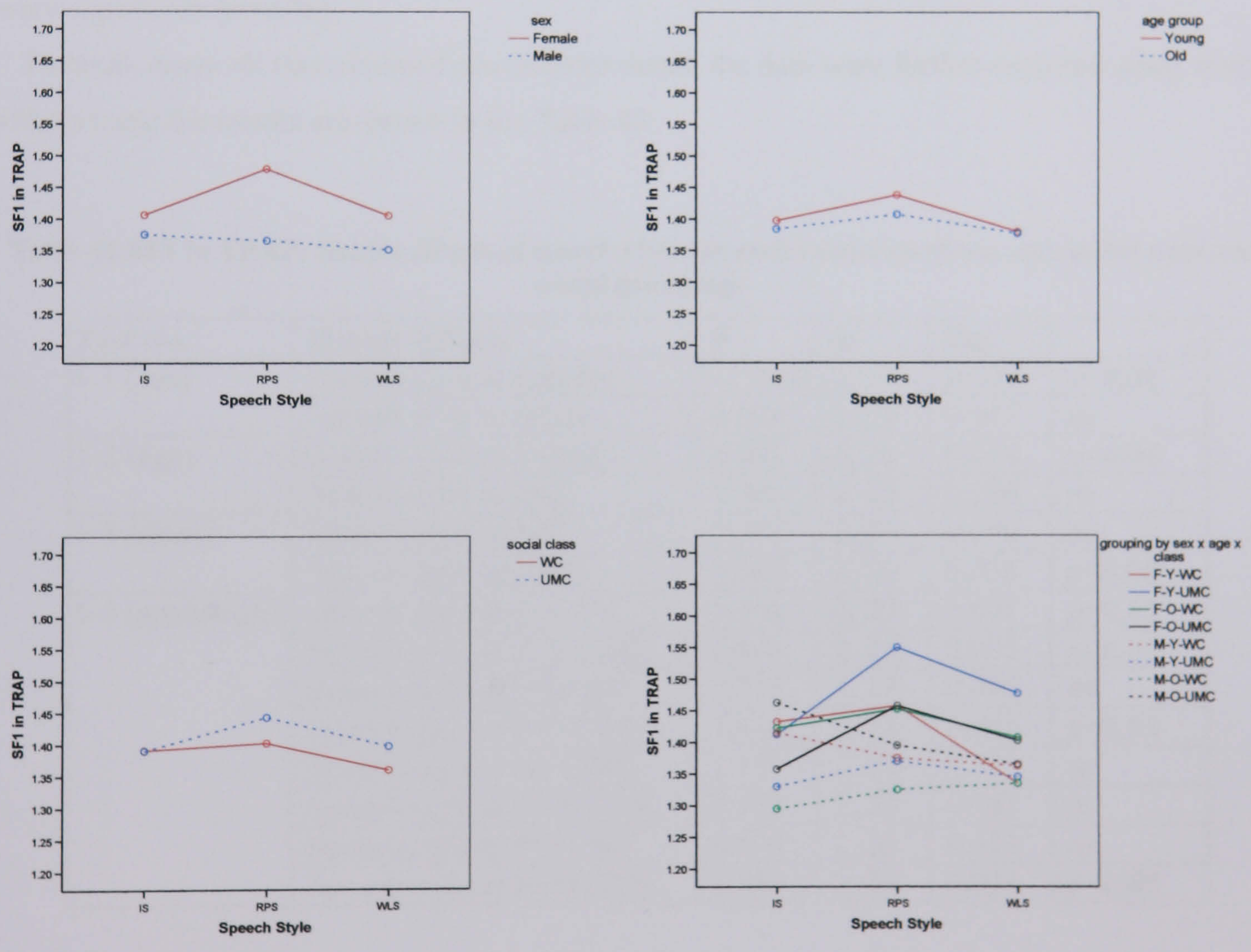


Figure 45 SF1 in TRAP: Interaction graphs for speech style x sex (top left), age (top right), social class (bottom-left), and social groupings (bottom-right)

Looking at the results for the interactions in Table 39, significant interactions were found between sex and speech style in T11, F(2, 60)= 4.554, *p*<0.05, and between social groupings and speech style in T14, F(14, 48)= 2.618, *p*<0.01, while non-significant interactions were found between age and speech style in T12, $F(2, 60)= 0.447$, $p=0.642$, and between social class and speech style in T12, $F(2, 60)= 1.198$, $p=0.309$. That is, the way in which the SF1 values were affected by speech style did differ for female and male speakers and for speakers divided by social groupings, but did not differ for young and old speakers, and for WC and UMC speakers. The first planned contrast revealed a significant interaction when comparing the values of social groupings in spontaneous speech style compared to non-spontaneous speech style, $F(7, 24)= 4.188$, $p<0.01$; this means that the profile of SF1 change between spontaneous speech and non-spontaneous speech was significantly different between social groupings. The second planned contrast revealed a significant interaction when comparing female and male values of SF1 in RPS compared to WLS, $F(1, 30)= 3.840$, $p<0.05$; this means that the profile of SF1 change between RPS and WLS was significantly different between female and male speakers. No other contrasts were significant ($p>0.05$).

To break down all these interactions in more detail, the data were further explored using simple effects tests; the results are shown in the Table 42:

Table 42 SF1 in TRAP: Simple effects of speech style for each condition of sex, age, social class, and social groupings

Test No.	**Simple Effects**	**F**	**df**	**Sig.**	
1-1 (sex)	Speech style at females	11.008	2, 29	0.000	***p*<0.01**
	Speech style at males	0.628	2, 29	0.541	ns
1-2 (age)	Speech style at Young	4.661	2, 29	0.018	***p*<0.05**
	Speech style at Old	1.269	2, 29	0.296	ns
1-3 (class)	Speech style at WC	2.548	2, 29	0.096	ns
	Speech style at UMC	3.667	2, 29	0.038	***p*<0.05**
1-4 (groupings)	Speech style at F-Y-WC	3.166	2, 23	0.007	***p*<0.01**
	Speech style at F-Y-UMC	6.846	2, 23	0.005	***p*<0.01**
	Speech style at F-O-WC	0.725	2, 23	0.495	ns
	Speech style at F-O-UMC	3.616	2, 23	0.043	***p*<0.05**
	Speech style at M-Y-WC	1.197	2, 23	0.32	ns
	Speech style at M-Y-UMC	0.582	2, 23	0.567	ns
	Speech style at M-O-WC	0.690	2, 23	0.512	ns
	Speech style at M-O-UMC	3.981	2, 23	0.033	***p*<0.05**

As can be seen in the Table 42, the simple effects of speech style were found to be significant for some conditions (i.e. female, young, UMC, F-Y-WC, F-Y-UMC, F-O-UMC, and M-O-UMC) but non-significant for the others (i.e. male, old, WC, F-O-WC, M-Y-WC, M-Y-UMC, and M-O-WC). Subsequently, significant simple effects were further examined by *post hoc* pairwise comparisons using the LSD. The tests revealed the detailed patterns of difference in speech style at each condition of the other factor; those patterns were shown in Table 43:

Table 43 SF1 in TRAP: Simple effects of speech style in T11, T12, T13, and T14 (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

Patterns for simple effect of speech style at:		Pairwise comparisons by LSD		
		IS vs. RPS	IS vs. WLS	RPS vs. WLS
Sex	**Female ****	<**	ns	>***
	Male ^{ns}	–	–	–
Age	**Young ***	ns	ns	>**
	Old ^{ns}	–	–	–
Class	WC ^{ns}	–	–	–
	UMC *	<*	ns	>*
Groupings	**F-Y-WC ****	ns	>*	>**
	F-Y-UMC**	<**	ns	ns
	F-O-WC ^{ns}	–	–	–
	F-O-UMC *	<*	ns	ns
	M-Y-WC ^{ns}	–	–	–
	M-Y-UMC ^{ns}	–	–	–
	M-O-WC ^{ns}	–	–	–
	M-O-UMC *	ns	>*	ns

Comparing the significant interaction effects with relevant interaction graphs in Figure 45, the possible interacted patterns are shaded in grey in the three right rows, and significant interactions from the first planned contrast (i.e. IS vs. RPS& WLS) are also indicated by shades of the conditions of factors in the second left row. Observing the relevant parts in the Figure 45, for the first interaction between sex and speech styles, the females has a significantly higher SF1 in RPS compared to IS or WLS, while the SF1 values for the males are rather consistent. For the second interaction between social groupings and speech styles, the profile across three speech styles for the F-Y-UMC and the F-O-UMC and the profile for the F-Y-WC and the M-O-UMC are different; for the former groups, their SF1 values significantly increase from IS to RPS and also apparently increase from IS to WLS, while for the latter groups, their SF1 values significantly decreased from IS to WLS either with very little increase or with decrease from IS to RPS.

As a whole, the patterns for the significant main and simple effects of speech style on the SF1 values of TRAP from these results are summarised as follows:

- Spontaneous (IS) = non-spontaneous (RPS&WLS), RPS > WLS: as the pattern from planned contrasts
- RPS > WLS = IS: as the general pattern (in T11 and T14), and as the patterns for the females and the UMC,
- RPS > WLS: as the general pattern (in T12 and T13), and as the pattern for the young,
- IS = RPS > WLS: as the pattern for the F-Y-WC,
- IS < RPS: as the pattern for the F-Y-UMC and the F-O-UMC,
- IS > WLS: as the pattern for the M-O-UMC

- Interactions: '*sex x IS-RPS-WLS', '**sex x RPS-WLS', '**grouping x IS-RPS-WLS', '**grouping x IS-RPS&WLS'.

6.4.4.2 SF1 in TRAP: phonetic environments

Let us now move on to the results for the effects of another within-subjects variable, phonetic environments, in the T21, T22, and T23 in which phonetic environments were compared with one of the social factors (i.e. sex, age, and social class) respectively. As we discussed previously, we especially focus on comparisons for the pairs presented in Table 18. Figure 46 shows the means and their SDs across phonetic environments:

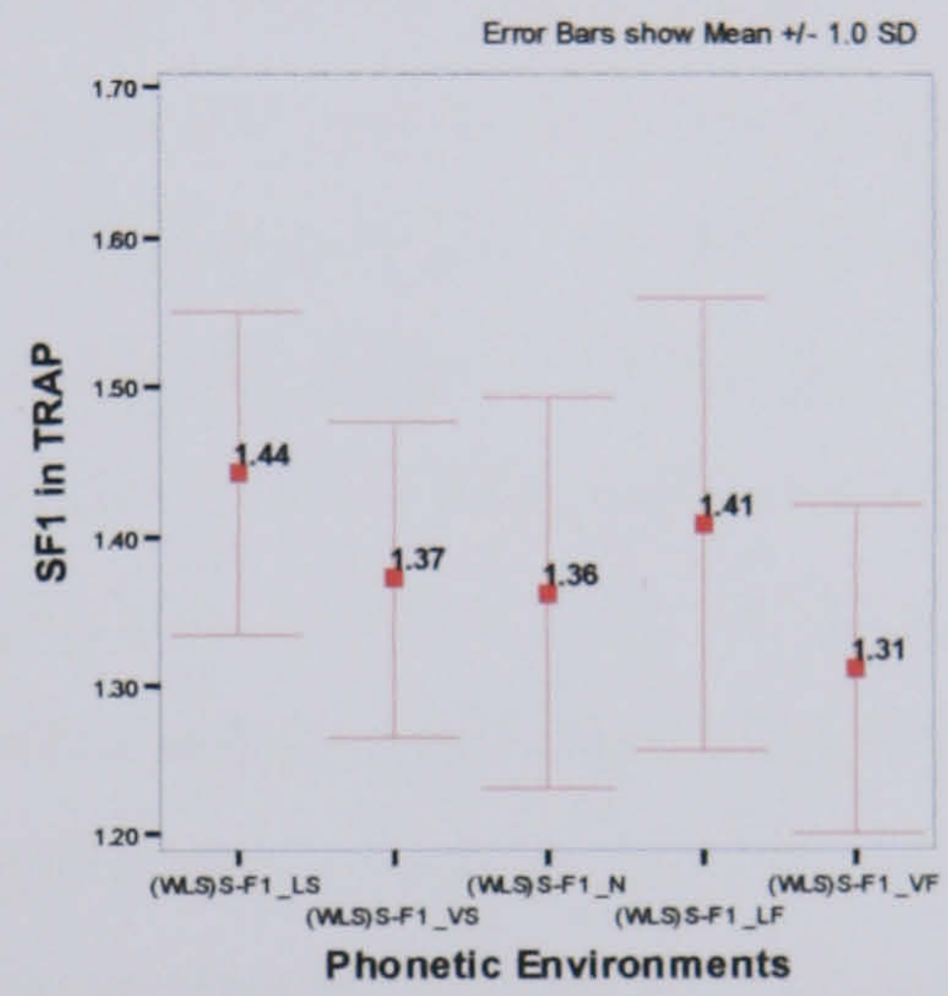


Figure 46 (SF1 in TRAP) Phonetic Environments: Means and SDs

The noticeable difference in the figure would be that the mean SF1 values before voiceless obstruents are higher than others, as found for the SF1 values of DRESS (§6.4.2.2). The mean for the vowels in _LF has the greatest SD, followed by the one for the vowels in _N; the SDs for the vowels in _LS, _VS and _VF are similar (cf. Appendix 10). Looking at the results for the main effect of speech style in Table 39, the difference between these means across phonetic environments was found to be very highly significant for all the tests 2-1, 2-2, and 2-3 at the level of $p<0.001$, so that phonetic environments proved to be a significant factor for the SF1 of TRAP vowels. In order to find out how the effects of these five phonetic environments differ, the results were further examined by *post hoc* pairwise comparisons; the comparisons revealed the following general pattern for the effects of following segments on the SF1 values of TRAP vowels:

*(A-SF1: Phonetic environments-pairwise-pattern-1, Tests-2-1, 2-2, and 2-3)****
_VF < _N = _VS < _LS
_VF < _LF

Table 44 presents the detailed results of the pairwise comparisons, but only contains the results for the particular pairwise comparisons provided in Table 18 above:

Table 44 SF1 in TRAP: General patterns for the main effects of phonetic environments by post hoc pairwise comparisons by LSD (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

General patterns for:	(1)voiceless or voiced		(2)stops or fricatives		(3)nasals – stops – fricatives			
	_LS – _VS	_LF – _VF	_LS – _LF	_VS – _VF	_N – _LS	_N – _VS	_N – _LF	_N – _VF
Test-2-1(by sex)***	>***	>***	ns	>***	<***	ns	ns	>*
Test-2-2(by age)***	>***	>***	ns	>***	<***	ns	ns	>*
Test-2-3(by class)***	>***	>***	ns	>***	<***	ns	ns	>*

All the tests in the TEST Set-2 showed the same pattern. (1) TRAP vowels before voiceless obstruents had significantly higher SF1 values than those before their voiced obstruents in the same manner of articulation, as found for the SF1 of DRESS vowels (§6.4.2.2). (2) Secondly, the vowels before stops had significantly higher values than those before fricatives when the following sounds were voiced (i.e. _VS > _VF), whilst there was no such difference when the following sounds were voiceless (i.e. _LS = _LF), as found for the SF1 of DRESS vowels (§6.4.2.2). (3) Thirdly, the vowels before nasals had significantly higher SF1 values than those before voiced fricatives and significantly lower than those before voiceless stops.

Now we turn to the results for the interaction effects between phonetic environments and one of the social factors. The graphs in Figure 47 show the interaction graphs for all these interactions. Looking at the results for the interactions in Table 39, all the interactions were non-significant (i.e. $p>0.05$), indicating that the way in which the SF1 values were affected by phonetic environments did not significantly differ for the females and the males, for the young and the old, and for the WC and the UMC.

To break down these non-significant interactions in more detail, the data were further explored using simple effects tests; the results are shown in the Table 45. As can be seen in the table, the simple effects of phonetic environments were all found to be significant. Therefore, all the simple effects were further examined by *post hoc* pairwise comparisons using the LSD. The detailed results focusing on the particular pairwise comparisons (cf. Table 18) are provided in Table 46 which for the sake of clarity repeats the general patterns that we saw in the Table 44.

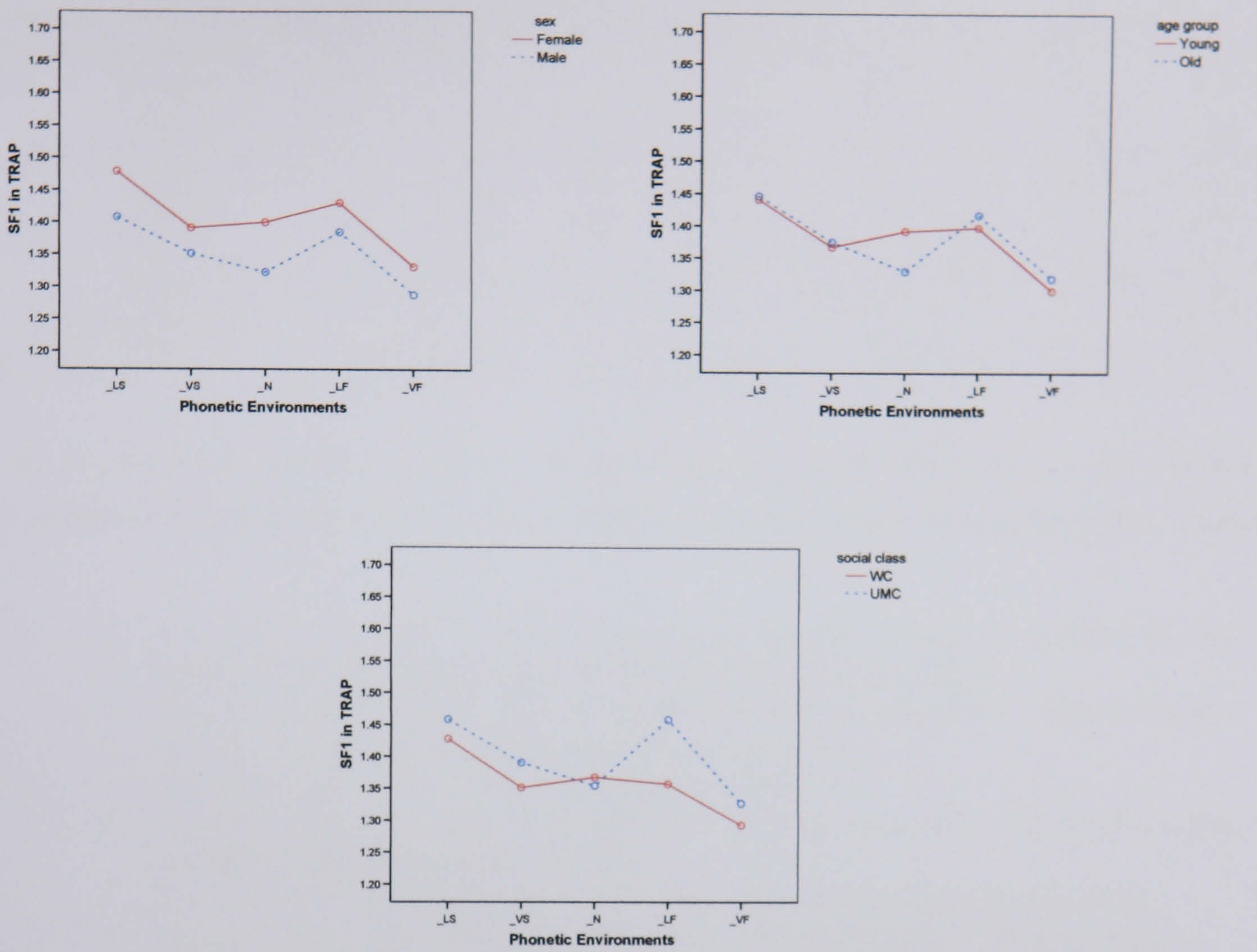


Figure 47 (SF1 in TRAP) Phonetic environments x sex (top left), age (top right), and social class (bottom)

Table 45 SF1 in TRAP: Simple effects of phonetic environments for each condition of sex, age, and social class

Test No.	Simple Effects	F	df	Sig.	
2-1 (by sex)	PhonEn. at females	10421	4, 27	0.000	***p*<0.001**
	PhonEn. at males	7.223	4, 27	0.000	***p*<0.001**
2-2 (by age)	PhonEn. at Young	8.935	4, 27	0.000	***p*<0.001**
	PhonEn. at Old	9.160	4, 27	0.000	***p*<0.001**
2-3 (by class)	PhonEn. at WC	6.971	4, 27	0.001	***p*<0.01**
	PhonEn. at UMC	11.980	4, 27	0.000	***p*<0.001**

Table 46 Patterns for the simple effects of phonetic environments on SF1 values of TRAP vowels (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

Patterns for simple effects of Phonetic Environments at:		(1)voiceless or voiced		(2)stops or fricatives		(3)nasals – stops – fricatives			
		LS – _VS	LF – _VF	LS – _LF	VS – _VF	N – _LS	N – _VS	N – _LF	N – _VF
Sex	Female***	>***	>**	ns	>*	<**	ns	ns	>*
	Male***	>**	>**	ns	>**	<**	ns	ns	ns
Age	Young***	>**	>**	ns	>**	ns	ns	ns	>**
	Old***	>**	>**	ns	>*	<***	ns	<*	ns
Class	WC**	>**	>*	>*	>*	<*	ns	ns	>*
	UMC***	>**	>***	ns	>**	<***	ns	<**	ns
General patterns for:									
T21, T22, T23***		>***	>***	ns	>***	<***	ns	ns	>*

As a whole, the patterns for the significant effects (i.e. main effects and simple effects) of phonetic environments on the SF1 values of TRAP from these results are summarised as follows:

- (1) _LS > _VS, _LF > _VF: as the general pattern, and as the patterns for the females, the males, the young, the old, the WC, and the UMC,
- (2) _LS = _LF, _VS > _VF: as the general pattern, and as the patterns for the females, the males, the young, the old, and the UMC,
- (2) _LS > _LF, _VS > _VF: as the pattern for the WC,
- (3) _N < _LS, _N = _VS, _N = _LF, _N > _VF: as the general pattern, and as the patterns for the females and the WC,
- (3) _N < _LS, _N = _VS, _N = _LF, _N = _VF: as the pattern for the males,
- (3) _N = _LS, _N = _VS, _N = _LF, _N > _VF: as the pattern for the young,
- (3) _N < _LS, _N = _VS, _N < _LF, _N = _VF: as the patterns for the old and the UMC.

6.4.4.3 SF1 in TRAP: sex

Now we turn to the results for the effects of sex in the T11 and T21 in which sex was compared with speech style and phonetic environments respectively. Let us firstly begin with the main effect of sex both in the T11 in which sex was compared with speech style in whole data and in the T21 in which sex was compared with phonetic environments within WLS data. The distributions of the SF1 values by sex are shown in Figure 48 below in which their means and SDs are displayed:

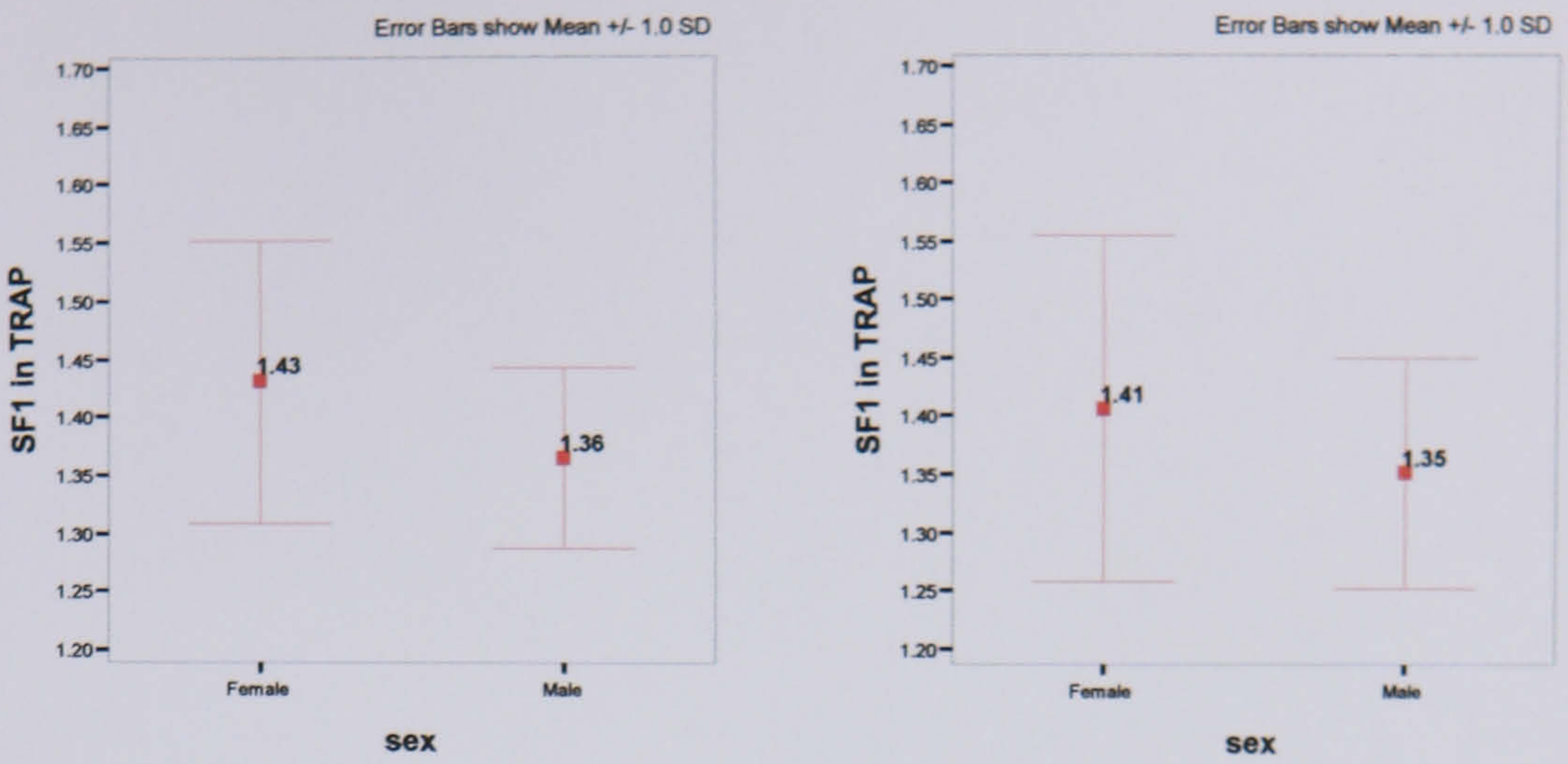


Figure 48 (SF1 in TRAP) Sex: Means and SDs in all speech styles in all speech styles for T11 (left) and in WLS for T21 (right)

For both tests, the mean of the SF1 values is higher for the females than for the males, as found for the SF1 of DRESS vowels (§ 6.4.1.1). Moreover, the SD and the range between maximum and minimum values for the females (cf. Appendix 10) were much greater for the females than for the males especially in T21, as found for the SF1 of DRESS vowels (§ 6.4.1.1). Looking at the Table 39, the main effect of sex was shown to be significant in T11, $F(1, 30)=4.308$, $p<0.05$, but non-significant in T21, $F(1, 30)=2.49$, $p=0.125$; this result is the same as the one for the SF1 of DRESS vowels (§ 6.4.1.3). These results indicate that there was a significant effect of sex on the SF1 values of TRAP vowels for entire data in general, whilst there was no such effect for WLS in particular. Therefore, the following general pattern for the effect of sex on the SF1 values of TRAP vowels can be obtained:

(A-SF1: Sex-pattern-1, for entire data) Female > Male
(A-SF1: Sex-pattern-2, for WLS data) Female = Male

As discussed in §6.4.4.1 and §6.4.4.2, while there was no significant interaction effect between sex and phonetic environments, there were significant interaction effects between sex and speech styles (i.e. IS vs. RPS vs. WLS, and IS vs. RPS&WLS). The result was interpreted in §6.4.4.1 that the way in which SF1 values were affected by speech styles significantly differed for the females and the males, and, as indicated in Table 43, it seems particularly so when comparing RPS with IS or WLS. This significant interaction, however, can also be interpreted as follows: the way in which SF1 values were affected by sex significantly differed across speech styles and between spontaneous and non-spontaneous speech.

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 47:

Table 47 SF1 in TRAP: Simple effects of sex for each condition of speech style and phonetic environments

Simple Effects	F	df	Sig.	
Sex at IS	0.718	1, 30	0.403	ns
Sex at RPS	9.893	1, 30	0.004	***p*<0.01**
Sex at WLS	2.379	1, 30	0.133	ns
Sex at _LS	3.704	1, 30	0.064	ns
Sex at _VS	1.126	1, 30	0.297	ns
Sex at _N	2.936	1, 30	0.097	ns
Sex at _LF	0.695	1, 30	0.411	ns
Sex at _VF	1.236	1, 30	0.275	ns

Possible interacted patterns are shaded in the table. As the general pattern of the main effect of sex for the entire data that we saw above was significant (i.e. F > M), the simple effect of sex was significant in RPS, i.e. F > M, but it was not significant in IS and WLS. This difference in sex effect across speech styles may be reflected to significant interactions with speech style. For the different phonetic environments, as we saw the general pattern of the main effect of sex for the WLS was F = M, the simple effect of sex was not significant in at all the conditions of the five phonetic environments.

Thus, for the sex factor, the general effect of sex on the SF1 values of TRAP vowels for entire data was F > M; however, the detailed simple effect for each condition of speech styles revealed that this was only true when the speech style was less-formal non-spontaneous speech style (i.e. RPS). The general effect of sex on the SF1 values of TRAP vowels in relation to phonetic environments within WLS was F = M, and this was also true at every phonetic environment. These results are summarised as follows:

- F > M: as the general pattern (for entire data), and as the pattern for RPS
- F = M: as the general pattern (for WLS data), as the patterns for IS and WLS, and as the patterns for all the phonetic environments (i.e. _LS, _VS, _N, _LF and _VF)
- Interactions: '*sex x IS-RPS-WLS', '**sex x RPS-WLS'.

6.4.4.4 SF1 in TRAP: age

We turn now to the results for the effects of age in the T12 and T22 in which age was compared with speech style in whole data and with phonetic environments in WLS data respectively. Let us begin with the main effect of age in both tests. The distributions of the SF1 values by age are shown in Figure 49 which displays their means and SDs:

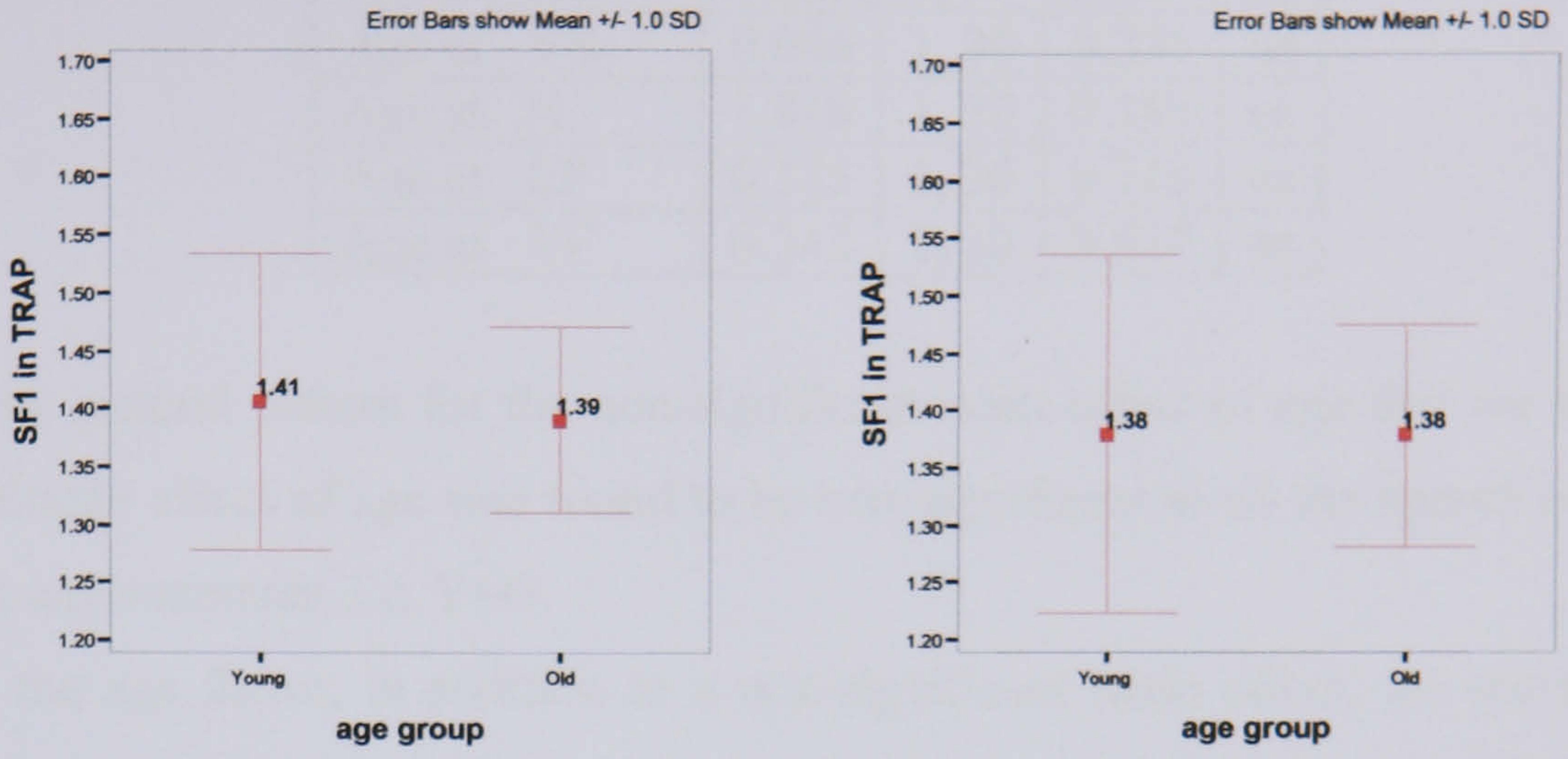


Figure 49 (SF1 in TRAP) Age: Means and SDs in all speech styles for T12 (left) and in WLS for T22 (right)

The mean of the SF1 values is slightly higher for young speakers than for old speakers in T12, while the means are almost same for young and old speakers in T22. The SDs are much greater for the young than for the old (cf. Appendix 10). Looking at the ANOVA table in Table 39, the main effects of age in T12 and T22 were both shown to be non-significant: F(1, 30)= 0.208, p=0.652 in T12 and F(1, 30)= 0.002, p=0.962 in T22. These results indicate that there was no significant effect of age on the SF1 values of TRAP vowels for entire data in general and for WLS in particular as well. Therefore, the following general pattern for the effect of age on the SF1 of TRAP vowels can be obtained:

(A-SF1: Age-pattern-1) Young = OLD

As discussed in §6.4.4.1 and §6.4.4.2, there was no significant interaction effect either between age and speech styles or between age and phonetic environments, indicating that the way in which the SF1 values were affected by age did not significantly differ either across speech styles or across phonetic environments (cf. Figure 45 and Figure 47).

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 48:

Table 48 SF1 in TRAP: Simple effects of age for each condition of speech style and phonetic environments

Simple Effects	F	df	Sig.	
Age at IS	0.129	1, 30	0.722	ns

Age at RPS	0.555	1, 30	0.462	ns
Age at WLS	0.005	1, 30	0.945	ns
Age at _LS	0.021	1, 30	0.886	ns
Age at _VS	0.046	1, 30	0.831	ns
Age at _N	1.838	1, 30	0.185	ns
Age at _LF	0.135	1, 30	0.716	ns
Age at _VF	0.242	1, 30	0.627	ns

Similar to the general pattern for the non-significant main effect of age that we saw above (i.e. Y=O), the simple effect of age was found to be non-significant at all the speech styles and in all the phonetic environments, i.e. Y=O.

Thus, for the age factor, in addition to a non-significant main effect, we see non-significant results for the effect of age for all speech styles and all phonetic environments. The results are summarised as follows:

- Y = O: as the general pattern (for entire data, and for WLS), and as the patterns for all speech styles and all phonetic environments.

6.4.4.5 SF1 in TRAP: social class

We turn now to the results for the effects of social class in the T13 and T23 in which social class was compared with speech style in whole data and with phonetic environments in WLS data respectively. Let us begin with the main effect of social class in both tests. The distributions of the SF1 values by social class are provided in Figure 50 which shows their means and SDs:

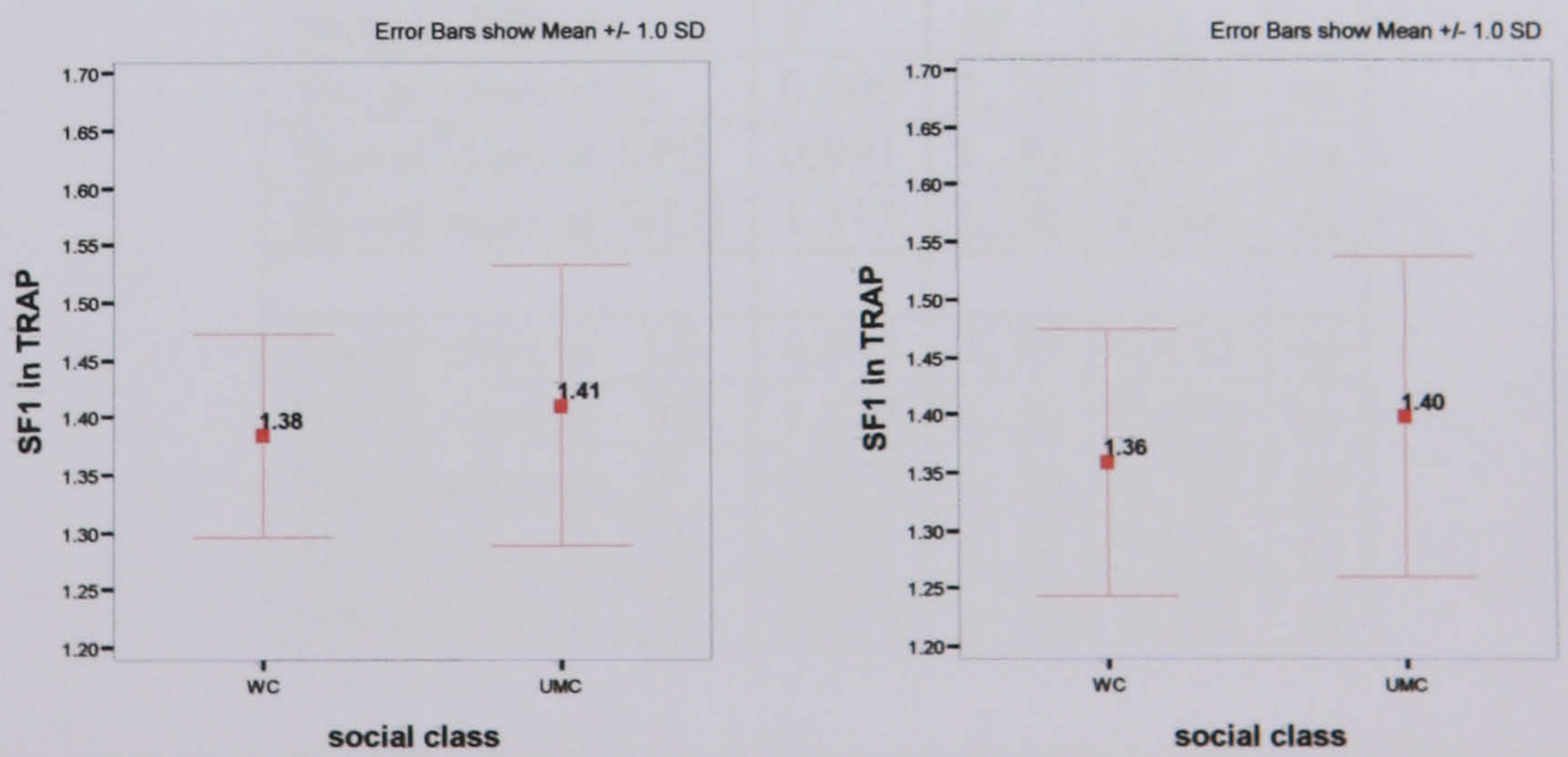


Figure 50 (SF1 in TRAP) Social class: Means and SDs in all speech styles for T13 (left) and in WLS for T23 (right)

In both tests, the means of the SF1 values were higher for UMC speakers than for WC speakers, as found for the SF1 values of the DRESS (§6.4.1.5). The greater SDs and wider range between maximum and minimum values for the UMC (cf. Appendix 10) indicate that the SF1 values for the UMC were more varied than for the WC; the same tendency was found for the SF1 values of the DRESS (§6.4.1.5). Looking at the ANOVA table in Table 39, the main effects of social class in T13 and T23 were both non-significant: $F(1, 30)= 0.591$, $p=0.448$ in T13 and $F(1, 30)= 1.17$, $p=0.288$ in T23. These results are the same as those for the SF1 of DRESS vowels (§6.4.1.5). These results indicate that there was no significant effect of social class on the SF1 values of TRAP vowels for entire data in general and for WLS in particular as well. Therefore, the following general pattern for the effect of social class on the SF1 of TRAP vowels can be obtained:

(A-SF1: Social class-pattern-1) WC = UMC

As discussed in §6.4.4.1 and §6.4.4.2, there was no significant interaction effect either between social class and speech styles or between social class and phonetic environments, indicating that the way in which the SF1 values were affected by social class did not significantly differ either across speech styles or across phonetic environments (cf. Figure 45 and Figure 47).

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 49:

Table 49 (SF1 in TRAP) Simple effects of social class for each condition of speech styles and phonetic environments

Simple Effects	F	df	Sig.	
Social class at IS	0.000	1, 30	0.986	ns
Social class at RPS	0.991	1, 30	0.327	ns
Social class at WLS	1.113	1, 30	0.300	ns
Social class at _LS	0.633	1, 30	0.433	ns
Social class at _VS	1.126	1, 30	0.297	ns
Social class at _N	0.078	1, 30	0.782	ns
Social class at _LF	3.881	1, 30	0.058	ns
Social class at _VF	0.774	1, 30	0.386	ns

Similar to the general pattern for the non-significant main effect of social class that we saw above (i.e. WC=UMC), the effect of social class for all speech styles and all phonetic environments were found to be non-significant.

Thus, for the social class factor, in addition to a non-significant main effect, we see non-significant results for the effect of social class for all speech styles and all phonetic environments. The results are summarised as follows:

- WC = UMC: as the general pattern (for entire data, and for WLS), and as the patterns for all speech styles and all phonetic environments.

6.4.4.6 SF1 in TRAP: social grouping (by sex, age and social class)

Let us now look at the results for the effects of social groupings in the T14 in which social grouping factor was compared with speech style in whole data. Let us begin with the main effect of social grouping. The distribution of the SF1 values by social grouping is provided in Figure 51 which shows their means and SDs:

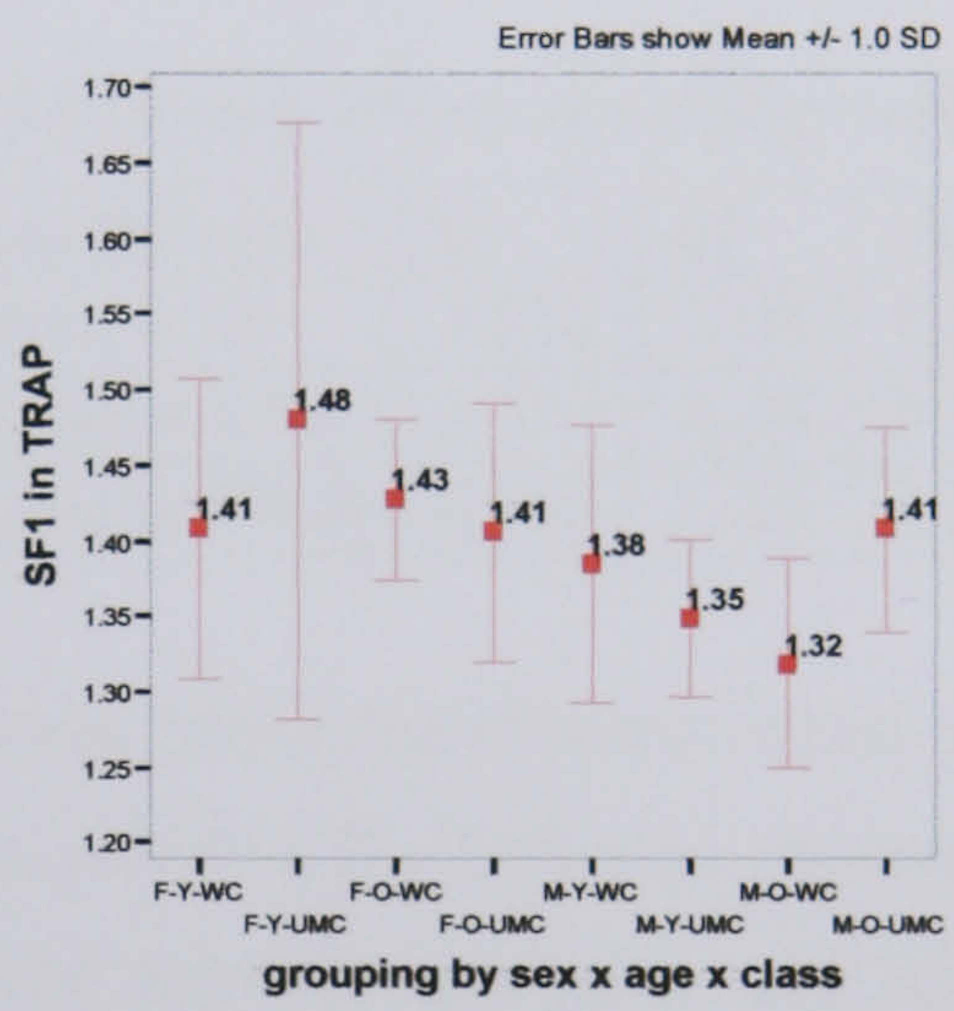


Figure 51 (SF1 in TRAP) Social grouping: Means and SDs in all speech styles for T14

The remarkable difference that we can see from the table and the figure would be that the SF1 values for F-Y-UMC are higher than any other groups, with the greatest SD and the widest range between maximum and minimum (cf. Appendix 10); this indicates that the SF1 values are more varied for F-Y-UMC speakers than for the other speakers. Similar tendencies are found for the SF1 of DRESS vowels (§6.4.1.6). Another thing is that most of the SF1 values for females are higher than those for males, as found for the SF1 of DRESS vowels (§6.4.1.6). It is notable that the changes in mean SF1 values and their SDs for TRAP vowels in Figure 51 look very similar those for DRESS vowels in Figure 30 that we saw previously. Looking at the ANOVA results in Table 39, the main effect of social grouping in the T14 was not significant, $F(7, 24)=1.108$, $p=0.39$. This result indicates that there was no significant effect of social grouping on the SF1 values of TRAP vowels. Therefore, the data could not be further examined for the difference between these groupings.

As discussed in §6.4.4.1, there were significant interaction effects between social groupings and speech styles (i.e. IS vs. RPS vs. WLS, and IS vs. RPS&WLS). The significant result was interpreted in §6.4.4.1 that the way in which SF1 values were affected by speech styles significantly differed for different groupings, and in particular, the pattern for the F-Y-UMC and the F-O-UMC (i.e. F-UMC) and that for the F-Y-WC and the M-O-UMC were different as can be seen in the Figure 45. This, however, can also be interpreted as follows; the way in which SF1 values were affected by social groupings significantly differed in different speech styles.

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 50:

Table 50 (SF1 in TRAP) Simple effects of social grouping for each speech style

Simple Effects	F	df	Sig.	
grouping at IS	1.372	7, 24	0.262	ns
grouping at RPS	1.75	7, 24	0.145	ns
grouping at WLS	0.915	7, 24	0.512	ns

Similar to the non-significant main effect, the effect of social grouping in all speech styles were found to be non-significant (i.e. $p>0.05$). No difference in social groupings across speech styles may confirm that the interaction between groupings and speech styles is simply due to the difference in profiles of different social groupings across speech styles. These non-significant results, therefore, prevented us from performing *post hoc* pairwise comparisons by LSD to see more detailed internal difference between groupings.

The result of the social grouping effect on the SF1 of TRAP is summarised as follows:

- Interactions: '**grouping x IS-RPS-WLS', '**grouping x IS-RPS&WLS'.

6.4.5 SF21 in TRAP

The results of the main effects and interaction effects for all the ANOVA tests in which the dependent variable was an SF21 value are provided in Table 51:

Table 51 ANOVA results for SF21 in TRAP: main effects and interaction effects

Test No.	Factor(s)	Type III Sum of Squares	df	Mean Square	F	Sig.	
1-1	sstyle	0.031	2, 60	0.015	3.382	0.041	$p<0.05$
	sex	0.152	1, 30	0.152	5.239	0.029	$p<0.05$
	sex x sstyle	0.019	2, 60	0.009	2.053	0.137	ns
1-2	sstyle	0.031	2, 60	0.015	3.387	0.040	$p<0.05$
	age	0.281	1, 30	0.281	11.381	0.002	$p<0.01$
	age x sstyle	0.019	2, 60	0.010	2.100	0.131	ns
1-3	sstyle	0.031	2, 60	0.015	3.235	0.046	$p<0.05$
	social class	0.182	1, 30	0.182	6.491	0.016	$p<0.05$
	social class x sstyle	0.006	2, 60	0.003	0.664	0.519	ns
1-4	sstyle	0.031	2, 48	0.015	3.837	0.028	$p<0.05$
	groupings	0.672	7, 24	0.096	6.602	0.000	$p<0.001$
	groupings x sstyle	0.099	14, 48	0.007	1.766	0.073	ns
2-1	PhonEn.	0.849	3.28, 98.27	0.259	23.365	0.000	$p<0.001$
	sex	0.448	1, 30	0.448	2.756	0.107	ns
	PhonEn x sex	0.065	3.28, 98.27	0.020	1.799	0.147	ns
2-2	PhonEn.	0.849	4, 120	0.212	22.789	0.000	$p<0.001$
	age	1.614	1, 30	1.614	13.036	0.001	$p<0.01$
	PhonEn x age	0.038	4, 120	0.009	1.016	0.402	ns
2-3	PhonEn.	0.849	4, 120	0.212	22.690	0.000	$p<0.001$
	social class	0.997	1, 30	0.997	6.905	0.013	$p<0.05$
	PhonEn x social class	0.033	4, 120	0.008	0.881	0.477	ns

This table will be referred to repeatedly as we discuss the effect of each factor one by one in the following sections.

6.4.5.1 SF21 in TRAP: speech style

Let us begin with the results for the effects of speech styles in the T11, T12, T13, and T14 in which speech style was compared with one of social factors (i.e. sex, age, social class, and social groupings) respectively. Figure 52 shows the means and their SDs across speech styles:

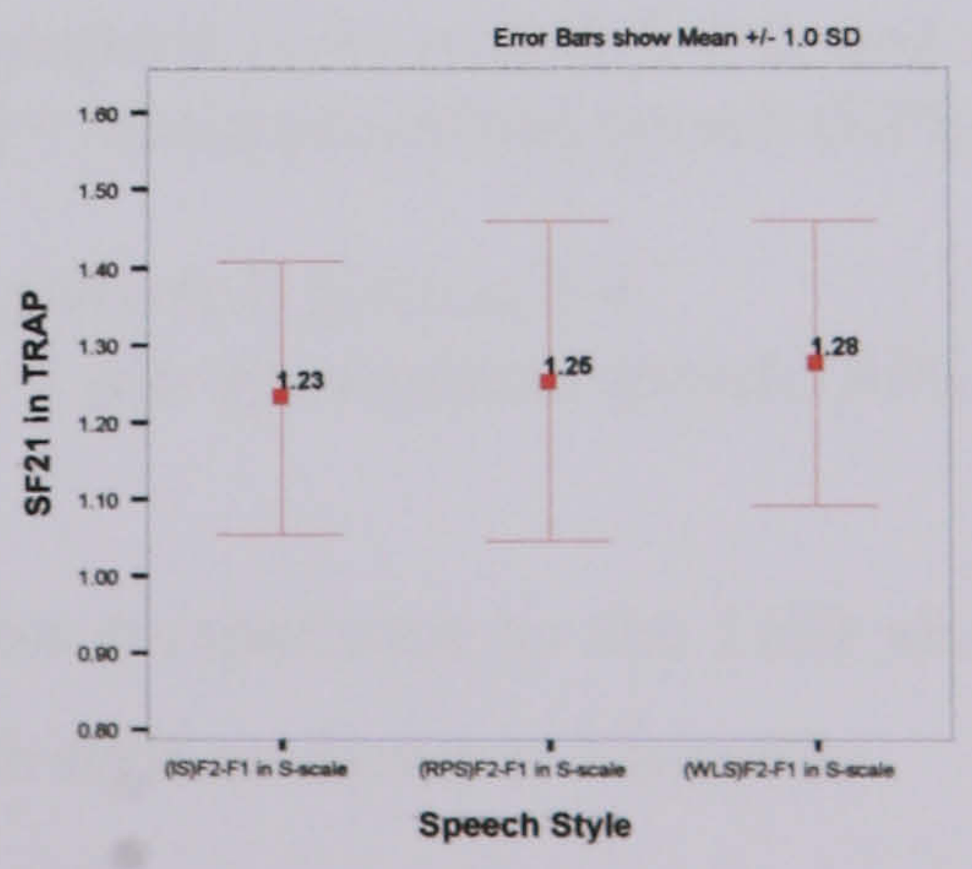


Figure 52 (SF21 in TRAP) Speech style: Means and SDs

The figure tells us that the mean of the SF21 values in WLS is the highest followed by the mean in RPS and by the mean in IS as the lowest, as found for the SF21 of DRESS vowels (§6.4.2.1). Looking at the results for the main effect of speech style in Table 51, the difference between these means across speech style was found to be significant at the level of $p<0.05$ for all the tests, T11, T12, T13, and T14. In order to find out how these three means differ, the significant results were further examined by both planned contrasts and *post hoc* pairwise comparisons by LSD. Firstly let us look at the results of the planned comparisons shown in Table 52:

Table 52 SF21 in TRAP: Planned contrasts for the main effects of speech style

Test No.	Style contrasts	Type III Sum of Squares	df	Mean Square	F	Sig.	
Test-1-1	IS vs. RPS&WLS	0.033	1, 30	0.033	3.575	0.068	ns
	RPS vs. WLS	0.018	1, 30	0.018	2.993	0.094	ns
Test-1-2	IS vs. RPS&WLS	0.033	1, 30	0.033	3.968	0.056	ns
	RPS vs. WLS	0.018	1, 30	0.018	2.506	0.124	ns
Test-1-3	IS vs. RPS&WLS	0.033	1, 30	0.033	3.690	0.064	ns
	RPS vs. WLS	0.018	1, 30	0.018	2.497	0.125	ns
Test-1-4	IS vs. RPS&WLS	0.033	1, 24	0.033	4.604	0.042	**$p<0.05$**
	RPS vs. WLS	0.018	1, 24	0.018	2.74	0.111	ns

The first contrasts in which we compare the means of SF21 values in spontaneous speech with those in non-spontaneous speech revealed non-significant results for all the tests but the T14; in this test, the mean SF21 value in spontaneous speech was significantly lower than the one in non-spontaneous speech at the level of $p<0.05$. The second contrasts in which we compare the means of SF21 values in RPS and WLS within non-spontaneous speech revealed non-significant results for all the tests. These patterns for the effect of speech style on the SF21 values of TRAP by contrast are expressed in the following formulas:

(A-SF21: Style-contrast-pattern 1) for tests 1-1, 1-2, and 1-3
Spontaneous speech (IS) = non-spontaneous speech (RPS&WLS)
RPS = WLS
(A-SF21: Style-contrast-pattern 2) for test 1-4
Spontaneous speech (IS) < non-spontaneous speech (RPS & WLS)
RPS = WLS

Similarly, the *post hoc* pairwise comparisons by the LSD also revealed the general pattern of SF21 values across three speech style as shown in Table 53:

Table 53 SF21 in TRAP: General patterns for the main effects of speech style by post hoc pairwise comparisons by LSD (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

Main effect of speech style in:	Pairwise comparisons by LSD		
	IS vs. RPS	IS vs. WLS	RPS vs. WLS
Test-1-1(by sex)*	ns	<*	ns
Test-1-2(by age)*	ns	<*	ns
Test-1-3(by class)*	ns	<*	ns
Test-1-4(by grouping)*	ns	<*	ns

The pairwise comparisons revealed significant results when comparing the SF21 values in IS with those in WLS; that is, the SF21 values were significantly lower in the IS than in the RPS. This suggests that, although there was no stepwise style shifting across three speech styles, there was a significant style shift between the more casual speech style (i.e. IS) and the more formal speech style (i.e. WLS). Therefore, the general pattern for the effect of speech style on the SF21 values of TRAP by pairwise comparisons would be expressed in the following formulas:

*(A- SF21: Style-pairwise-pattern 1)*for tests 1-1, 1-2, 1-3 and 1-4*
IS < WLS

Now we turn to the results for the interaction effects between speech style and one of the social factors. The graphs in Figure 53 show the interaction graphs for all these interactions. Looking at the results for the interactions in Table 27, all the interactions were non-significant: $F(2, 60)= 2.053$, $p=0.137$ (for sex and speech style in T11), $F(2, 60)= 2.100$, $p=0.131$ (for age and speech style in T12), $F(2, 60)= 0.644$, $p=0.519$ (for social class and speech style in T13) and $F(14, 48)= 1.766$, $p=0.073$ (for social groupings and speech style in T14). This means that the way in which the SF21 values were affected by speech style did not differ for male and female speakers, for young and old speakers, for WC and UMC speakers, and for eight social groupings. The second planned contrast in which we compared RPS with WLS revealed a significant interaction when comparing male and female values of SF21 in RPS compared to WLS, $F(1, 30)= 6.045$, $p<0.05$. Looking at the relevant parts of the interaction graph in Figure 53, on the contrary to the decrease of the SF21 values from WLS to RPS for the females, the mean SF21 values for the males do not change much between WLS and RPS or even slightly increase from WLS to RPS. No other contrasts were significant ($p>0.05$).

To break down all these interactions in more detail, the data were further explored using simple effects tests; the results are shown in Table 54:

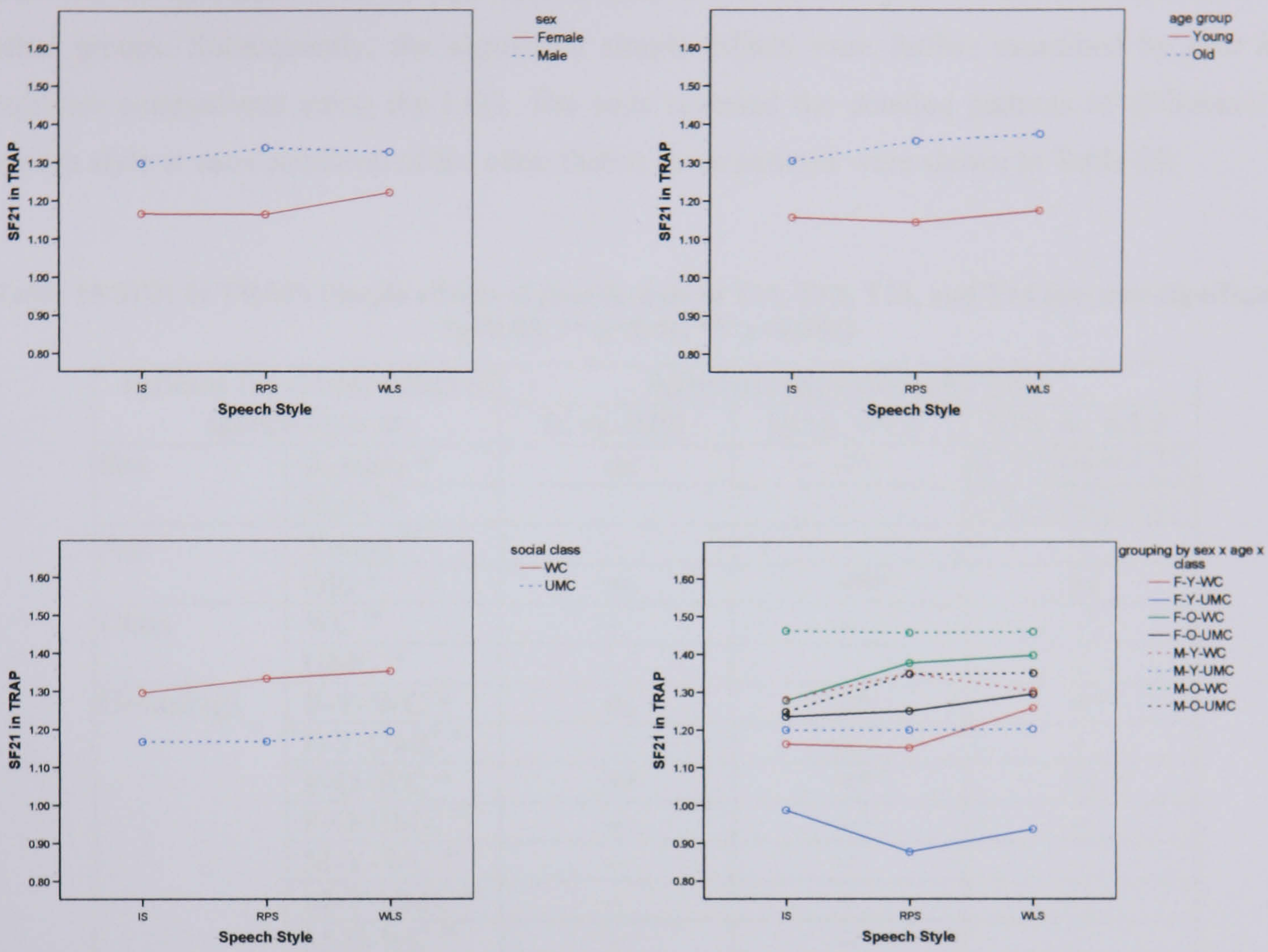


Figure 53 SF21 in TRAP: Interaction graphs for speech style x sex (top left), age (top right), social class (bottom-left), and social groupings (bottom-right)

Table 54 SF21 in TRAP: Simple effects of speech style for each condition of sex, age, social class, and social groupings

Test No.	Simple Effects	F	df	Sig.	
1-1 (sex)	Speech style at females	5.337	2. 29	0.011	***p*<0.05**
	Speech style at males	1.174	2, 29	0.323	ns
1-2 (age)	Speech style at Young	1.000	2, 29	0.38	ns
	Speech style at Old	4.146	2, 29	0.026	***p*<0.05**
1-3 (class)	Speech style at WC	2.777	2, 29	0.079	ns
	Speech style at UMC	1.117	2, 29	0.341	ns
1-4 (groupings)	Speech style at F-Y-WC	3.914	2, 23	0.034	***p*<0.05**
	Speech style at F-Y-UMC	2.592	2, 23	0.097	ns
	Speech style at F-O-WC	3.517	2, 23	0.046	***p*<0.05**
	Speech style at F-O-UMC	1.050	2, 23	0.366	ns
	Speech style at M-Y-WC	1.149	2, 23	0.335	ns
	Speech style at M-Y-UMC	0.002	2, 23	0.998	ns
	Speech style at M-O-WC	0.005	2, 23	0.995	ns
	Speech style at M-O-UMC	2.812	2, 23	0.081	ns

As shown in the table, the simple effects of speech style were found to be significant for the females, the old, the F-Y-WC, and the F-O-WC at the level of $p<0.05$, but not significant for other groups. Subsequently, the significant simple effects were further examined by *post hoc* pairwise comparisons using the LSD. The tests revealed the detailed patterns of difference in speech style at each condition of the other factor; those patterns were shown in Table 55:

Table 55 SF21 in TRAP: Simple effects of speech style in T11, T12, T13, and T14 (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

Patterns for simple effect of speech style at:		Pairwise comparisons by LSD		
		IS vs. RPS	IS vs. WLS	RPS vs. WLS
Sex	**Female ***	ns	<*	<**
	Male ^{ns}	–	–	–
Age	Young ^{ns}	–	–	–
	Old *	ns	<**	ns
Class	WC ^{ns}	–	–	–
	UMC ^{ns}	–	–	–
Groupings	**F-Y-WC ***	ns	<*	<*
	F-Y-UMC ^{ns}	–	–	–
	F-O-WC *	<*	<*	ns
	F-O-UMC ^{ns}	–	–	–
	M-Y-WC ^{ns}	–	–	–
	M-Y-UMC ^{ns}	–	–	–
	M-O-WC ^{ns}	–	–	–
	M-O-UMC ^{ns}	–	–	–

Comparing the significant interaction effects with relevant interaction graphs in Figure 53, the possible interacted patterns are shaded in grey in the three right rows, and significant interactions from the first planned contrast (i.e. IS vs. RPS&WLS) are also indicated by shades of the conditions of factors in the second left row. Observing the relevant parts in the Figure 53, for the interaction between sex and speech styles (i.e. RPS vs. WLS), the profile of the SF21 values from RPS to WLS is rather flat for the males, but it is slightly increasing for the females.

As a whole, the patterns for the significant effects (i.e. main effects and simple effects) of speech style on the SF1 values of TRAP from these results are summarised as follows:

- Spontaneous (IS) = non-spontaneous (RPS&WLS), RPS = WLS: as the pattern from planned contrasts (in T11, T12 and T13)
- Spontaneous (IS) < non-spontaneous (RPS&WLS), RPS = WLS: as the pattern from planned contrast (in T14)
- IS < WLS: as the general pattern (in T11, T12, T13 and T14), and as the pattern for the old,
- IS = RPS < WLS: as the patterns for the females and the F-Y-WC,

- IS < RPS = WLS: as the pattern for the F-O-WC
- Interaction: '*sex x RPS-WLS'.

6.4.5.2 SF21 in TRAP: phonetic environments

Let us now move on to the results for the effects of another within-subjects variable, phonological factor , in the T21, T22, and T23 in which phonetic environments were compared with one of the social factors (i.e. sex, age, and social class) respectively. As we discussed previously, we especially focus on comparisons for the pairs presented in Table 18. Figure 54 shows the means and their SDs across phonetic environments:

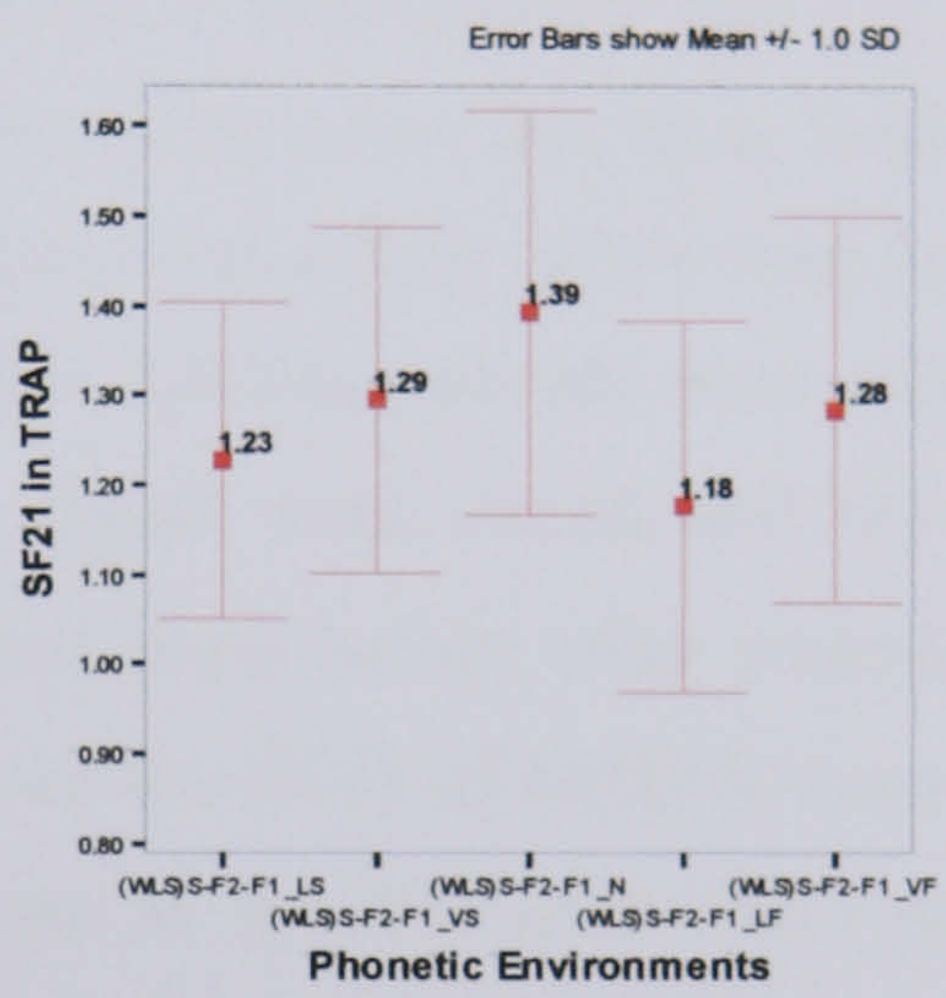


Figure 54 (SF21 in TRAP) Phonetic Environments: Means and SDs

Apparent differences in mean that we can see from Figure 54 and Appendix 10 would be firstly that the mean SF21 values of TRAP vowels are higher before voiced obstruents than before the their voiceless counterparts; this tendency is very similar to those for the SF1 of DRESS vowels (§6.4.1.2). Secondly they are higher before nasals compared to any other environments. Looking at the results for the main effect of speech style in Table 51, the difference between these means across phonetic environments was found to be very highly significant for all the tests at the level of $p<0.001$, so that phonetic environments proved to be a significant factor for the SF21 of TRAP vowels. In order to find out how the effects of these five phonetic environments differ, the results were further examined by *post hoc* pairwise comparisons; the comparisons revealed the following general pattern for the effects of following segments on the SF21 values of TRAP vowels:

*(A-SF21: Phonetic environments-pairwise-pattern-1, Tests-2-1 to 2-3)****

_LF < _LS < _VS = _VF < _N

Table 56 presents the detailed results of the pairwise comparisons, but only contains the results for the particular pairwise comparisons provided in Table 18 above:

Table 56 SF21 in TRAP: General patterns for the main effects of phonetic environments by post hoc pairwise comparisons by LSD (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

General patterns for:	(1)voiceless or voiced		(2)stops or fricatives		(3)nasals – stops – fricatives			
	LS – VS	LF – VF	LS – LF	VS – VF	N – LS	N – VS	N – LF	N – VF
Test-2-1(by sex)***	<***	<***	>*	ns	>***	>**	>***	>**
Test-2-2(by age)***	<***	<***	>*	ns	>***	>**	>***	>**
Test-2-3(by class)***	<***	<***	>*	ns	>***	>**	>***	>**

The pattern found throughout these tests showed that (1) TRAP vowels before voiceless obstruents had significantly lower SF21 values than those before their voiced counterparts in the same manner of articulation, that (2) the vowels before stops had significantly higher values than those before fricatives when the following sounds were voiceless, while there was no such difference when the following sounds were voiced, and (3) the vowels before nasals had significantly higher values than those before other voiced/voiceless obstruents. The first result is the same as the one for the SF21 of DRESS vowels (§6.4.2.2), whereas the second result is partially similar to the one for the SF21 of DRESS vowels in that the vowel before stops had higher SF21 (§6.4.2.1).

We turn now to the results for the interaction effects between phonetic environments and one of the social factors. The graphs in Figure 55 show the interaction graphs for all these interactions. Looking at the results for the interactions in Table 51, none of the interactions were significant (i.e. $p>0.05$), indicating that the way in which SF21 values were affected by phonetic environments did not significantly differ for the young and the old, for the young and the old, and for the WC and the UMC.

To break down these non-significant interactions in more detail, the data were further explored using simple effects tests; the results are displayed in the Table 57. As can be seen in the table, the simple effects of phonetic environments were found to be significant for all the conditions. Subsequently all these significant simple effects were further examined by *post hoc* pairwise comparisons using the LSD. The tests revealed the detailed patterns of difference in phonetic environments at each condition of all the factors. The detailed results focusing on the particular pairwise comparisons are provided in Table 58 which for the sake of clarity repeats the general patterns that we saw in the Table 56:

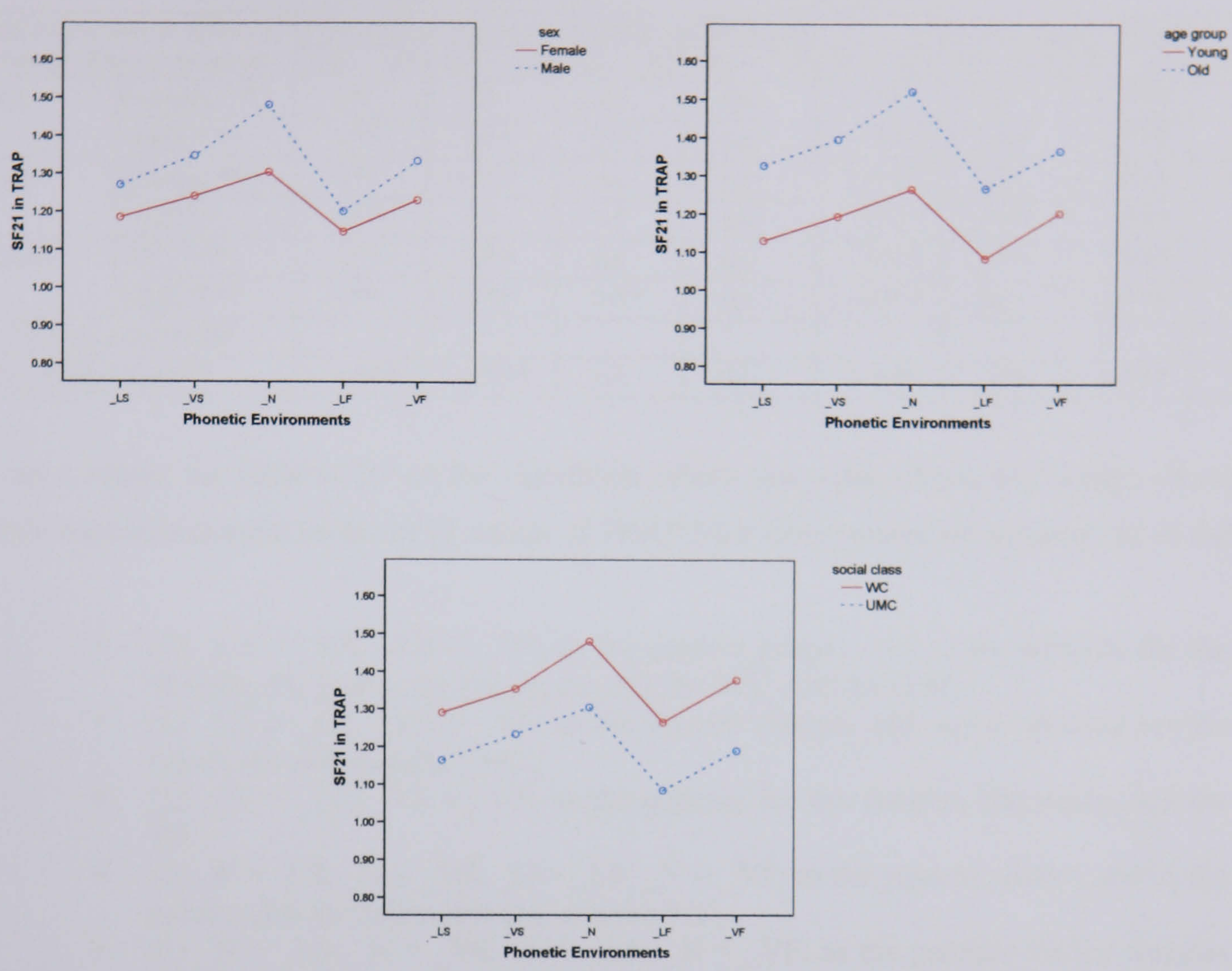


Figure 55 (SF21 in TRAP) Phonetic environments x sex (top left), age (top right) and social class (bottom)

Table 57 SF21 in TRAP: Simple effects of phonetic environments for each condition of sex, age, and social class

Test No.	Simple Effects	F	df	Sig.	
2-1 (by sex)	PhonEn. at females	7.948	4, 27	0.000	***p*<0.001**
	PhonEn. at males	22.847	4, 27	0.000	***p*<0.001**
2-2 (by age)	PhonEn. at Young	9.044	4, 27	0.000	***p*<0.001**
	PhonEn. at Old	15.607	4, 27	0.000	***p*<0.001**
2-3 (by class)	PhonEn. at WC	11.845	4, 27	0.000	***p*<0.001**
	PhonEn. at UMC	11.350	4, 27	0.000	***p*<0.001**

Table 58 Patterns for the simple effects of phonetic environments on SF21 values of TRAP vowels (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

Patterns for simple effects of Phonetic Environments at:		(1)voiceless or voiced		(2)stops or fricatives		(3)nasals – stops – fricatives			
		_LS – _VS	_LF – _VF	_LS – _LF	_VS – _VF	_N – _LS	_N – _VS	_N – _LF	_N – _VF
Sex	Female ***	<*	<*	ns	ns	>**	ns	>***	ns
	Male ***	<**	<**	>*	ns	>***	>**	>***	>**
Age	Young ***	<**	<**	ns	ns	>***	ns	>***	ns
	Old***	<**	<*	>*	ns	>***	>**	>***	>**
Class	WC ***	<**	<**	ns	ns	>***	>**	>***	>*
	UMC***	<**	<**	>**	ns	>***	ns	>***	>*
General patterns for:									
T21, T22, T23***		<***	<***	>*	ns	>***	>**	>***	>**

As a whole, the patterns for all the significant effects (i.e. main effects and simple effects) of phonetic environments on the SF21 values of TRAP from these results are summarised as follows:

- (1) _LS < _VS, _LF < _VF: as the general pattern, and as the patterns for the females, the males, the young, the old, the WC, and the UMC,
- (2) _LS > _LF, _VS = _VF: as the general pattern, and as the patterns for the males, the old, and the UMC,
- (2) _LS = _LF, _VS = _VF: as the patterns for the females, the young and the WC,
- (3) _N > _LS, _N > _VS, _N > _LF, _N > _VF: as the general pattern, and as the patterns for the males, the old, and the WC,
- (3) _N > _LS, _N = _VS, _N > _LF, _N = _VF: as the patterns for the females and the young,
- (3) _N > _LS, _N = _VS, _N > _LF, _N > _VF: as the pattern for the UMC.

6.4.5.3 SF21 in TRAP: sex

Now we turn to the results for the effects of sex in the T11 and T21 in which sex was compared with speech style in whole data and with phonetic environments in WLS data respectively. Let us firstly begin with the main effect of sex in both tests. The distributions of the SF21 values by sex are shown in Figure 56 below in which their means and SDs are displayed:

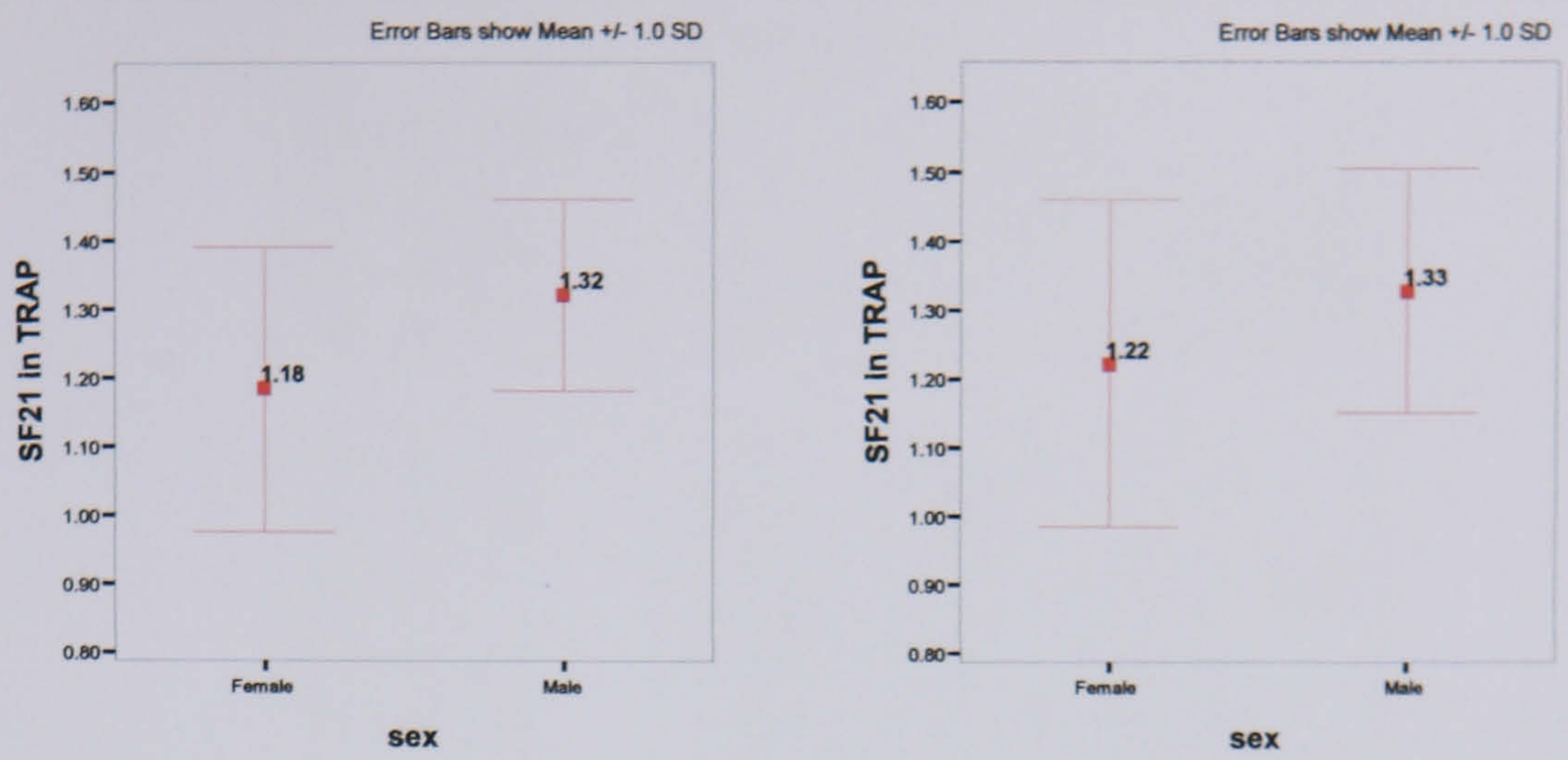


Figure 56 (SF21 in TRAP) Sex: Means and SDs in all speech styles in all speech styles for T11 (left) and in WLS for T21 (right)

In both tests, the means of the SF21 values for females are lower than those for males. Moreover, the SDs (cf. Appendix 10) are greater for the females than for the males, indicating that the SF21 values for the females were more varied than for the males. These greater SDs and wider range for the females were also found for the SF21 values of DRESS vowels (§6.4.2.3). Looking at the Table 51, the main effect of sex in T11 was shown to be significant, $F(1, 30)= 5.239$, $p<0.05$, while the one in T21 was shown to be non-significant, $F(1, 30)= 2.756$, $p= 0.107$. These results indicate that there was a significant effect of sex on the SF21 values of TRAP vowels for entire data in general, but there was no such effect for WLS data in particular. Therefore, the following general patterns for the effect of sex on the SF21 of TRAP vowels can be obtained:

(A-SF21: Sex-pattern-1, for entire data) * Female < Male
(A-SF21: Sex-pattern-2, for WLS data) Female = Male

As discussed in §6.4.5.1 and §6.4.5.2, while there was no significant interaction between sex and phonetic environments, there was a significant interaction between sex and speech styles (i.e. RPS vs. WLS). The result was interpreted in §6.4.5.1 that the way in which SF21 values were affected by speech styles significantly differed for the females and the males. This interaction, however, can also be interpreted in the following way: the way in which SF21 values were affected by sex significantly differed between RPS and WLS.

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 59:

Table 59 SF21 in TRAP: Simple effects of sex for each condition of speech style and phonetic environments

Simple Effects	F	df	Sig.	
Sex at IS	5.101	1, 30	0.031	***p*<0.05**
Sex at RPS	6.715	1, 30	0.015	***p*<0.05**
Sex at WLS	2.817	1, 30	0.104	ns
Sex at _LS	1.955	1, 30	0.172	ns
Sex at _VS	2.621	1, 30	0.116	ns
Sex at _N	5.718	1, 30	0.023	***p*<0.05**
Sex at _LF	0.538	1, 30	0.469	ns
Sex at _VF	1.903	1, 30	0.178	ns

Possibly interacted patterns are shaded in the table. Similar to the general pattern for the entire data, the effects of sex at IS and RPS were found to be significant at the level of $p<0.05$, i.e. F < M. The simple effect of sex at WLS was, however, found to be non-significant as we saw the general pattern for the WLS. This different sex effect particularly between RPS and WLS may be reflected to the significant interaction with speech styles. Within WLS data, the simple effects of sex in most of the phonetic environments were found to be non-significant, i.e. F = M. Only significant was the effect of sex when the vowels were followed by nasals; in this environment, the SF21 values for female speakers were significantly lower than those for male speakers, i.e. F < M.

Thus, for the sex factor, the general effect of sex on the SF21 values of TRAP vowels for entire data was F < M, and the detailed simple effect for each condition of speech styles revealed that this was true when the speech style was less-formal speech styles (i.e. IS and RPS). The general effect of sex on the SF21 values of TRAP vowels in relation to phonetic environments within WLS was F = M, and this was also true at all the phonetic environments except _N environment in which the values were significantly lower for the females than for the males like the general effect of sex on entire data. These results are summarised as follows:

- F < M: as the general pattern (for entire data), and as the patterns for IS, RPS and _N
- F = M: as the general pattern (for WLS data), and as the patterns for WLS, _LS, _VS, _LF and _VF
- Interaction: '*sex x RPS-WLS'.

6.4.5.4 SF21 in TRAP: age

We turn now to the results for the effects of age in the T12 and T22 in which age was compared with speech style in whole data and with phonetic environments in WLS data respectively. Let us begin with the main effect of age in both tests. The distributions of the SF21 values by age are shown in Figure 57 which displays their means and SDs:

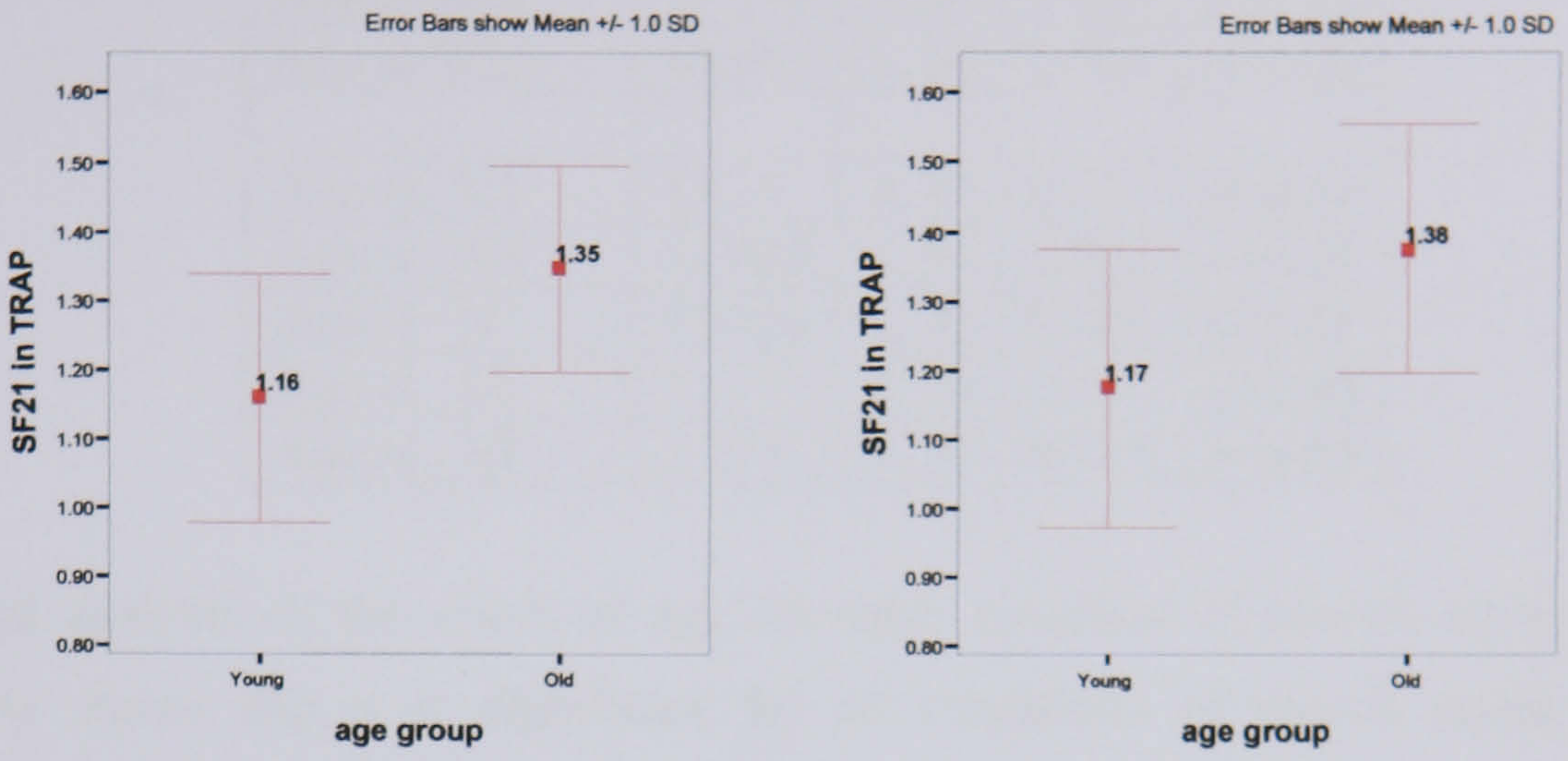


Figure 57 (SF21 in TRAP) Age: Means and SDs in all speech styles for T12 (left) and in WLS for T22 (right)

In both tests, the means of the SF21 values are higher for old speakers than for young speakers, as found for the SF21 of DRESS vowels (§6.4.2.4). The SDs are slightly greater for the young than for the old (cf. Appendix 10). This tendency is opposite to the one for the SF21 of DRESS vowels (§6.4.2.4). Looking at the ANOVA table in Table 51, the main effects of age in T12 and T22 were both shown to be highly significant: $F(1, 30)= 11.381$, $p<0.01$ in T12 and $F(1, 30)= 13.036$, $p<0.01$ in T22. These results are the same as the ones for the SF21 of DRESS vowels (§6.4.2.4). These results indicate that the mean difference between young and old speakers was significant for entire data in general and for WLS in particular as well; that is, the SF2 values were higher for the old than for the young. Therefore, the following general pattern for the effect of age on the SF21 of TRAP vowels can be obtained:

(A-SF21: Age-pattern-1) Young < OLD

As discussed in §6.4.5.1 and §6.4.5.2, there was no significant interaction effect either between age and speech styles or between age and phonetic environments, indicating that the way in which the SF21 values were affected by age did not significantly differ either across speech styles or across phonetic environments (cf. Figure 53 and Figure 55).

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 60:

Table 60 SF21 in TRAP: Simple effects of age for each condition of speech style and phonetic environments

Simple Effects	F	df	Sig.	
Age at IS	6.735	1, 30	0.014	***p*<0.05**
Age at RPS	11.278	1, 30	0.002	***p*<0.01**
Age at WLS	13.009	1, 30	0.001	***p*<0.01**
Age at _LS	14.17	1, 30	0.001	***p*<0.01**
Age at _VS	11.962	1, 30	0.002	***p*<0.01**
Age at _N	15.021	1, 30	0.001	***p*<0.01**
Age at _LF	7.617	1, 30	0.01	***p*<0.05**
Age at _VF	5.237	1, 30	0.029	***p*<0.05**

This detailed analysis of the effect of age for each condition of speech styles and phonetic environments shows that *p* is significant for all conditions of speech styles and phonetic environments. That is, as can be seen in the Figure 53 and Figure 55, the SF21 values were significantly higher for the old speakers than for the young speakers in every condition; this is the same pattern for the significant main effect of age that we saw above (i.e. Y<O).

Thus, the main effect of age on the SF21 values was Y<O. This pattern was also true across all the conditions of speech styles and phonetic environments. These results are summarised as follows:

- Y < O: as the general pattern (for entire data and for WLS data), and as the patterns for all the conditions of speech styles and phonetic environments (i.e. IS, RPS, WLS, _LS, _VS, _N, _LF and _VF)

6.4.5.5 SF21 in TRAP: social class

We turn now to the results for the effects of social class in the T13 and T23 in which social class was compared with speech style in whole data and with phonetic environments in WLS data respectively. Let us begin with the main effect of social class in both tests. The distributions of the SF21 values by social class are provided in Figure 58 which shows their means and SDs:

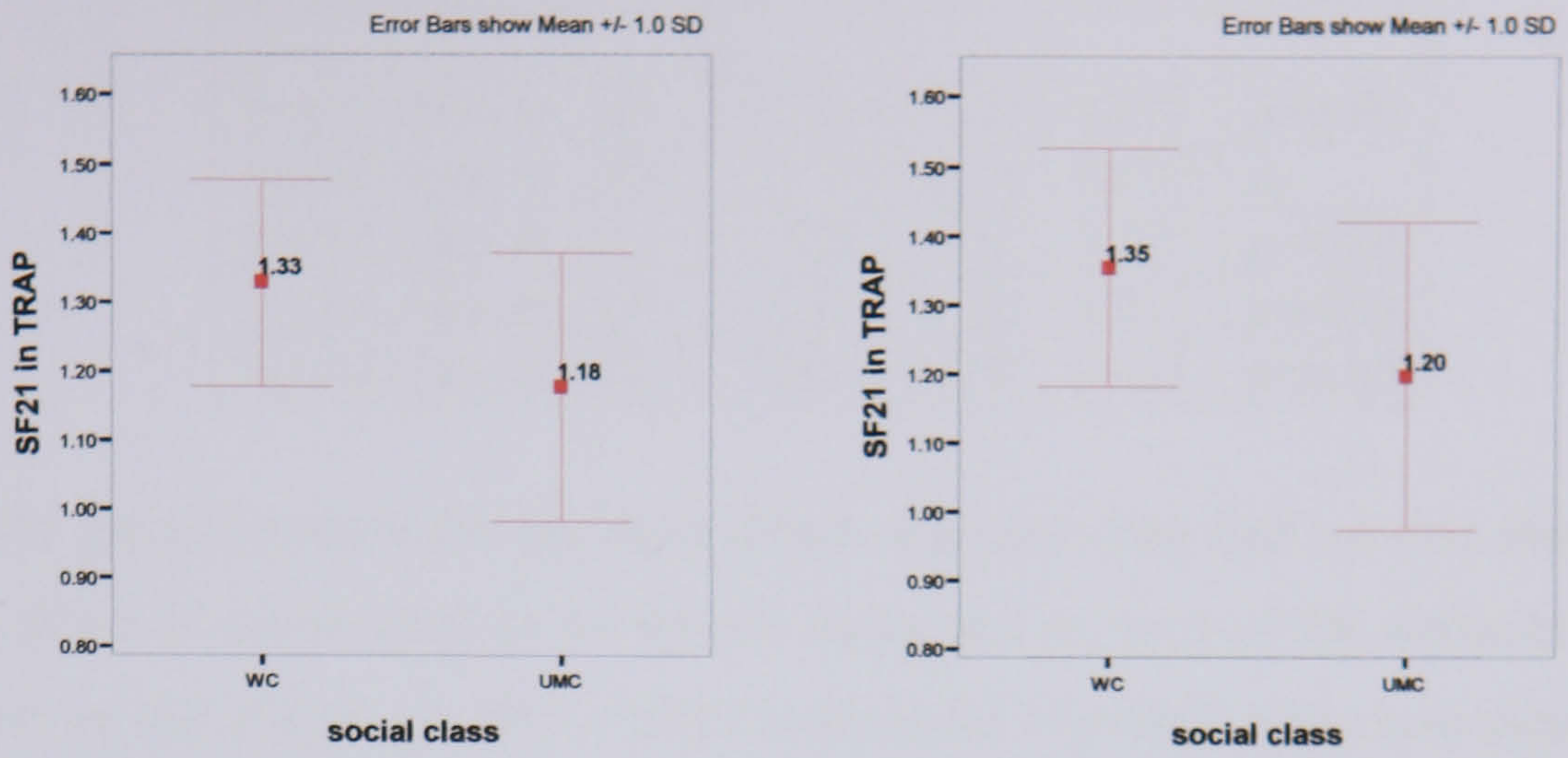


Figure 58 (SF21 in TRAP) Social class: Means and SDs in all speech styles for T13 (left) and in WLS for T23 (right)

In both tests, the means of the SF21 values are higher for WC speakers than for UMC speakers, as found for the SF21 of DRESS vowels (§6.4.2.5). The greater SDs for the UMC (cf. Appendix 10) indicate that the SF21 values for the UMC were more varied than for the WC. This tendency is the same as the one for the SF21 of DRESS vowels (§6.4.2.5). Looking at the ANOVA table in Table 51, the main effects of social class in T13 and T23 were both significant: $F(1, 30)=6.491$, $p<0.05$ in T13 and $F(1, 30)=6.905$, $p<0.05$ in T23. These results indicate that there was a significant effect of social class on the SF21 values of TRAP vowels for entire data in general and for WLS in particular as well. Therefore, the following general pattern for the effect of social class on the SF21 of TRAP vowels can be obtained:

(A-SF21: Social class-pattern-1) * WC > UMC

As discussed in §6.4.5.1 and §6.4.5.2, there was no significant interaction effect either between social class and speech styles or between social class and phonetic environments, indicating that the way in which the SF21 values were affected by social class did not significantly differ either across speech styles or across phonetic environments (cf. Figure 53 and Figure 55).

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 61:

Table 61 (SF21 in TRAP) Simple effects of social class for each condition of speech styles and phonetic environments

Simple Effects	F	df	Sig.	
Social class at IS	4.769	1, 30	0.037	$p<0.05$
Social class at RPS	5.928	1, 30	0.021	$p<0.05$

Social class at WLS	6.941	1, 30	0.013	***p*<0.05**
Social class at _LS	4.526	1, 30	0.042	***p*<0.05**
Social class at _VS	3.337	1, 30	0.078	ns
Social class at _N	5.528	1, 30	0.025	***p*<0.05**
Social class at _LF	7.237	1, 30	0.012	***p*<0.05**
Social class at _VF	7.261	1, 30	0.011	***p*<0.05**

Similar to the general pattern for the main effect of social class that we saw above (i.e. WC > UMC), the effect of social class in all speech styles and in most of the phonetic environments were found to be significant, i.e. WC > UMC at the level of $p<0.05$. Only non-significant was the effect of social class before voiced stops; in this environment, the SF21 values for WC speakers were not significantly different from those for UMC speakers, i.e. WC = UMC.

Thus, the main effect of social class on the SF21 values were WC > UMC. This pattern was also true across all the conditions of speech styles and phonetic environments except _VS environment in which the values were not different between the WC and the UMC. These results are summarised as follows:

- WC > UMC: as the general pattern (for entire data and for WLS data), and as the patterns for IS, RPS, WLS, _LS, _N, _LF and _VF
- WC = UMC: as the pattern for _VS.

6.4.5.6 SF21 in TRAP: social grouping (by sex, age and social class)

Let us now look at the results for the effects of social groupings in the T14 in which social grouping factor was compared with speech style in whole data. Let us begin with the main effect of social grouping. The distribution of the SF21 values by social grouping is provided in Figure 59 which shows their means and SDs:

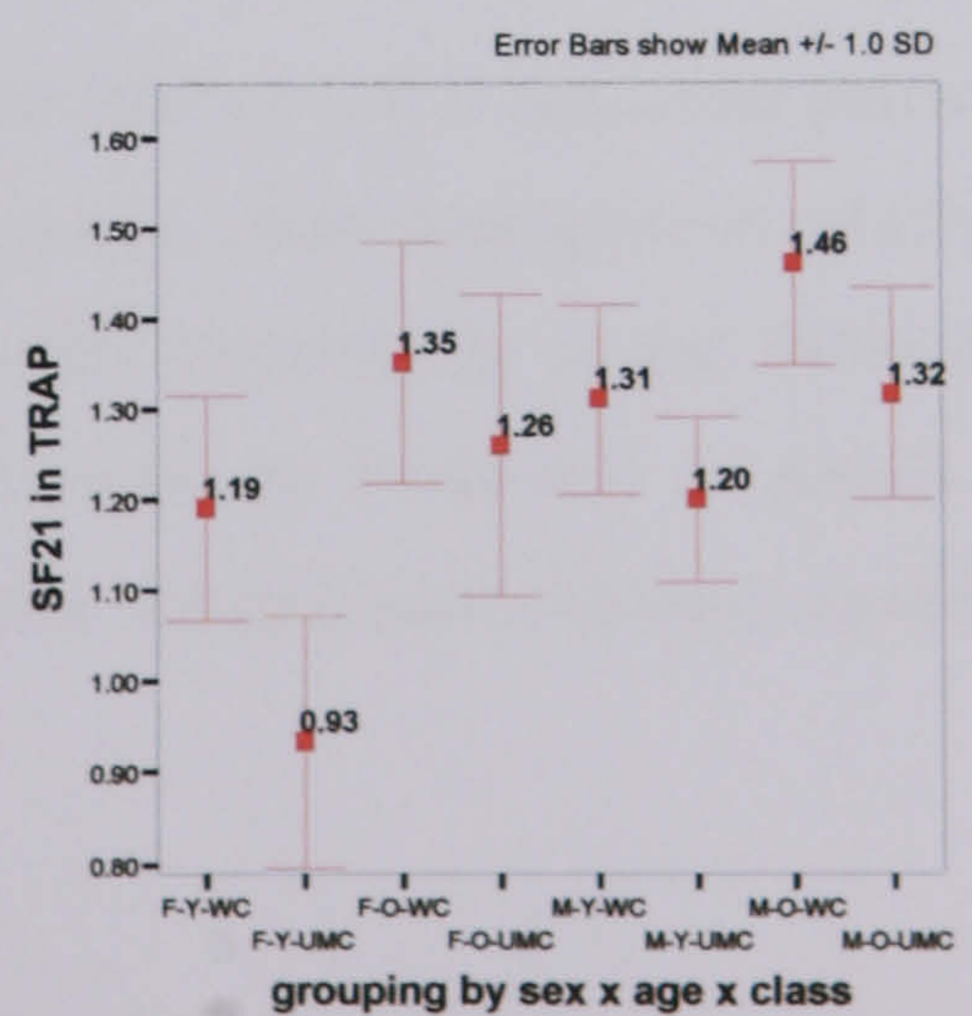


Figure 59 (SF21 in TRAP) Social grouping: Means and SDs in all speech styles for T14

There are several noticeable differences that we can see from the figure. Firstly, the SF21 values for old WC speakers are higher than any other groups. Secondly the values for the F-Y-UMC are much lower than any other groups; this tendency is the same as the one for the SF21 of DRESS vowels (§6.4.2.6). Thirdly the SDs and the ranges between maximum and minimum values for female speakers (i.e. F-Y-WC, F-Y-UMC, F-O-WC and F-O-UMC) are greater and wider than those for male speakers (cf. Appendix 10), indicating that the SF21 values are more varied for the females than the males. Fourthly, if we compare each pair for the comparisons for sex, age and social class, the patterns are following the general patterns that we saw in the previous sections (i.e. F < M, Y < O, and WC > UMC). Looking at the ANOVA results in Table 51, the main effect of social grouping in the T14 was very highly significant, $F(7, 24) = 6.602$, $p<0.001$, indicating that there was a significant effect of social grouping on the SF21 values of TRAP vowels. In order to find out how these means from the eight groupings differ from each other, the data were further examined by *post hoc* pairwise comparisons by LSD; the results are presented in the Table 62 below:

Table 62 SF21 in TRAP: Post hoc pairwise comparisons by LSD for social groupings by sex x age x social class in T14 (selected results for sex comparisons, age comparisons, and social class comparisons are in the dark grey cells, the medium grey cells, and the light grey cells respectively)

	F-Y-WC	F-Y-UMC	F-O-WC	F-O-UMC	M-Y-WC	M-Y-UMC	M-O-WC	M-O-UMC
F-Y-WC	x	**$p<0.01$**	**ns**	ns	**ns**	ns	$p<0.01$	ns
F-Y-UMC		x	$p<0.001$	**$p<0.01$**	$p<0.001$	**$p<0.01$**	$p<0.001$	$p<0.001$
F-O-WC			x	**ns**	ns	ns	**ns**	ns
F-O-UMC				x	ns	ns	$p<0.05$	**ns**
M-Y-WC					x	**ns**	**ns**	ns
M-Y-UMC						x	$p<0.01$	**ns**
M-O-WC							x	**ns**
M-O-UMC								x

As we discussed in §6.4.1.6, our interest lies in particular pairwise comparisons (cf. Table 25) for the purpose of sex, age and social class comparisons which are presented in the dark grey, medium grey and light grey cells respectively in the Table 62. The results for those selected pairwise comparisons are presented in Table 63, in which an inequality sign indicates the significant result for each pairwise comparison with their significance level expressed by asterisks:

Table 63 SF21 in TRAP: Selected post hoc pairwise comparisons by LSD for the main effects of social groupings by sex x age x social class in T14 (ns: non-significant, *p<0.05, **p<0.01, ***p<0.001)

Pairs	Sex Comparisons			Age Comparisons			Social Class Comparisons		
	Female		*Male*	*Young*		*Old*	*WC*		*UMC*
1	*F*-Y-WC	=	*M*-Y-WC	F-*Y*-WC	=	F-*O*-WC	F-Y-*WC*	>**	F-Y-*UMC*
2	*F*-Y-UMC	<**	*M*-Y-UMC	F-*Y*-UMC	<**	F-*O*-UMC	F-O-*WC*	=	F-O-*UMC*
3	*F*-O-WC	=	*M*-O-WC	M-*Y*-WC	=	M-*O*-WC	M-Y-*WC*	=	M-Y-*UMC*
4	*F*-O-UMC	=	*M*-O-UMC	M-*Y*-UMC	=	M-*O*-UMC	M-O-*WC*	=	M-O-*UMC*

As can be seen from the table, all the significant results involve the comparisons in which one of the groups is F-Y-UMC. That is, the SF21 values for the F-Y-UMC were significantly lower than those for M-Y-UMC ($p<0.01$) as a sex comparison (i.e. F < M), significantly lower than those for F-O-UMC ($p<0.01$) as an age comparison (i.e. Y < O), and significantly lower than those for F-Y-WC ($p<0.01$) as a social class comparison (i.e. WC > UMC).

As discussed in §6.4.5.1, there was no significant interaction effect between social groupings and speech, indicating that the way in which the SF21 values were affected by social groupings did not significantly differ across speech styles (cf. Figure 53).

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 64:

Table 64 (SF21 in TRAP) Simple effects of social grouping for each speech style

Simple Effects	**F**	**df**	**Sig.**	
grouping at IS	3.648	7, 24	0.008	***p*<0.01**
grouping at RPS	7.646	7, 24	0.000	***p*<0.001**
grouping at WLS	6.636	7, 24	0.000	***p*<0.001**

Similar to the significant main effect, the effect of social grouping in all speech styles were found to be highly significant. Therefore, the results were further examined by *post hoc* pairwise comparisons by LSD. The tests revealed the detailed patterns of difference in social groupings at each condition of speech styles (i.e. IS, RPS and WLS); those patterns are shown in Table 65:

Table 65 SF21 in TRAP: Selected post hoc pairwise comparisons by LSD for the simple effect of social groupings in IS speech (top), in RPS speech (middle) and in WLS speech (bottom) in T14 (ns: non-significant, *p<0.05, **p<0.01, ***p<0.001)

in IS speech

Pairs	Sex Comparisons			Age Comparisons			Social Class Comparisons		
	Female		Male	Young		Old	WC		UMC
1	F-Y-WC	=	M-Y-WC	F-Y-WC	=	F-O-WC	F-Y-WC	=	F-Y-UMC
2	F-Y-UMC	<*	M-Y-UMC	F-Y-UMC	<*	F-O-UMC	F-O-WC	=	F-O-UMC
3	F-O-WC	=	M-O-WC	M-Y-WC	=	M-O-WC	M-Y-WC	=	M-Y-UMC
4	F-O-UMC	=	M-O-UMC	M-Y-UMC	=	M-O-UMC	M-O-WC	>*	M-O-UMC

in RPS speech

Pairs	Sex Comparisons			Age Comparisons			Social Class Comparisons		
	Female		Male	Young		Old	WC		UMC
1	F-Y-WC	<*	M-Y-WC	F-Y-WC	<*	F-O-WC	F-Y-WC	>**	F-Y-UMC
2	F-Y-UMC	<**	M-Y-UMC	F-Y-UMC	<***	F-O-UMC	F-O-WC	=	F-O-UMC
3	F-O-WC	=	M-O-WC	M-Y-WC	=	M-O-WC	M-Y-WC	=	M-Y-UMC
4	F-O-UMC	=	M-O-UMC	M-Y-UMC	=	M-O-UMC	M-O-WC	=	M-O-UMC

in WLS speech

Pairs	Sex Comparisons			Age Comparisons			Social Class Comparisons		
	Female		Male	Young		Old	WC		UMC
1	F-Y-WC	=	M-Y-WC	F-Y-WC	=	F-O-WC	F-Y-WC	>**	F-Y-UMC
2	F-Y-UMC	<**	M-Y-UMC	F-Y-UMC	<***	F-O-UMC	F-O-WC	=	F-O-UMC
3	F-O-WC	=	M-O-WC	M-Y-WC	=	M-O-WC	M-Y-WC	=	M-Y-UMC
4	F-O-UMC	=	M-O-UMC	M-Y-UMC	=	M-O-UMC	M-O-WC	=	M-O-UMC

As we saw above, the general patterns of the SF21 values by social groupings were that (1) F < M in the Y-UMC group ($p<0.01$), (2) Y < O in the F-UMC group ($p<0.01$), and (3) WC > UMC in the F-Y group ($p<0.01$).

The first general pattern for sex was equally true for all the speech styles at the level of $p<0.05$ in IS, and at the level of $p<0.01$ in RPS and WLS. In RPS, this pattern was also found in the Y-WC group at the level of $p<0.05$; therefore, in RPS, F-Y (female-young) speakers had significantly lower SF21 values than M-Y (male-young) speakers.

The second general pattern for age was equally true for all the speech styles at the level of $p<0.05$ in IS, and at the level of $p<0.001$ in RPS and WLS. In RPS, again, this pattern was also found in the F-WC group at the level of $p<0.05$; therefore, in RPS, F-Y (female-young) speakers had significantly lower SF21 values than F-O (female-old) speakers.

The third general pattern for social class was equally true for RPS and WLS at the level of $p<0.01$, but not for IS (i.e. $p>0.05$). In IS, however, this pattern was found in the M-O group at the level of $p<0.05$.

The patterns for all the significant main and simple effects of social groupings on the SF21 values of TRAP from these results are summarised as follows:

- F < M: as the general pattern for the Y-UMC, as the patterns for the Y-UMC in IS, RPS and WLS, as the pattern for the Y-WC in RPS,
- F = M: as the patterns for the O-WC and the O-UMC in IS, RPS and WLS, as the patterns for the Y-WC in IS and RPS,
- Y < O: as the general pattern for the F-UMC, as the patterns for the F-UMC in IS, RPS and WLS, as the pattern for the F-WC in RPS,
- Y = O: as the patterns for the M-WC and the M-UMC in IS, RPS and WLS, as the patterns for the F-WC in IS and WLS,
- WC > UMC: as the general pattern for the F-Y, as the patterns for the F-Y in RPS and WLS, as the pattern for the M-O in IS
- WC = UMC: as the patterns for the F-O, the M-Y and the M-O in RPS and WLS, as the patterns for the F-Y, the F-O, and the M-Y in IS.

6.4.6 Provisional Summary for TRAP

In this section, we consider both SF1 and SF21 together on a vowel scatter plot for a provisional summary as in §6.4.3. Overall summary and discussions of TRAP in relation to DRESS and STRUT will be left for a later section, §6.5.

6.4.6.1 TRAP and speech style

Speech style proved to be a significant factor both for the SF1 and SF21 of DRESS vowels not only in general, but also for many sub groups. The statistical results are summarised in the following schematic graphs:

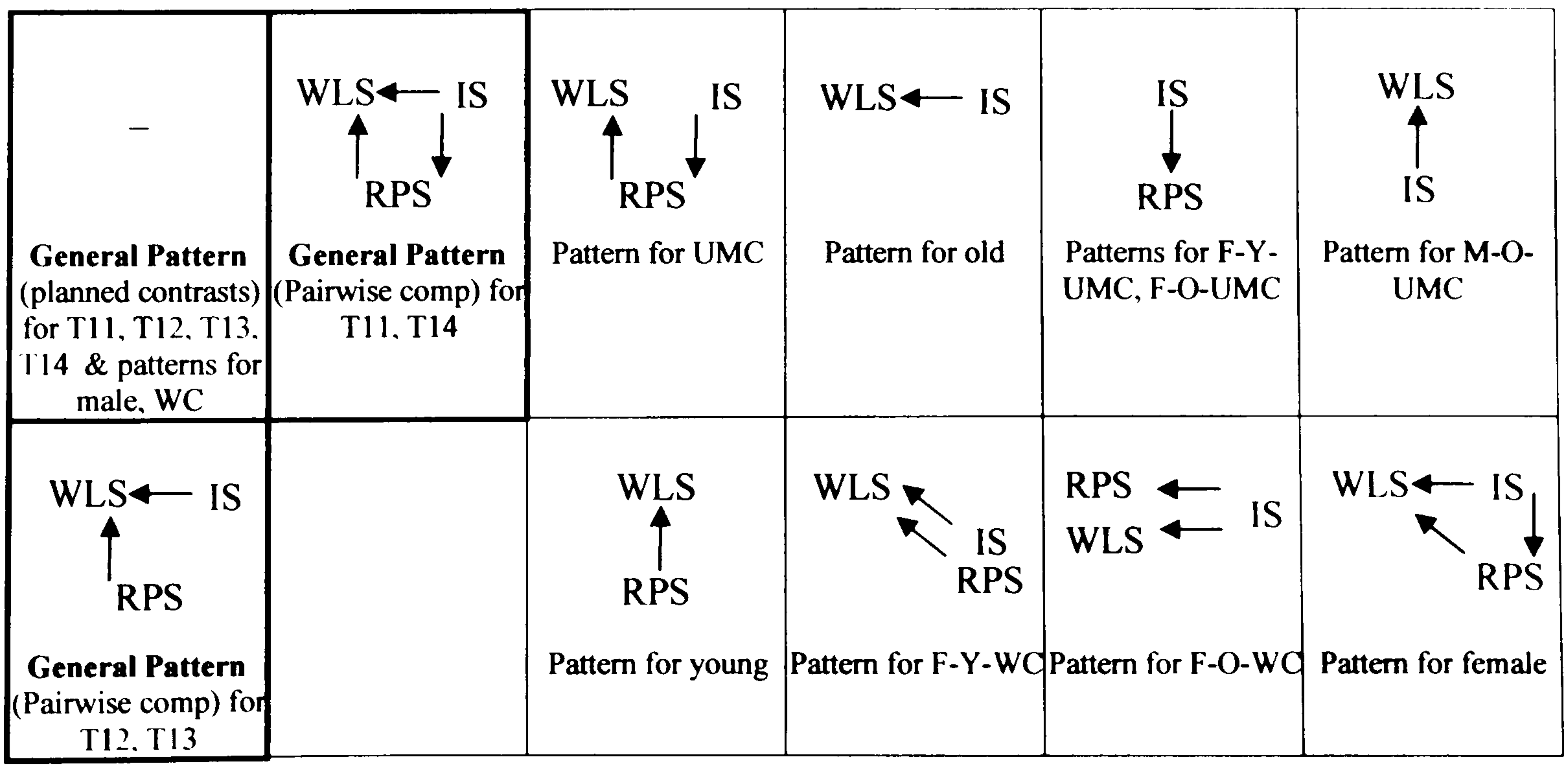
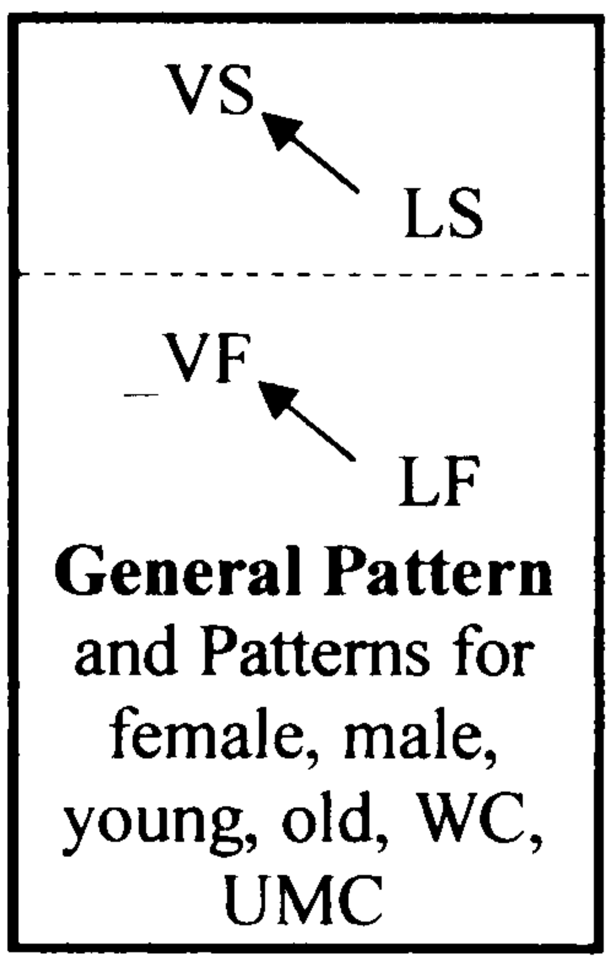


Figure 60 TRAP by speech style: schematic patterns

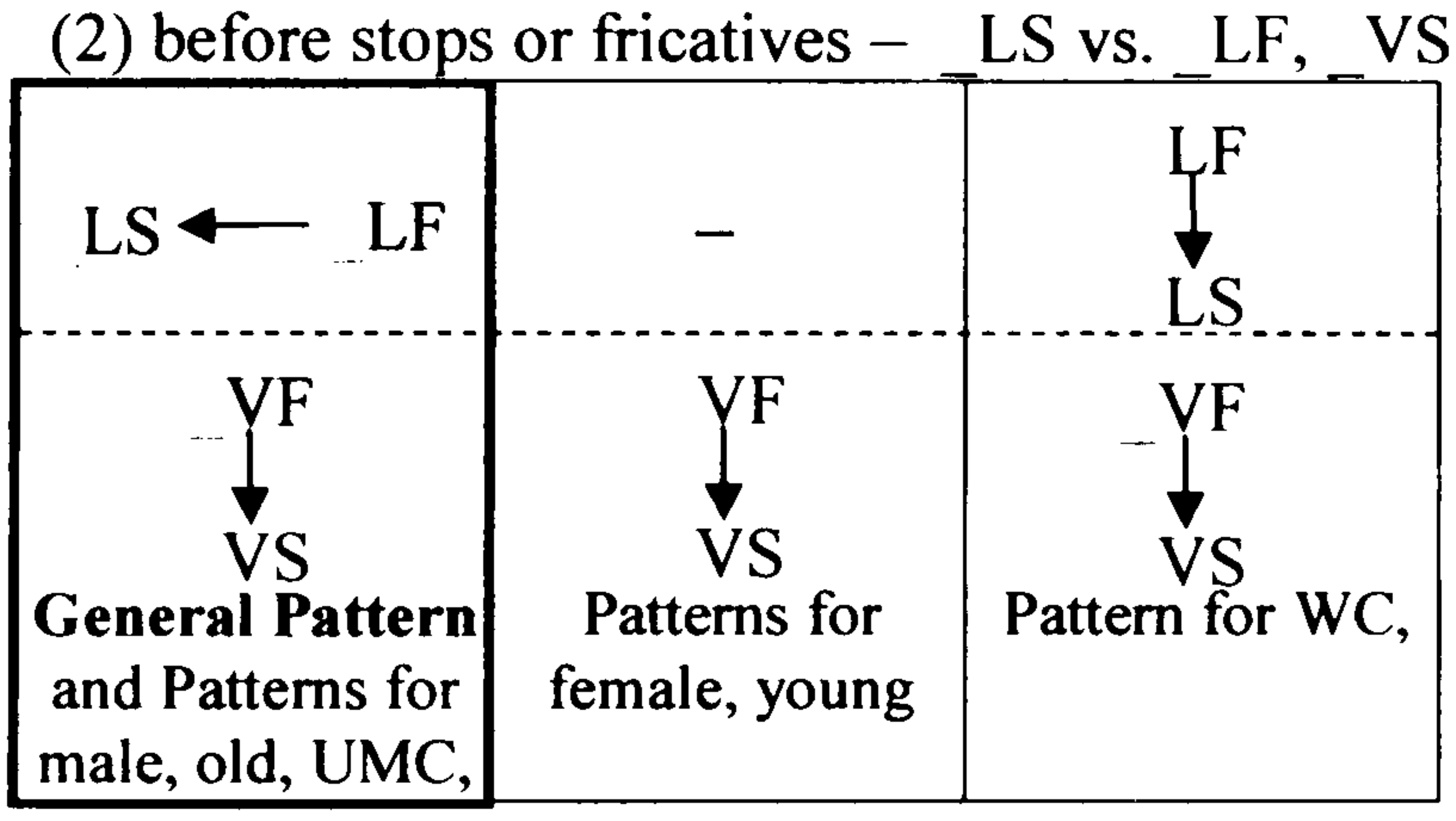
6.4.6.2 TRAP and phonetic environments

Phonetic environments proved to be a very highly significant factor both for the SF1 and SF21 of TRAP vowels not only in general, but also for all the sub groups. Comparison focussed on: (1) before voiceless or voiced obstruents, (2) before stop or fricative, and (3) before nasal or obstruent. The statistical results are summarised in the following schematic graphs:

(1) before voiceless or voiced obstruents – _LS vs. _VS, _LF vs. _VF



(2) before stops or fricatives – _LS vs. _LF, _VS vs. _VF



(3) before nasals, stops or fricatives – _N vs. _LS, _N vs. _VS, _N vs. _LF, _N vs. _VF

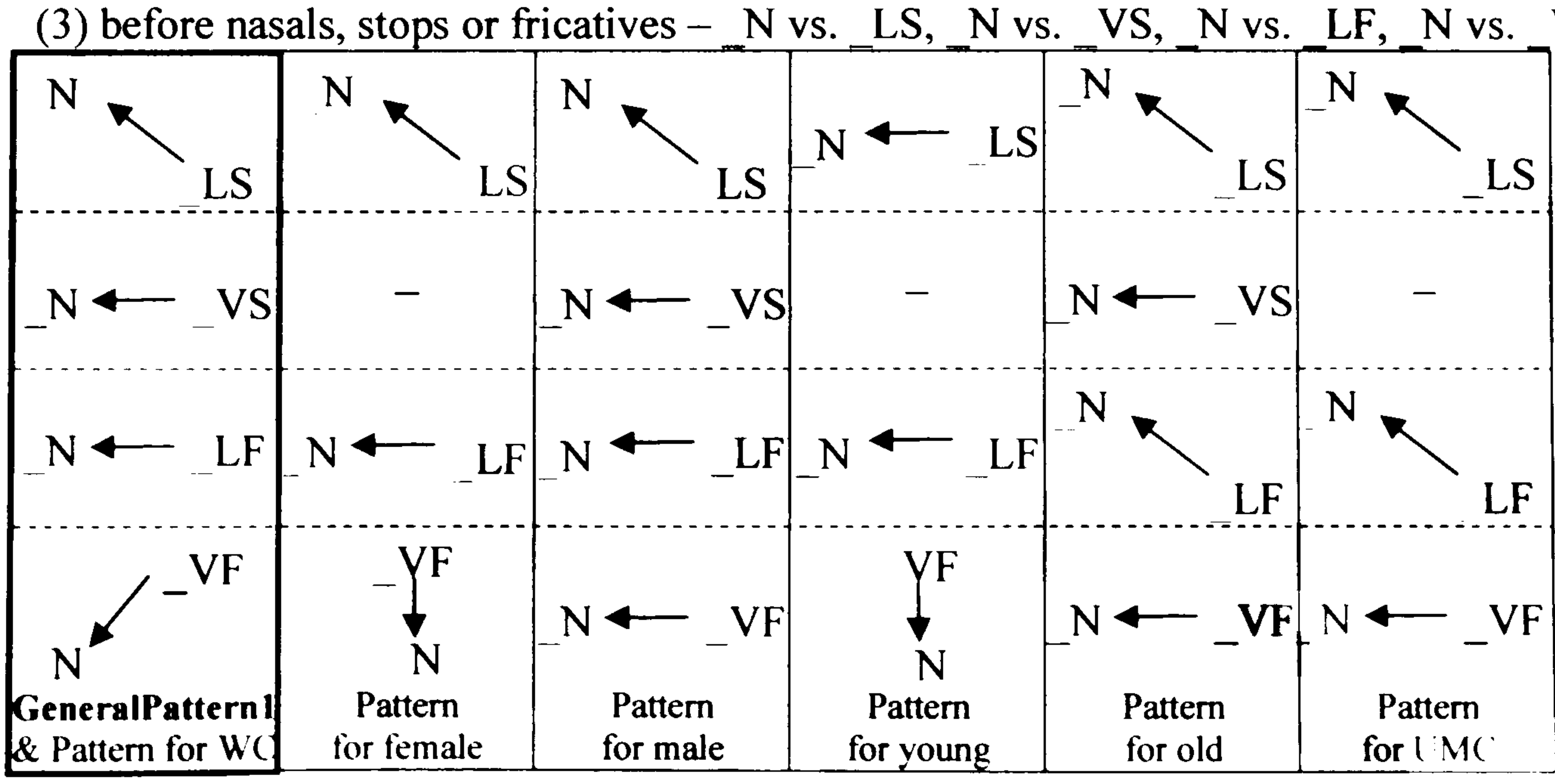


Figure 61 TRAP by phonetic environments: schematic patterns

6.4.6.3 TRAP and sex

The general relationship between sex and vowel openness was F > M for the entire data and particularly in less formal non-spontaneous speech style (i.e. RPS), while it was F = M for the WLS data.

The general effect of sex to vowel frontness was M > F for the entire data and particularly in less formal speech styles, while it was F = M for the WLS data. Even within WLS, however, the relationship M > F was also found only before nasals.

These results are summarised in the following schematic graphs:

M ↖ F	–	M ← F
General Pattern (for entire data) & pattern for RPS	**General Pattern** (for WLS data) & patterns for WLS, _LS, _VS, _LF, _VF	Pattern for IS, _N

Figure 62 TRAP by sex: schematic patterns

6.4.6.4 TRAP and age

The general relationship between age and vowel openness was always O = Y, while the general relationship between age and vowel frontness was always O > Y. Therefore, in summary, the TRAP vowels were always more back for the young than for the old as schematically shown in Figure 63:

O → Y
General Pattern (for entire & WLS data), patterns for IS, RPS, WLS, _LS, _VS, _N, _LF, _VF

Figure 63 TRAP by age: schematic pattern

6.4.6.5 TRAP and social class

The relationship between social class and vowel openness was always WC = UMC, while the general relationship between social class and vowel frontness was WC > UMC except for the environment before voiced stops. These results are summarised in the following schematic graphs:

WC ← UMC	–
General Pattern (for entire & WLS data), IS, RPS, WLS, _LS, _N, _LF, _VF	Pattern for _VS

Figure 64 TRAP by social class: schematic patterns

6.4.6.6 TRAP and social groupings

In terms of vowel openness, the noticeable difference between social groupings was in the distribution of the vowels for F-Y-UMC; their mean vowels were relatively lower than those of any other group with wider SDs. Statistical results, however, indicated that there was no significant different across social grouping regarding the openness at any condition.

In terms of vowel frontness, there were two noticeable differences between social groupings. Firstly, the vowels for old WC speakers were more front than any other groups. Secondly, the vowels for the F-Y-UMC were much more back than any other groups. The statistical tests revealed the following patterns:

(1) sex comparison:
M > F for the Y-UMC both in general and in IS, RPS and WLS,
M > F for the Y-WC in RPS,
F = M for all other groups in all other conditions,
(2) age comparison:
O > Y for the F-UMC both in general and in IS, RPS and WLS,
O > Y for the F-WC in RPS
Y = O for all other groups in all other conditions,
(3) social class comparison:
WC > UMC for the F-Y both in general and in RPS and WLS,
WC > UMC for the M-O in IS
WC = UMC for all other groups in all other conditions.

These results are summarised in the following schematic graphs:

Sex comparisons		Age comparisons		Social class comparisons	
M ← F	–	O → Y	–	WC ← UMC	–
•Y-UMC (in general, IS, RPS, WLS), •Y-WC (in RPS)	All other groups	•F-UMC (in general, IS, RPS, WLS), •F-WC (in RPS)	All other groups	•F-Y (in general, RPS, WLS), •M-O (in IS)	All other groups

Figure 65 TRAP by social groupings: schematic patterns

6.4.7 SF1 in STRUT

The results of the main effects and interaction effects for all the ANOVA tests in which the dependent variable was an SF1 value are provided in Table 66:

Table 66 ANOVA results for SF1 in STRUT: main effects and interaction effects

Test No.	Factor(s)	Type III Sum of Squares	df	Mean Square	F	Sig.	
1-1	sstyle	0.018	2, 60	0.009	3.631	0.032	$p<0.05$
	sex	0.000	1, 30	0.000	0.010	0.921	ns
	sex x sstyle	0.009	2, 60	0.005	1.947	0.152	ns
1-2	sstyle	0.018	2, 60	0.009	3.514	0.036	$p<0.05$
	age	0.050	1, 30	0.050	6.947	0.013	$p<0.05$
	age x sstyle	0.005	2, 60	0.002	0.918	0.405	ns
1-3	sstyle	0.018	2, 60	0.009	3.606	0.033	$p<0.05$
	social class	0.049	1, 30	0.049	6.681	0.015	$p<0.05$
	social class x sstyle	0.008	2, 60	0.004	1.727	0.186	ns
1-4	sstyle	0.018	2, 48	0.009	3.673	0.033	$p<0.05$
	groupings	0.111	7, 24	0.016	2.44	0.049	$p<0.05$
	groupings x sstyle	0.04	14, 48	0.003	1.187	0.315	ns
2-1	PhonEn.	0.425	2.50, 75.05	0.170	14.962	0.000	$p<0.001$
	sex	0.001	1, 30	0.001	0.022	0.884	ns
	PhonEn x sex	0.015	2.50, 75.05	0.006	0.535	0.627	ns
2-2	PhonEn.	0.425	2.40, 72.11	0.177	15.264	0.000	$p<0.001$
	age	0.214	1, 30	0.214	5.124	0.031	$p<0.05$
	PhonEn x age	0.032	2.40, 72.11	0.013	1.153	0.328	ns
2-3	PhonEn.	0.425	2.42, 72.61	0.176	15.973	0.000	$p<0.001$
	social class	0.127	1, 30	0.127	2.848	0.102	ns
	PhonEn x social class	0.069	2.42, 72.61	0.029	2.600	0.071	ns

This table will be referred to repeatedly as we discuss the effect of each factor one by one in the following sections.

6.4.7.1 SF1 in STRUT: speech style

Let us begin with the results for the effects of speech styles in the T11, T12, T13, and T14 in which speech style was compared with one of social factors (i.e. sex, age, social class, and social groupings) respectively. Figure 66 shows the means and their SDs across speech styles:

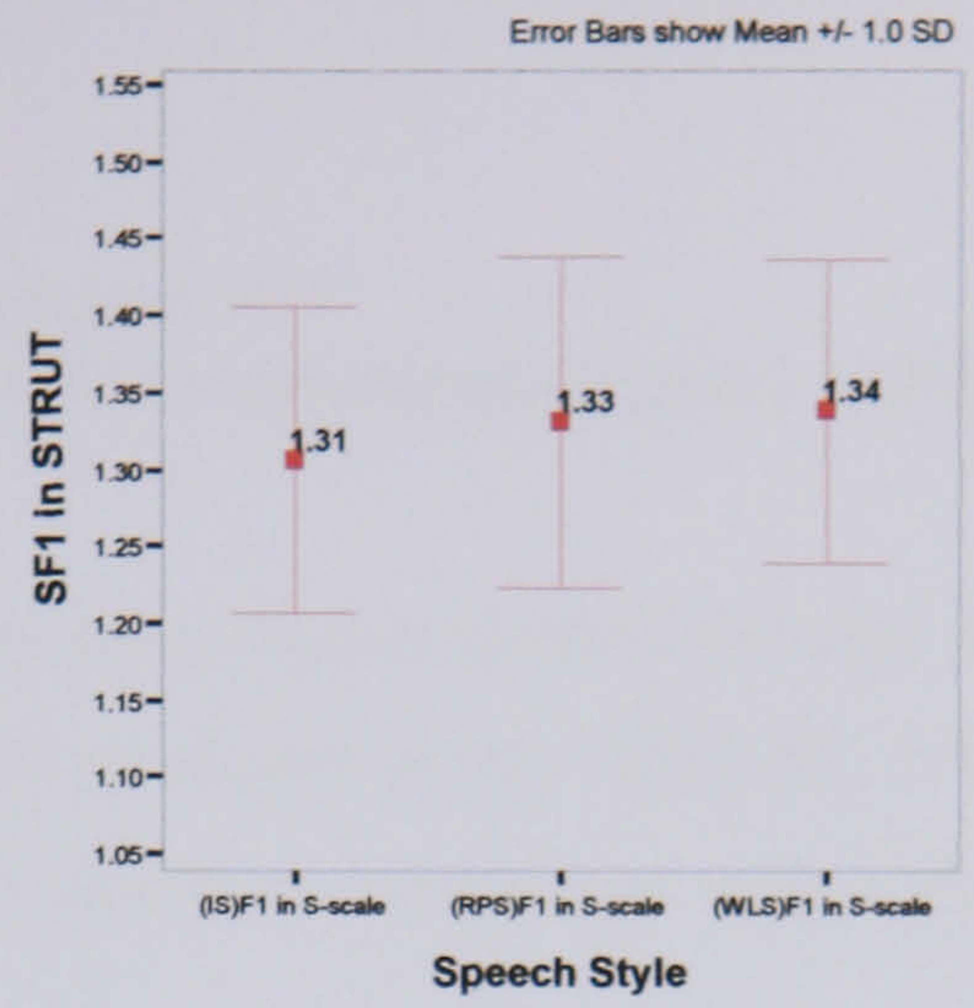


Figure 66 (SF1 in STRUT) Speech style: Means and SDs

The figure tells us that the mean of the SF1 values in IS is slightly lower than the means of those in RPS and WLS. The SDs for the RPS are slightly greater than those for IS and WLS (cf. Appendix 10); this may indicate that the SF1 values of the vowels in RPS varied slightly more than those of the vowels in IS and WLS. Looking at the results for the main effect of speech style in Table 66, the difference between these means across speech style was found to be significant at the level of $p<0.05$ for all the tests. Therefore, in order to find out how these three means differ, the results were further examined by both planned contrasts and *post hoc* pairwise comparisons by LSD. Firstly let us look at the results of the planned contrasts shown in Table 67:

Table 67 SF1 in STRUT: Planned contrasts for the main effects of speech style

Test No.	**Style contrasts**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	
Test-1-1	IS vs. RPS&WLS	0.025	1, 30	0.025	5.357	0.028	***p*<0.05**
	RPS vs. WLS	0.002	1, 30	0.002	0.484	0.492	ns
Test-1-2	IS vs. RPS&WLS	0.025	1, 30	0.025	5.357	0.028	***p*<0.05**
	RPS vs. WLS	0.002	1, 30	0.002	0.442	0.511	ns
Test-1-3	IS vs. RPS&WLS	0.025	1, 30	0.025	5.124	0.031	***p*<0.05**
	RPS vs. WLS	0.002	1, 30	0.002	0.517	0.478	ns
Test-1-4	IS vs. RPS&WLS	0.025	1, 24	0.025	5.364	0.029	***p*<0.05**
	RPS vs. WLS	0.002	1, 24	0.002	0.499	0.487	ns

The table tells us that, throughout analyses, SF1 values in spontaneous speech style were significantly lower than those in non-spontaneous speech styles (i.e. RPS and WLS). This result is opposite to the one for the SF1 of the DRESS vowels (§6.4.1.1). Within non-spontaneous speech, however, the values for RPS were not significantly different from those in WLS. This pattern for the effect of speech style on the SF1 values of STRUT by contrast is expressed in the following formulas:

*(U-SF1: Style-contrast-pattern 1)**
Spontaneous speech (IS) < non-spontaneous speech (RPS&WLS)
RPS = WLS

Similarly, the *post hoc* pairwise comparisons by the LSD also revealed the general pattern of SF1 values across three speech style as shown in the Table 68, in which an inequality sign indicates the significant result for each pairwise comparison with their significance level expressed by asterisks:

Table 68 SF1 in STRUT: General patterns for the main effects of speech style by post hoc pairwise comparisons by LSD (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

Main effect of speech style in:	Pairwise comparisons by LSD		
	IS vs. RPS	IS vs. WLS	RPS vs. WLS
Test-1-1(by sex)**	ns	<*	ns
Test-1-2(by age)*	ns	<*	ns
Test-1-3(by class)*	ns	<*	ns
Test-1-4(by grouping)**	ns	<*	ns

For all the analyses, the SF1 values in the IS were found to be significantly higher than in the WLS at the level of $p<0.05$ and $p<0.01$, while the SF1 values in the RPS were no more significantly different from those in the IS than those in WLS. These results suggest that, for the SF1 values of STRUT vowels, there was a significant style shift from IS to WLS, but there was no style shift between IS and RPS, and between RPS and WLS.

In summary, the general pattern for the effect of speech style on the SF1 values of STRUT by pairwise comparisons would be expressed in the following formulas:

*(U-SF1: Style-pairwise-pattern 1)** IS < WLS

We now turn to the results for the interaction effects between speech style and one of the social factors. The graphs in Figure 67 show the interaction graphs for all these interactions. Looking at the results for the interactions in Table 66, none of the interactions were found to be significant: $F(2, 60)= 1.947$, $p= 0.152$ in T11, $F(2, 60)= 0.918$, $p= 0.405$ in T12, $F(2, 60)= 1.727$, $p= 0.186$ in T13, and $F(14, 48)= 1.187$, $p= 0.315$ in T14. That is, the way in which the SF1 values were affected by speech style did not differ for female and male speakers, for young and old speakers, for WC and UMC speakers, and for speakers divided by social groupings. Planned contrasts revealed a significant interaction only when comparing WC and UMC values of SF1 in RPS compared to WLS, F(1, 30)= 5.204, $p<0.05$; this means that the profile of SF1 change between RPS and WLS was significantly different between WC and UMC speakers. No other contrasts were significant ($p>0.05$).

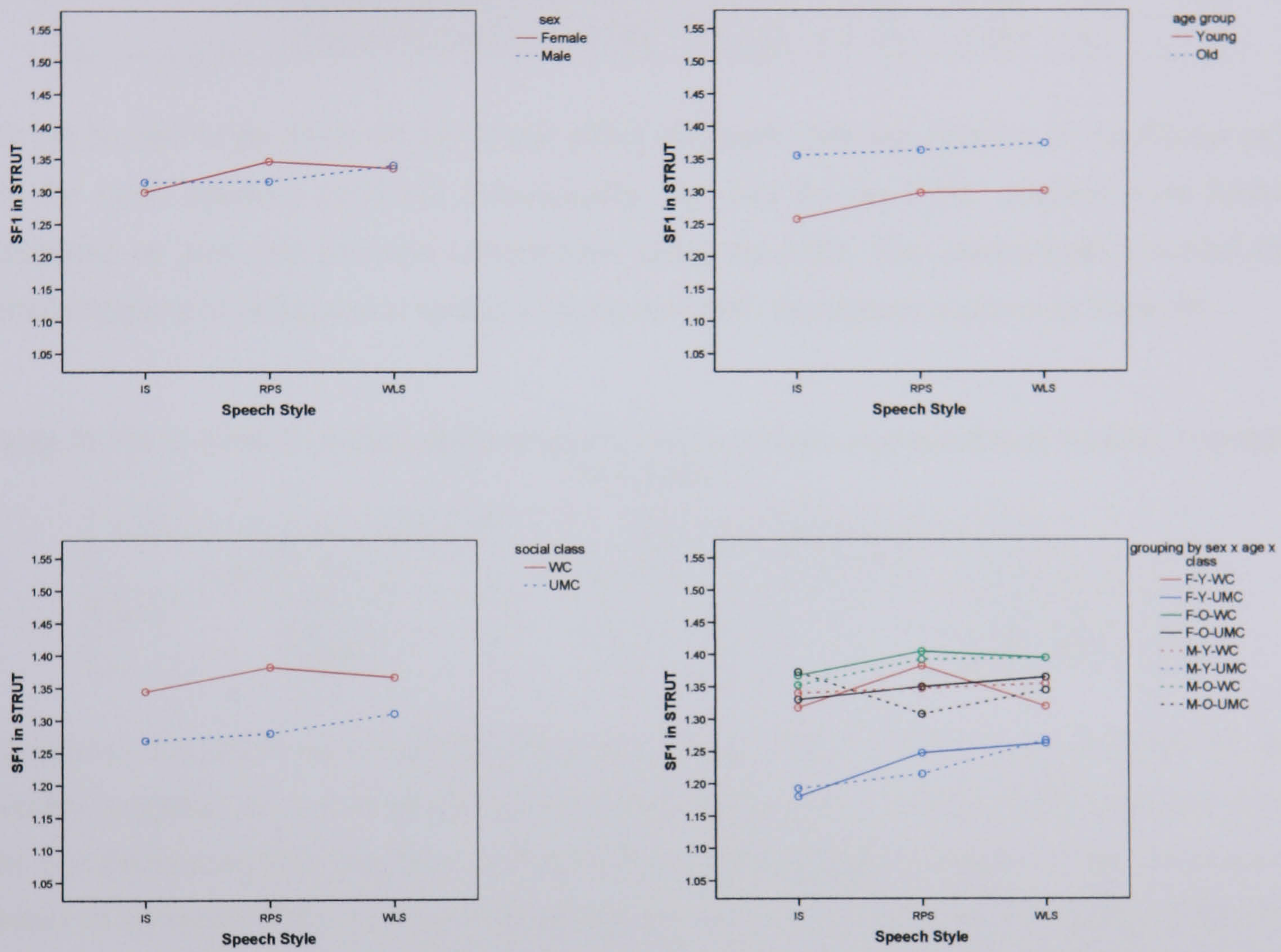


Figure 67 SF1 in STRUT: Interaction graphs for speech style x sex (top left), age (top right), social class (bottom-left), and social groupings (bottom-right)

To break down these interactions in more detail, the data were further explored using simple effects tests; the results are shown in the Table 69:

Table 69 SF1 in STRUT: Simple effects of speech style for each condition of sex, age, social class, and social groupings

Test No.	Simple Effects	F	df	Sig.	
1-1 (sex)	Speech style at females	3.020	2, 29	0.064	ns
	Speech style at males	1.947	2, 29	0.161	ns
1-2 (age)	Speech style at Young	3.158	2, 29	0.057	ns
	Speech style at Old	0.702	2, 29	0.504	ns
1-3 (class)	Speech style at WC	1.694	2, 29	0.201	ns
	Speech style at UMC	4.028	2, 29	0.029	***p*<0.05**

1-4 (groupings)	Speech style at F-Y-WC	2.415	2, 23	0.112	ns
	Speech style at F-Y-UMC	2.764	2, 23	0.084	ns
	Speech style at F-O-WC	0.447	2, 23	0.645	ns
	Speech style at F-O-UMC	0.541	2, 23	0.589	ns
	Speech style at M-Y-WC	0.105	2, 23	0.901	ns
	Speech style at M-Y-UMC	3.185	2, 23	0.06	ns
	Speech style at M-O-WC	0.752	2, 23	0.483	ns
	Speech style at M-O-UMC	1.413	2, 23	0.264	ns

As can be seen in the Table 69, the simple effect of speech style was found to be significant only for the UMC speakers ($p<0.05$). Subsequently, the data for the UMC speakers were further examined by *post hoc* pairwise comparisons using the LSD. The comparisons revealed the detailed pattern of difference in speech style for the UMC: the pattern is shown in Table 70:

Table 70 SF1 in STRUT: Simple effects of speech style in T13 (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

Patterns for simple effect of speech style at:		Pairwise comparisons by LSD		
		IS vs. RPS	IS vs. WLS	RPS vs. WLS
Class	**WC** ^{ns}	–	–	–
	UMC *	ns	<*	<*

Comparing the significant interaction effect with the relevant interaction graph in Figure 67, the possible interacted patterns are shaded in grey in the three right rows, and significant interactions from the first planned contrast (i.e. IS vs. RPS&WLS) are also indicated by shades of the conditions of factors in the second left row. Observing the relevant parts in the Figure 67, the profile of the SF1 values from RPS to WLS is slightly decreasing for the WC, whereas it is slightly increasing for the UMC.

As a whole, the patterns for the significant effects (i.e. main effects and simple effects) of speech style on the SF1 values of STRUT from these results are summarised as follows:

- Spontaneous (IS) < non-spontaneous (RPS&WLS), RPS = WLS: as the pattern from planned contrasts
- IS < RPS&WLS: as the general pattern (in T11, T12, T13 and T14),
- IS < WLS: as the general pattern (in T11, T12, T13 and T14),
- IS = RPS < WLS: as the pattern for the UMC
- Interaction: '*class x RPS-WLS'.

6.4.7.2 SF1 in STRUT: phonetic environments

Let us now move on to the results for the effects of another within-subjects variable, phonological factor, in the T21, T22, and T23 in which phonetic environments were compared with one of the social factors (i.e. sex, age, and social class) respectively. As we discussed previously, we especially focus on comparisons for the pairs presented in Table 18. Figure 68 shows the means and their SDs across phonetic environments:

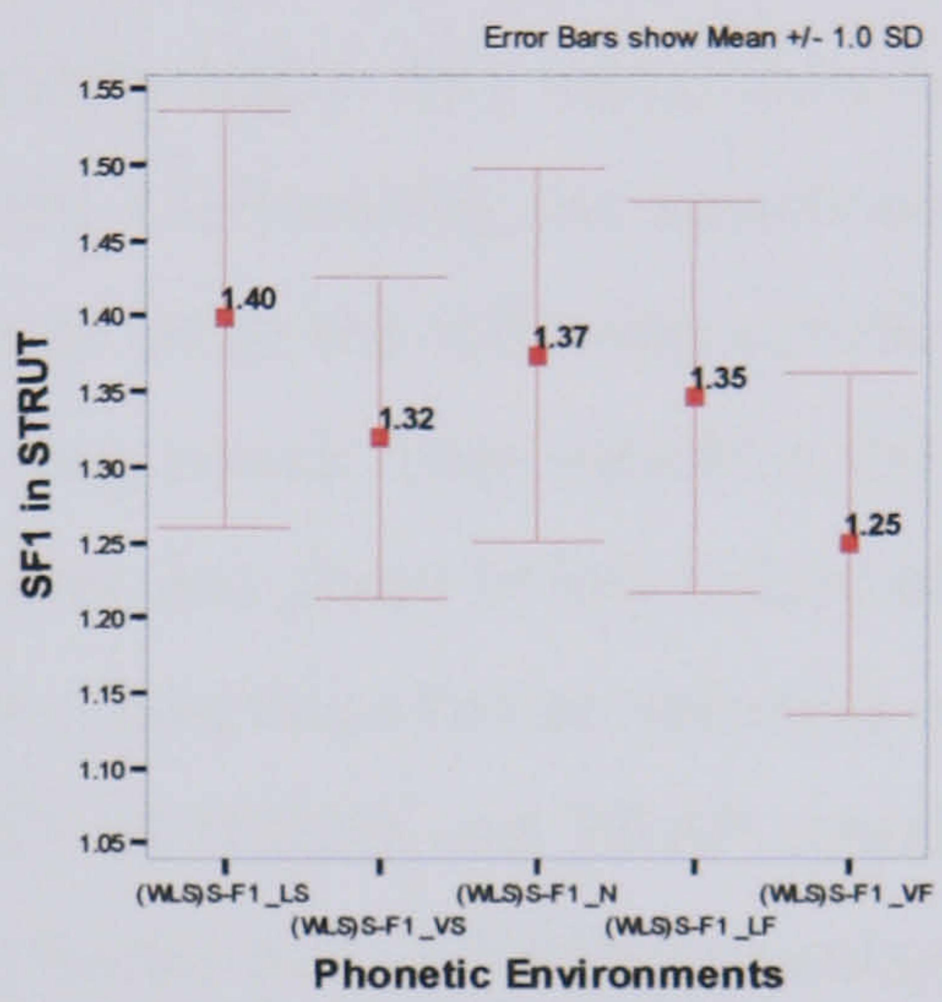


Figure 68 (SF1 in STRUT) Phonetic Environments: Means and SDs

The noticeable difference in the figure would be that the mean values of SF1 before voiceless obstruents are higher than their voiced counterparts. This tendency is similar to those for the SF1 values of DRESS and TRAP (§6.4.1.2 and §6.4.4.2). The vowels before voiceless stops has the highest mean among all the others, with the greater SDs and the wider range (cf. Appendix 10), indicating that their SF1 values of the vowels in that environment are more varied than those for other environments. Looking at the results for the main effect of speech style in Table 66, the difference between these means across phonetic environments was found to be very highly significant for all the tests at the level of $p<0.001$, so that phonetic environments proved to be a significant factor for the SF1 of STRUT vowels. In order to find out how the effects of these five phonetic environments differ, the results were further examined by *post hoc* pairwise comparisons; the comparisons revealed the following general pattern for the effects of following segments on the SF1 values of STRUT vowels:

*(U-SF1: Phonetic environments-pairwise-pattern-1, Tests-2-1, 2-2, and 2-3)****
_VF < _VS < _N = _LS
_VF < _LF

Table 71 presents the detailed results of the pairwise comparisons, but only contains the results for the particular pairwise comparisons provided in Table 18 above:

Table 71 SF1 in STRUT: General patterns for the main effects of phonetic environments by post hoc pairwise comparisons by LSD (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

General patterns for:	(1)voiceless or voiced		(2)stops or fricatives		(3)nasals – stops – fricatives			
	_LS – _VS	_LF – _VF	_LS – _LF	_VS – _VF	_N – _LS	_N – _VS	_N – _LF	_N – _VF
Test-2-1(by sex)***	>**	>***	ns	>***	ns	>**	ns	>***
Test-2-2(by age)***	>**	>***	ns	>***	ns	>**	ns	>***
Test-2-3(by class)***	>**	>***	ns	>***	ns	>**	ns	>***

All the tests in the TEST Set-2 showed the same pattern. (1) Firstly, STRUT vowels before voiceless obstruents had significantly higher SF1 values than those before their voiced consonants in the same manner of articulation. (2) Secondly, the vowels before stops had significantly higher values than those before fricatives when the following sounds were voiced, whilst there was no such difference when the following sounds were voiceless. (3) Thirdly, the vowels before nasals had significantly higher SF1 values than those before voiced obstruents, whilst they did not have significantly different SF1 values from those before voiceless obstruents. The first two results are the same as the ones for the SF1 of DRESS and TRAP vowels (§6.4.1.2 and §6.4.4.2), and the last result is the same as the one for the SF1 of DRESS vowels (§6.4.1.2).

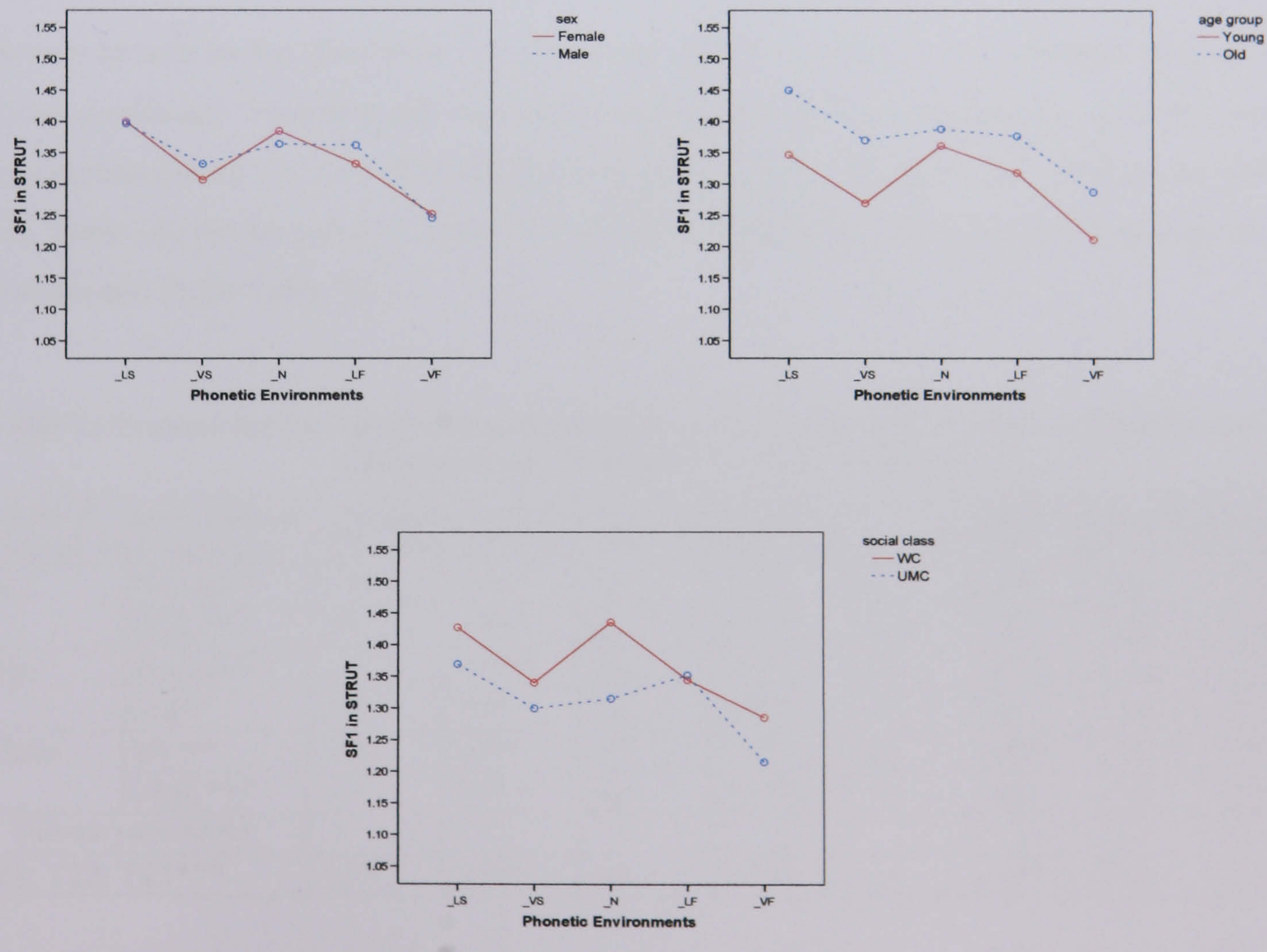


Figure 69 (SF1 in STRUT) Phonetic environments x sex (top left), age (top right), and social class (bottom)

Now we turn to the results for the interaction effects between phonetic environments and one of the social factors. The graphs in Figure 69 show the interaction graphs for all these interactions. Looking at the results for the interactions in Table 66, all the interactions were non-significant (i.e. $p>0.05$), indicating that the way in which the SF1 values were affected by phonetic environments did not significantly differ for the females and the males, for the young and the old, and for the WC and the UMC.

To break down these non-significant interactions in more detail, the data were further explored using simple effects tests; the results are shown in the Table 72:

Table 72 SF1 in STRUT: Simple effects of phonetic environments for each condition of sex, age, and social class

Test No.	Simple Effects	F	df	Sig.	
2-1 (by sex)	PhonEn. at females	5.359	4, 27	0.003	***p*<0.01**
	PhonEn. at males	7.530	4, 27	0.000	***p*<0.001**
2-2 (by age)	PhonEn. at Young	9.132	4, 27	0.000	***p*<0.001**
	PhonEn. at Old	5.515	4, 27	0.002	***p*<0.01**
2-3 (by class)	PhonEn. at WC	5.442	4, 27	0.01	***p*<0.01**
	PhonEn. at UMC	10.022	4, 27	0.000	***p*<0.001**

As can be seen in the tableTable 72, the simple effects of phonetic environments were all found to be significant. Therefore, all the simple effects were further examined by *post hoc* pairwise comparisons using the LSD. The detailed results focusing on the particular pairwise comparisons (cf. Table 18) are provided in Table 73 which for the sake of clarity repeats the general patterns that we saw in the Table 71:

Table 73 Patterns for the simple effects of phonetic environments on SF1 values of STRUT vowels (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

Patterns for simple effects of Phonetic Environments at:		(1)voiceless or voiced		(2)stops or fricatives		(3)nasals – stops – fricatives			
		LS – VS	LF – VF	LS – LF	VS – VF	N – LS	N – VS	N – LF	N – VF
Sex	Female**	>**	>**	ns	>**	ns	>**	ns	>***
	Male***	>*	>***	ns	>***	ns	ns	ns	>**
Age	Young***	>*	>***	ns	>**	ns	>**	ns	>***
	Old**	>*	>**	ns	>***	<*	ns	ns	>**
Class	WC**	>**	>**	>*	>**	ns	>**	>**	>***
	UMC***	>*	>***	ns	>***	<*	ns	ns	>**
General patterns for:									
T21, T22, T23***		>**	>***	ns	>***	ns	>**	ns	>***

As a whole, the patterns for the significant main and simple effects of phonetic environments on the SF1 values of STRUT from these results are summarised as follows:

- (1) _LS > _VS, _LF > _VF: as the general pattern, and as the patterns for the females, the males, the young, the old, the WC, and the UMC,
- (2) _LS = _LF, _VS > _VF: as the general pattern, and as the patterns for the females, the males, the young, the old, and the UMC,
- (2) _LS > _LF, _VS > _VF: as the pattern for the WC,
- (3) _N = _LS, _N > _VS, _N = _LF, _N > _VF: as the general pattern, and as the patterns for the females and the young,
- (3) _N = _LS, _N > _VS, _N > _LF, _N > _VF: as the pattern for the WC,
- (3) _N = _LS, _N = _VS, _N = _LF, _N > _VF: as the pattern for the males,
- (3) _N < _LS, _N = _VS, _N = _LF, _N > _VF: as the patterns for the old and the UMC.

6.4.7.3 SF1 in STRUT: sex

Now we turn to the results for the effects of sex in the T11 and 31 in which sex was compared with speech style in whole data and with phonetic environments in WLS data respectively. Let us firstly begin with the main effect of sex in both tests. The distributions of the SF1 values by sex are shown in Figure 70 below in which their means and SDs are displayed:

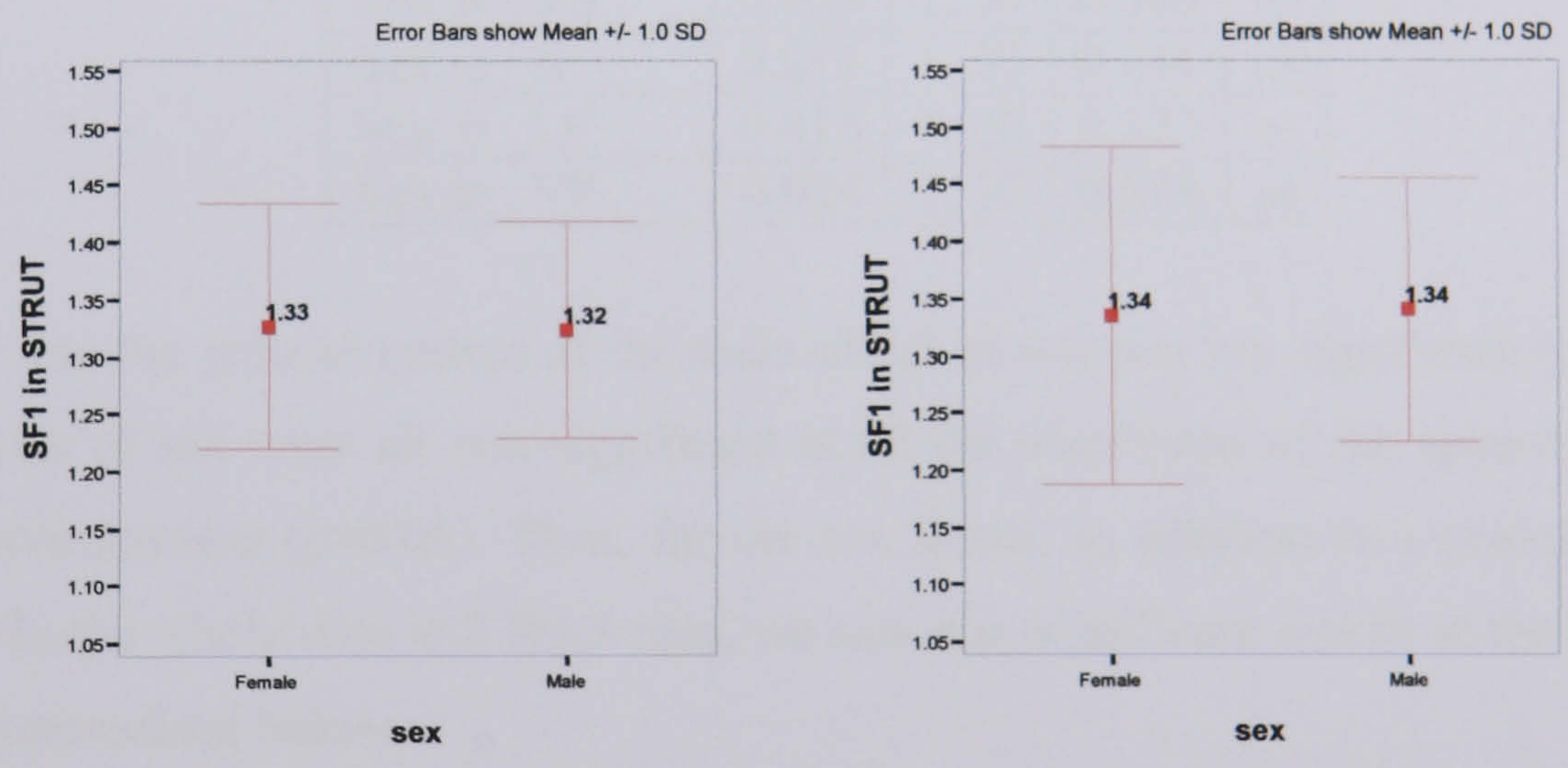


Figure 70 (SF1 in STRUT) Sex: Means and SDs in all speech styles in all speech styles for T11 (left) and in WLS for T21 (right)

For both T11 and T21, the means of the SF1 values for male and female are very similar, apart from the fact that the SDs are slightly higher for the females than for the males. Looking at the Table 66, the main effect of sex was shown to be non-significant both in T11, F(1, 30)= 0.010, *p*= 0.921, in T21, F(1, 30)= 0.022, *p*=0.884, indicating that there was no significant effect of sex on the SF1 values of STRUT vowels for entire data in general and for WLS in particular. Therefore, the following general pattern for the effect of sex on the SF1 values of STRUT vowels can be obtained:

(U-SF1: Sex-pattern-1, for entire data and WLS data) Female = Male

As discussed in §6.4.7.1 and §6.4.7.2, there was no significant interaction effect either between sex and speech styles or between sex and phonetic environments, indicating that the way in which the SF1 values were affected by sex did not significantly differ either across speech styles or across phonetic environments (cf. Figure 67 and Figure 69).

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 74:

Table 74 SF1 in STRUT: Simple effects of sex for each condition of speech style and phonetic environments

Simple Effects	F	df	Sig.	
Sex at IS	0.194	1, 30	0.663	ns
Sex at RPS	0.652	1, 30	0.426	ns
Sex at WLS	0.02	1, 30	0.888	ns
Sex at _LS	0.004	1, 30	0.95	ns
Sex at _VS	0.453	1, 30	0.506	ns
Sex at _N	0.217	1, 30	0.644	ns
Sex at _LF	0.418	1, 30	0.523	ns
Sex at _VF	0.024	1, 30	0.879	ns

As we saw that the general pattern of the main effect of sex was not significant (i.e. F = M), the simple effects of sex were all non-significant at all the conditions of the speech styles and the phonetic environments ($p>0.05$). Thus, for the sex factor, in addition to a non-significant main effect both in the whole data and WLS data, we saw non-significant results at the level of simple effects as summarised below:

- F = M: as the general pattern (for entire data and WLS data), and as the patterns for IS, RPS, WLS, _LS, _VS, _N, _LF and _VF.

6.4.7.4 SF1 in STRUT: age

We turn now to the results for the effects of age in the T12 and T22 in which age was compared with speech style in whole data and with phonetic environments in WLS data respectively. Let us begin with the main effect of age in both tests. The distributions of the SF1 values by age are shown in Figure 71 which displays their means and SDs:

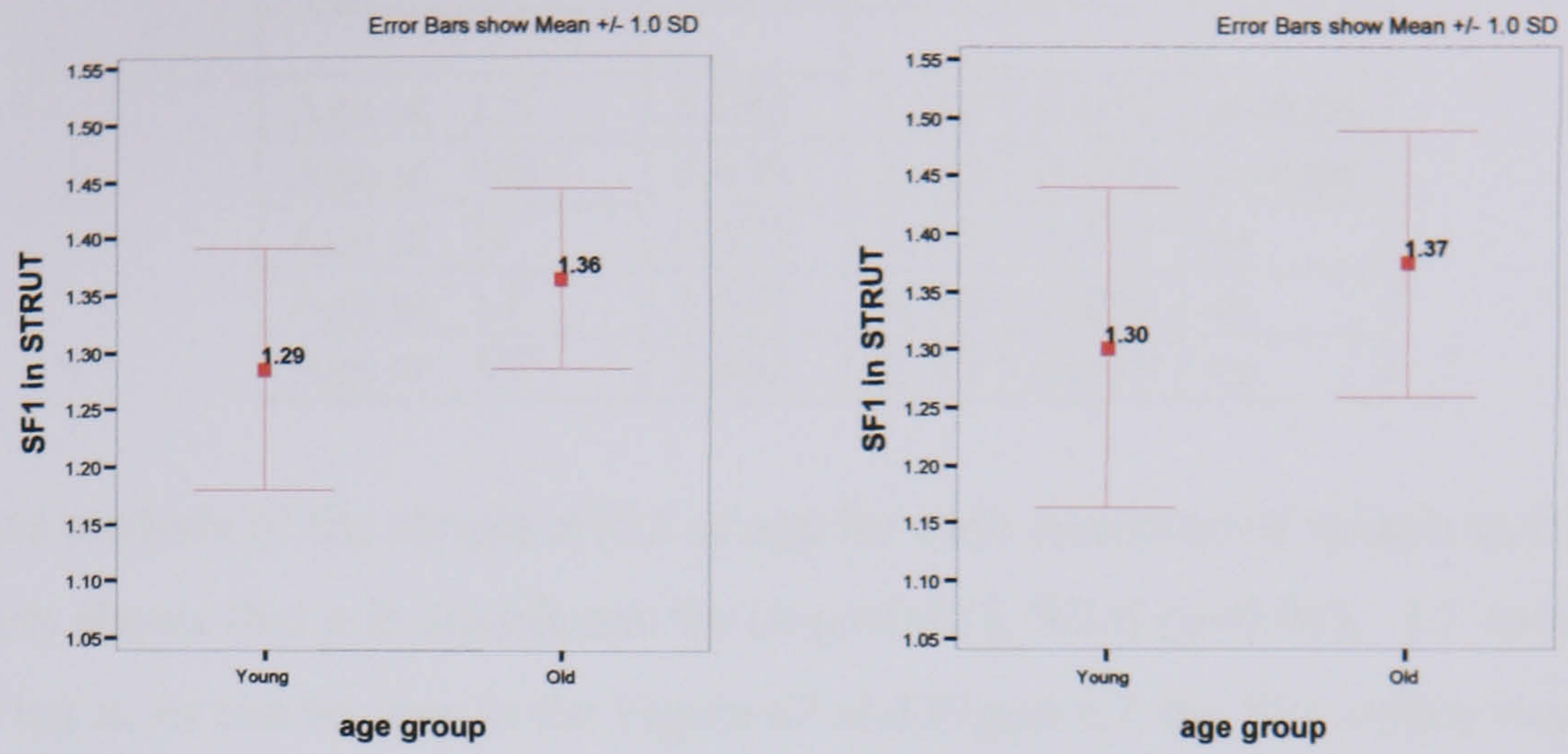


Figure 71 (SF1 in STRUT) Age: Means and SDs in all speech styles for T12 (left) and in WLS for T22 (right)

In both tests, the means of the SF1 values are higher for old speakers than for young speakers; this tendency is opposite to the one for the SF1 values of the DRESS vowels (§6.4.1.4). The SDs are greater for the young than for the old (cf. Appendix 10); this result is opposite to the ones for the SF1values of the DRESS and TRAP vowels (§6.4.1.4 and §6.4.4.4). Looking at the ANOVA table in Table 66, the main effects of age were shown to be significant: $F(1, 30)= 6.947$, $p<0.05$ in T12 and $F(1, 30)= 5.124$, $p<0.05$ in T22. These results indicate that there was a significant effect of age on the SF1 values of STRUT vowels for entire data in general and for WLS in particular as well. Therefore, the following general pattern for the effect of age on the SF1 of STRUT vowels can be obtained:

(U-SF1: Age-pattern-1) Young < OLD

As discussed in §6.4.7.1 and §6.4.7.2, there was no significant interaction effect either between age and speech styles or between age and phonetic environments, indicating that the way in which the SF1 values were affected by age did not significantly differ either across speech styles or across phonetic environments (cf. Figure 67 and Figure 69).

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 75:

Table 75 SF1 in STRUT: Simple effects of age for each condition of speech style and phonetic environments

Simple Effects	F	df	Sig.	
Age at IS	10.149	1, 30	0.003	***p*<0.01**
Age at RPS	3.246	1, 30	0.082	ns

Age at WLS	5.16	1, 30	0.03	***p*<0.05**
Age at _LS	5.085	1, 30	0.032	***p*<0.05**
Age at _VS	8.938	1, 30	0.006	***p*<0.01**
Age at _N	0.371	1, 30	0.547	ns
Age at _LF	1.671	1, 30	0.206	ns
Age at _VF	3.981	1, 30	0.055	ns

This detailed analysis of the simple effect of age for each condition of speech styles and phonetic environments shows that *p* is significant for IS ($p<0.01$), WLS ($p<0.05$), _LS ($p<0.05$) and _VS ($p<0.01$). That is, as can be seen in the Figure 67 and Figure 69, the SF1 values were significantly higher for the old speakers than for the young speakers in IS and WLS, and in the environments of preceding voiceless/voiced stops; this is the same pattern for the significant main effect of age that we saw above (i.e. Y < O). The tests revealed, however, that the effect of age was not significant for other conditions, i.e. RPS, _N, _LF and _VF, although the profiles of difference in the mean SF1 values between young and old speakers were on the lines of the general tendency, Y < O.

Thus, the main effect of age on the SF1 values was Y < O; the values were higher for the old than for the young. This pattern was also true when the vowels were produced in IS and WLS and when they occur before voiceless/voiced stops. The results are summarised as follows:

- Y < O: as the general pattern (for entire data and for WLS), and as the patterns for IS, WLS, _LS and _VS,
- Y = O: as the patterns for RPS, _N, _LF and _VF.

6.4.7.5 SF1 in STRUT: social class

We turn now to the results for the effects of social class in the T13 and T23 in which social class was compared with speech style in whole data and with phonetic environments in WLS data respectively. Let us begin with the main effect of social class in both tests. The distributions of the SF1 values by social class are provided in Figure 72 which shows their means and SDs:

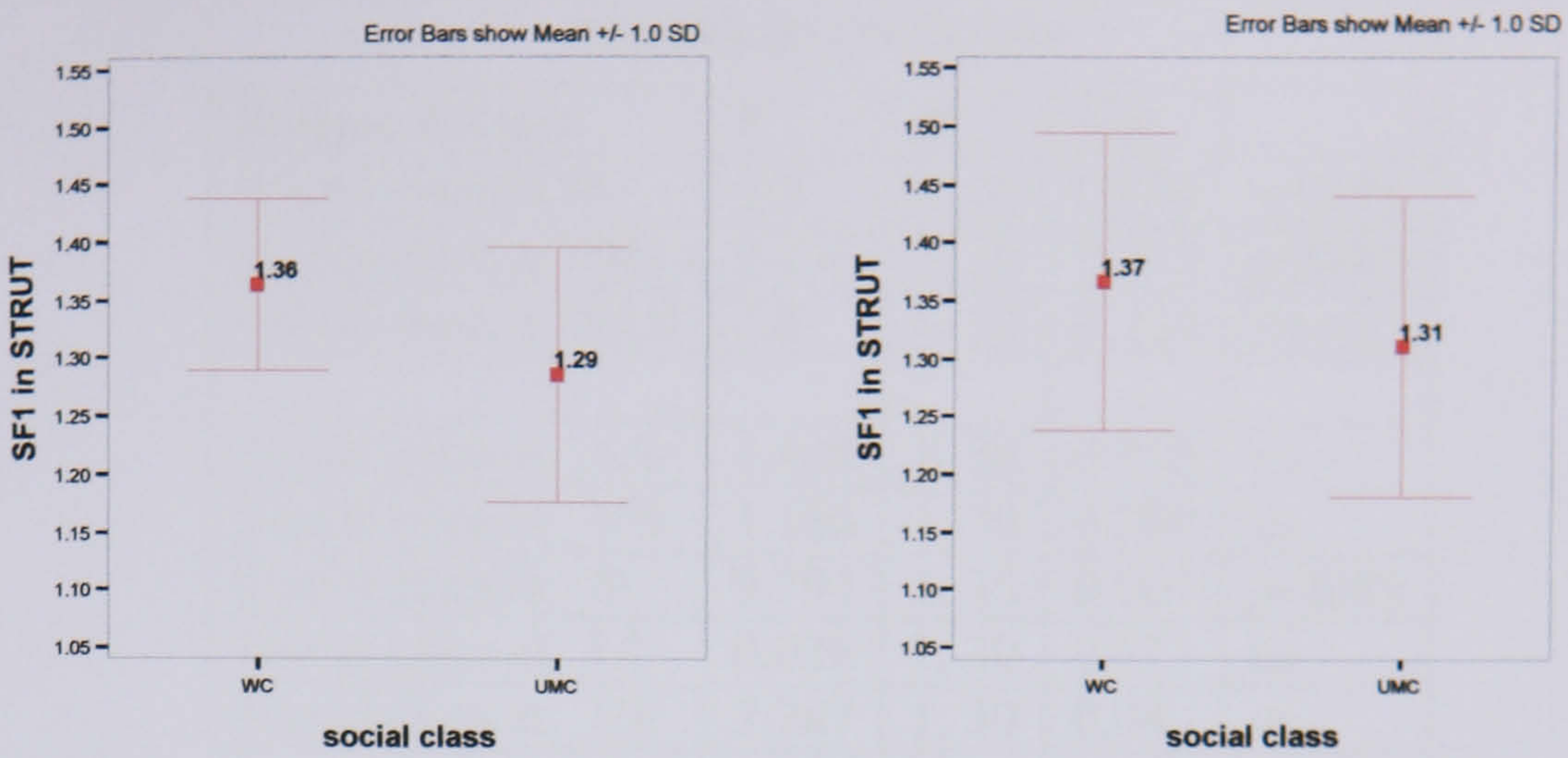


Figure 72 (SF1 in STRUT) Social class: Means and SDs in all speech styles for T13 (left) and in WLS for T23 (right)

In both tests, the means of the SF1 values were lower for UMC speakers than for WC speakers. This tendency is opposite to the ones for the SF1 values of the DRESS and TRAP vowels (§6.4.1.5 and §6.4.4.5). The greater SDs for the UMC in entire data (cf. Appendix 10) indicate that the SF1 values for the UMC were more varied than for the WC. This tendency is the same as the ones for the SF1 values of the DRESS and TRAP vowels (§6.4.1.5 and §6.4.4.5). Looking at the ANOVA table in Table 66, the main effect of social class in T11 was shown to be significant, $F(1, 30)= 6.681$, $p<0.05$, while the one in T21 was shown to be non-significant, $F(1, 30)= 2.848$, $p= 0.102$. These results indicate that there was a significant effect of social class on the SF1 values of STRUT vowels for entire data in general, but there was no such effect for WLS data in particular. Therefore, the following general patterns for the effect of social class on the SF1 of STRUT vowels can be obtained:

*(U-SF1: Social class-pattern-1, for entire data)** WC > UMC
(U-SF1: Social class-pattern-2, for WLS data) WC = UMC

As discussed in §6.4.7.1 and §6.4.7.2, while there was no significant interaction between social class and phonetic environments, there was a significant interaction between social class and speech styles (i.e. RPS vs. WLS). The result was interpreted in §6.4.7.1 that the way in which the SF1 values were affected by speech styles significantly differed for the WC and the UMC. This interaction, however, can also be interpreted as follows; the way in which the SF1 values were affected by social class significantly differ between RPS and WLS.

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 76:

Table 76 (SF1 in STRUT) Simple effects of social class for each condition of speech styles and phonetic environments

Simple Effects	F	df	Sig.	
Social class at IS	5.3	1, 30	0.028	***p*<0.05**
Social class at RPS	9.231	1, 30	0.005	***p*<0.01**
Social class at WLS	2.8	1, 30	0.105	ns
Social class at _LS	1.448	1, 30	0.238	ns
Social class at _VS	1.166	1, 30	0.289	ns
Social class at _N	9.793	1, 30	0.004	***p*<0.01**
Social class at _LF	0.026	1, 30	0.873	ns
Social class at _VF	3.287	1, 30	0.08	ns

Possibly interacted patterns are shaded in the table. Similar to the general pattern for the entire data, the effects of social class were found to be significant for IS ($p<0.05$) and RPS ($p<0.01$), i.e. WC > UMC. The simple effect of social class for WLS was, however, found to be non-significant as we saw the general pattern for the WLS. This different social class effect particularly between RPS and WLS may be reflected to the significant interaction with speech styles. Within WLS data, the simple effects of social class in most of the phonetic environments were found to be non-significant, i.e. WC = UMC. Only significant was the effect of social class before nasals; in this environment, the SF1 values for the UMC were significantly lower than those for the WC, i.e. WC > UMC. The results of these simple effects of social class to the SF1 values of STRUT in T13 and T23 are similar to those of the simple effects of sex to the SF21 values of TRAP in T11 and T21 (§6.4.5.3).

Thus, for the social class factor, the general effect of social class on the SF1 values of STRUT vowels for entire data was WC > UMC, and the detailed simple effect for each condition of speech styles revealed that this was true when the speech style was less formal speech styles. The general effect of social class on the SF1 values of STRUT vowels in relation to phonetic environments within WLS was WC = UMC, and this was also true at all the phonetic environments except _N environment in which the values were significantly lower for the UMC than for the WC like the general effect of social class on entire data. These results are summarised as follows:

- WC > UMC: as the general pattern (for entire data), and as the patterns for IS, RPS and _N
- WC = UMC: as the general pattern (for WLS data), and as the patterns for WLS, _LS, _VS, _LF and _VF
- Interaction: '*class x RPS-WLS'.

6.4.7.6 SF1 in STRUT: social grouping (by sex, age and social class)

Let us now look at the results for the effects of social groupings in the T14 in which social grouping factor was compared with speech style in whole data. Let us begin with the main effect of social grouping. The distribution of the SF1 values by social grouping is provided in Figure 73 which shows their means and SDs:

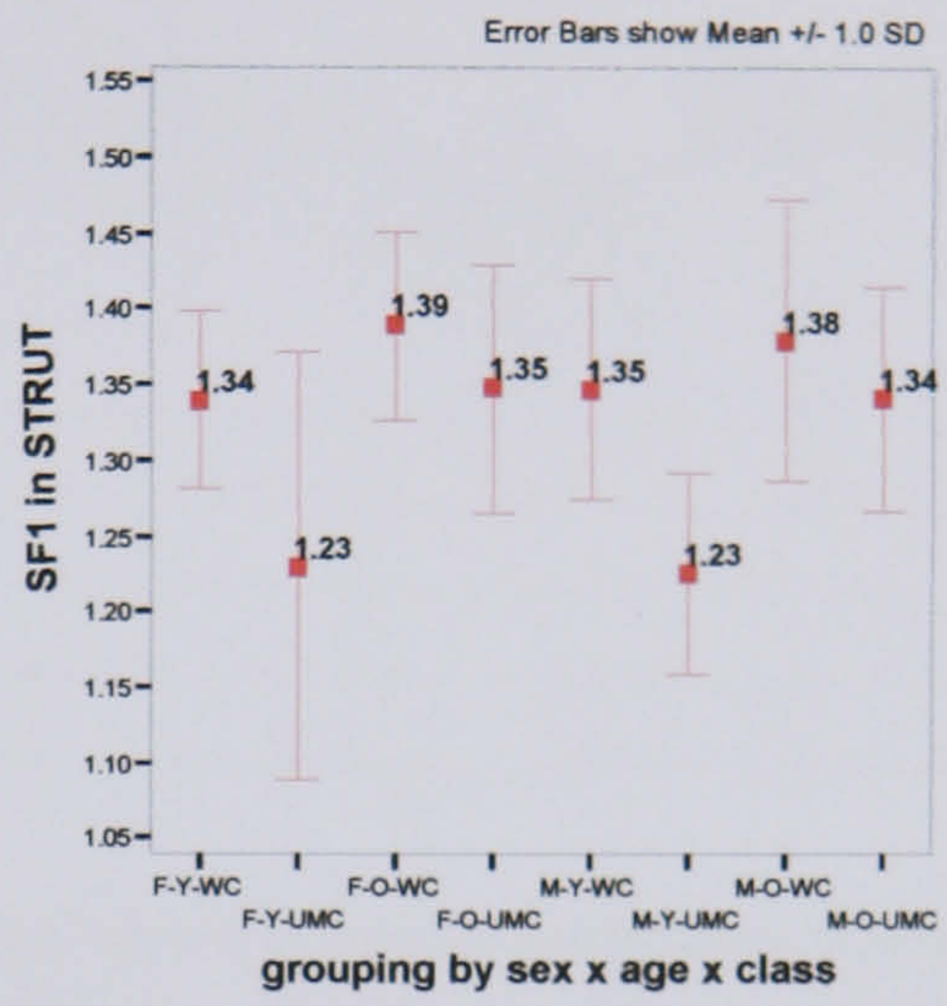


Figure 73 (SF1 in STRUT) Social grouping: Means and SDs in all speech styles for T14

There are a few noticeable differences in the figure. Firstly, the SF1 values for old WC speakers are higher than any other groups. This tendency is the same as the one for the effect of social grouping to the SF21 of TRAP vowels (§6.4.5.6). Secondly the values for young UMC speakers are much lower than any other groups, with the F-Y-UMC having the greatest SDs and the widest range between maximum and minimum values (cf. Appendix 10). Although this tendency is the same as the ones for the SF1 values of DRESS and TRAP vowels (§6.4.1.6 and §6.4.4.6), the tendency of the F-Y-UMC having the lower SF1 values than any other groups is opposite to the one for the SF1 values of DRESS and TRAP vowels (§6.4.1.6 and §6.4.4.6). These tendencies for the SF1 of DRESS, TRAP and STRUT are very much in lines for the findings of Fabricius (2007, see also §4.6.2).

Thirdly, if we compare each pair for the comparisons for sex and age, the patterns are following the general patterns within WLS that we saw in the previous sections (i.e. F = M, and Y < O), although the apparent pattern for the social class effect does look more like the general pattern to entire data (i.e. WC > UMC) rather than the general pattern within WLS (i.e. WC = UMC). Looking at the ANOVA results in Table 66, the main effect of social grouping in the T14 was significant, $F(7, 24)= 2.44$, $p<0.05$, indicating that there was a significant effect of social grouping on the SF1 values of STRUT vowels. In order to find out how these means from the eight groupings differ from each other, the data were further examined by *post hoc* pairwise comparisons by LSD; the results are presented in the Table 77 below:

Table 77 SF1 in STRUT: Post hoc pairwise comparisons by LSD for social groupings by sex x age x social class in T14 (selected results for sex comparisons, age comparisons, and social class comparisons are in the dark grey cells, the medium grey cells, and the light grey cells respectively)

	F-Y-WC	F-Y-UMC	F-O-WC	F-O-UMC	M-Y-WC	M-Y-UMC	M-O-WC	M-O-UMC
F-Y-WC	x	***p*<0.01**	**ns**	ns	**ns**	ns	ns	ns
F-Y-UMC		x	*p*<0.05	***p*<0.05**	ns	**ns**	*p*<0.05	ns
F-O-WC			x	**ns**	ns	*p*<0.01	**ns**	ns
F-O-UMC				x	ns	*p*<0.05	ns	**ns**
M-Y-WC					x	***p*<0.05**	**ns**	ns
M-Y-UMC						x	*p*<0.05	**ns**
M-O-WC							x	**ns**
M-O-UMC								x

As we discussed in §6.4.1.6, our interest lies in particular pairwise comparisons (cf. Table 25) for the purpose of sex, age and social class comparisons which are presented in the dark grey, medium grey and light grey cells respectively in the Table 77. The results for those selected pairwise comparisons are presented in Table 78 in which an inequality sign indicates the significant result for each pairwise comparison with their significance level expressed by asterisks:

Table 78 SF1 in STRUT: Selected post hoc pairwise comparisons by LSD for the main effects of social groupings by sex x age x social class in T14 (ns: non-significant, *p<0.05, **p<0.01, ***p<0.001)

Pairs	Sex Comparisons			Age Comparisons			Social Class Comparisons		
	Female		*Male*	*Young*		*Old*	*WC*		*UMC*
1	*F*-Y-WC	=	*M*-Y-WC	F-*Y*-WC	=	F-*O*-WC	F-Y-*WC*	=	F-Y-*UMC*
2	*F*-Y-UMC	=	*M*-Y-UMC	F-*Y*-UMC	<*	F-*O*-UMC	F-O-*WC*	=	F-O-*UMC*
3	*F*-O-WC	=	*M*-O-WC	M-*Y*-WC	=	M-*O*-WC	M-Y-*WC*	>*	M-Y-*UMC*
4	*F*-O-UMC	=	*M*-O-UMC	M-*Y*-UMC	=	M-*O*-UMC	M-O-*WC*	=	M-O-*UMC*

Firstly, the sex comparisons revealed that the mean SF1 values were not significantly different between female and male speaker in any pair of the four groups (i.e. Y-WC, Y-UMC, O-WC and O-UMC); that is, the general main effect pattern of sex for entire data, i.e. F = M, that we saw previously (§6.4.7.3) was equally true for all these sub groups. Secondly, the age comparisons revealed that the F-Y-UMC were significantly lower than those for the F-O-UMC ($p<0.05$), indicating that the values were significantly lower for the young than for the old in the group of F-UMC, as we saw as the general pattern of age in the previous section (§6.4.7.4); that is, the general main effect pattern of age (i.e. Y < O) was found for the F-UMC group, but not for the other groups (i.e. F-WC, M-WC and M-UMC). This result is the same as the one for the effect of social grouping to the SF21 of TRAP vowels (§6.4.5.6). Lastly, the social class comparisons revealed that the SF1 values for the M-Y-UMC were significantly lower than those for the M-Y-WC ($p<0.05$), indicating that the values were lower for the UMC than for the WC in the group of M-Y as we saw as the general pattern of social class in the previous section (§6.4.7.5); that is, the general main effect pattern of social class (i.e. WC > UMC) was found for the M-Y group, but not for the other groups (i.e. F-Y, F-O and M-O).

As discussed in §6.4.7.1, there was no significant interaction effect between social groupings and speech style, indicating that the way in which the SF1 values were affected by social groupings did not significantly differ across speech styles (cf. Figure 67).

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 79:

Table 79 (SF1 in STRUT) Simple effects of social grouping for each speech style

Simple Effects	F	df	Sig.	
grouping at IS	3.993	7, 24	0.005	***p*<0.01**
grouping at RPS	2.102	7, 24	0.083	ns
grouping at WLS	1.145	7, 24	0.369	ns

Although the main effect of social grouping on the SF1 values of STRUT vowels was significant, the simple effect of social grouping was significant only for IS at the level of $p<0.01$, but not for RPS and WLS (i.e. $p>0.05$). Therefore, this significant result for the IS was further examined by *post hoc* pairwise comparisons by LSD. The tests revealed the detailed pattern of difference in social groupings in IS; the pattern is shown in Table 80:

Table 80 SF21 in TRAP: Selected post hoc pairwise comparisons by LSD for the simple effect of social groupings in IS speech in T14 (ns: non-significant, *p<0.05, **p<0.01, ***p<0.001)

in IS speech

Pairs	Sex Comparisons			Age Comparisons			Social Class Comparisons		
	Female		*Male*	*Young*		*Old*	*WC*		*UMC*
1	*F*-Y-WC	=	*M*-Y-WC	F-*Y*-WC	=	F-*O*-WC	F-Y-*WC*	>*	F-Y-*UMC*
2	*F*-Y-UMC	=	*M*-Y-UMC	F-*Y*-UMC	<*	F-*O*-UMC	F-O-*WC*	=	F-O-*UMC*
3	*F*-O-WC	=	*M*-O-WC	M-*Y*-WC	=	M-*O*-WC	M-Y-*WC*	>*	M-Y-*UMC*
4	*F*-O-UMC	=	*M*-O-UMC	M-*Y*-UMC	<**	M-*O*-UMC	M-O-*WC*	=	M-O-*UMC*

The first general pattern for sex (i.e. F = M) was equally true for all the four groups within IS.

The second general pattern for age (i.e. Y < O) in the group of F-UMC was also found within IS at the level of $p<0.05$. The same pattern was also found in the group of M-UMC at the level of $p<0.01$; therefore, in IS, Y-UMC speakers had significantly lower SF1 values than O-WC speakers.

The third general pattern for social class (i.e. WC > UMC) in the group of M-Y was equally true within IS at the level of $p<0.05$. The same pattern was also found in the group of F-Y at the level of $p<0.05$; therefore, in IS, Y-UMC speakers had significantly lower SF1 values than O-WC speakers.

The patterns for all the significant effects (i.e. main effects and simple effects) of social groupings on the SF1 values of STRUT from these results are summarised as follows:

- F = M: as the general pattern for Y-WC, Y-UMC, O-WC and O-UMC groups, as the patterns for Y-WC, Y-UMC, O-WC and O-UMC groups in IS,
- Y < O: as the general pattern for F-UMC, as the patterns for F-UMC and M-UMC in IS,
- Y = O: as the patterns for F-WC, M-WC and M-UMC, as the patterns for F-WC and M-WC in IS,
- WC > UMC: as the general pattern for M-Y, as the patterns for F-Y and M-Y in IS,
- WC = UMC: as the general patterns for F-Y, F-O and M-O, as the patterns for F-O and M-O in IS.

6.4.8 SF21 in STRUT

The results of the main effects and interaction effects for all the ANOVA tests in which the dependent variable was an SF21 value are provided in Table 81:

Table 81 ANOVA results for SF21 in STRUT: main effects and interaction effects

Test No.	Factor(s)	Type III Sum of Squares	df	Mean Square	F	Sig.	
1-1	sstyle	0.014	2, 60	0.007	1.731	0.186	ns
	sex	0.038	1, 30	0.038	3.616	0.067	ns
	sex x sstyle	0.000	2, 60	0.000	0.043	0.958	ns
1-2	sstyle	0.014	2, 60	0.007	1.814	0.172	ns
	age	0.010	1, 30	0.010	0.898	0.351	ns
	age x sstyle	0.012	2, 60	0.006	1.475	0.237	ns
1-3	sstyle	0.014	2, 60	0.007	1.768	0.179	ns
	social class	0.002	1, 30	0.002	0.134	0.716	ns
	social class x sstyle	0.006	2, 60	0.003	0.685	0.508	ns
1-4	sstyle	0.014	2, 48	0.007	2.151	0.127	ns

	groupings	0.132	7, 24	0.019	2.078	0.086	ns
	groupings x sstyle	0.089	14, 48	0.006	1.903	0.05	***P*=0.05**
2-1	**PhonEn.**	0.353	4, 120	0.088	10.999	0.000	***p*<0.001**
	sex	0.192	1, 30	0.192	2.057	0.162	ns
	PhonEn x sex	0.042	4, 120	0.011	1.321	0.266	ns
2-2	**PhonEn.**	0.353	4, 120	0.088	10.619	0.000	***p*<0.001**
	age	0.148	1, 30	0.148	1.558	0.222	ns
	PhonEn x age	0.008	4, 120	0.002	0.239	0.916	ns
2-3	**PhonEn.**	0.353	4, 120	0.088	10.714	0.000	***p*<0.001**
	social class	0.001	1, 30	0.001	0.014	0.905	ns
	PhonEn x social class	0.017	4, 120	0.004	0.509	0.729	ns

This table will be referred to repeatedly as we discuss the effect of each factor one by one in the following sections.

6.4.8.1 SF21 in STRUT: speech style

Let us begin with the results for the effects of speech styles in the T11, T12, T13, and T14 in which speech style was compared with one of social factors (i.e. sex, age, social class, and social groupings) respectively. Figure 74 shows the means and their SDs across speech styles:

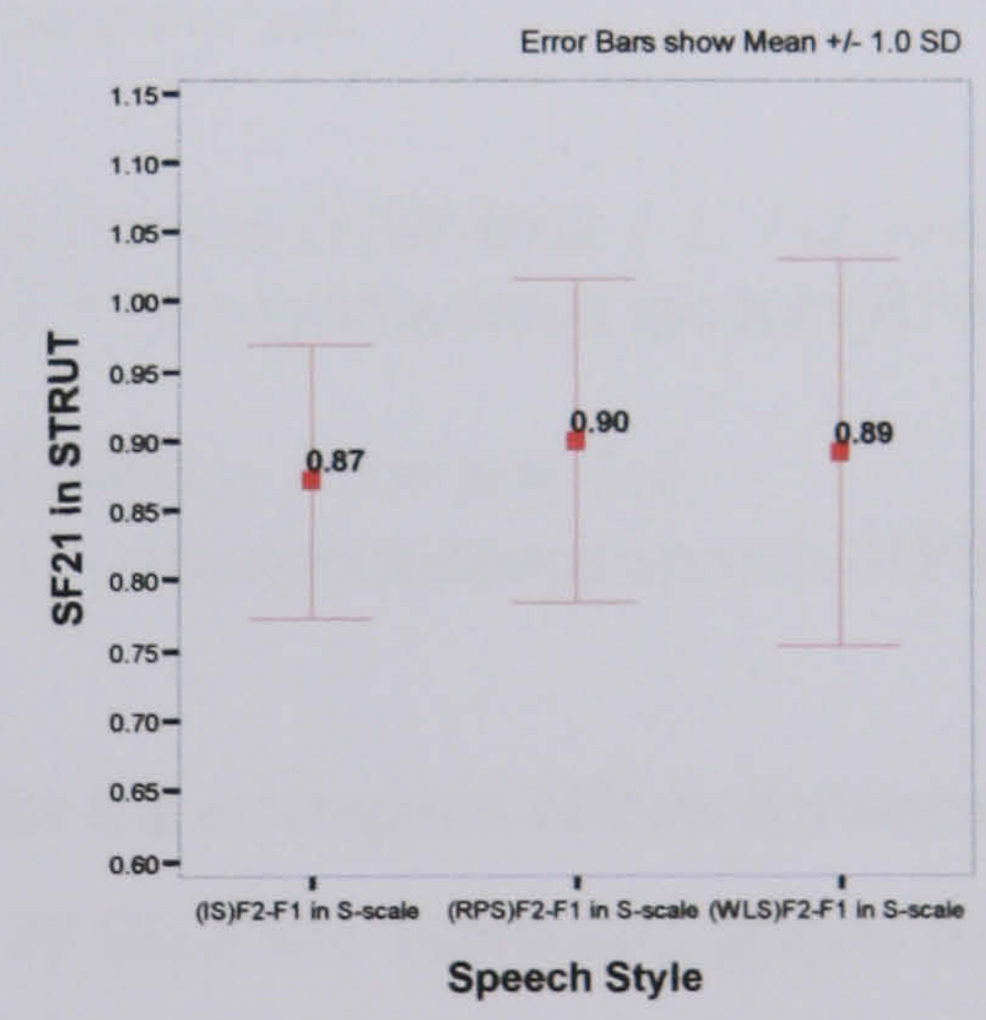


Figure 74 (SF21 in STRUT) Speech style: Means and SDs

The figure tells us that the means of the SF21 values are slightly higher for RPS and WLS than for IS. The SDs and the rage are greater for WLS (cf. Appendix 10), indicating the SD21 values for the vowels in WLS are more varied than those for the vowels in IS and RPS. Looking at the results for the main effect of speech style in Table 81, the difference between these means across speech style was found non-significant for all the tests. The results of the planned contrasts are shown in Table 82:

Table 82 SF21 in STRUT: Planned contrasts for the main effects of speech style

Test No.	Style contrasts	Type III Sum of Squares	df	Mean Square	F	Sig.	
Test-1-1	IS vs. RPS&WLS	0.020	1, 30	0.020	3.327	0.078	ns
	RPS vs. WLS	0.002	1, 30	0.002	0.265	0.611	ns
Test-1-2	IS vs. RPS&WLS	0.020	1, 30	0.020	3.607	0.067	ns
	RPS vs. WLS	0.002	1, 30	0.002	0.269	0.608	ns
Test-1-3	IS vs. RPS&WLS	0.020	1, 30	0.020	3.351	0.077	ns
	RPS vs. WLS	0.002	1, 30	0.002	0.274	0.605	ns
Test-1-4	IS vs. RPS&WLS	0.02	1, 24	0.02	5.75	0.025	$p<0.05$
	RPS vs. WLS	0.002	1, 24	0.002	0.261	0.614	ns

All the contrasts in T11, T12, and T13 were shown to be non-significant. Only significant was the contrast when we compare spontaneous speech with non-spontaneous speech in T14; that is, the SF21 values in spontaneous speech were significantly lower than those in non-spontaneous speech in relation to social groupings in T14. These results indicate that there was no significant effect of speech style on the SF21 values of STRUT vowels in general, but there was a significant effect only when we compare spontaneous speech with non-spontaneous speech (i.e. IS vs. RPS&WLS). Therefore, the following general pattern for the effect of speech style on the SF21 values of STRUT vowels can be obtained:

(U-SF21: Style-contrast-pattern 1) for tests 1-1, 1-2, and 1-3
Spontaneous speech (IS) = non-spontaneous speech (RPS&WLS)
RPS = WLS
(U-SF21: Style-contrast-pattern 1) for test-1-4
Spontaneous speech (IS) < non-spontaneous speech (RPS&WLS)
RPS = WLS

Now we turn to the results for the interaction effects between speech style and one of the social factors. The graphs in Figure 75 show the interaction graphs for all these interactions. Looking at the results for the interactions in Table 81, the interaction effect between social grouping and speech style was significant, $F(14, 48)= 1.903$, $p=0.05$[54]; this indicates that the way in which SF21 values were affected by speech style differed across different social groupings. All the other interactions were non-significant: $F(2, 60)= 0.043$, $p=0.958$ (for sex and speech style in T11), $F(2, 60)= 1.475$, $p=0.237$ (for age and speech style in T12), and $F(2, 60)= 0.685$, $p=0.508$ (for social class and speech style in T13). This means that the way in which the SF21 values were affected (or not affected) by speech style did not differ for male and female speakers, for young and old

[54] When the probability of something occurring by chance is exactly 5%, we can accept that it is a true finding (Andy 2005: 25).

speakers, and for WC and UMC speakers. Planned contrasts in which we compared IS speech with a combination of RPS&WLS speech revealed one significant interaction when comparing the SF21 values for eight social groupings in spontaneous speech style compared to non-spontaneous speech styles, $F(7, 24)= 3.997$, $p<0.01$; this means that the way in which SF21 values were affected by speech styles significantly differed for the eight social groupings. No other contrasts were significant ($p>0.05$).

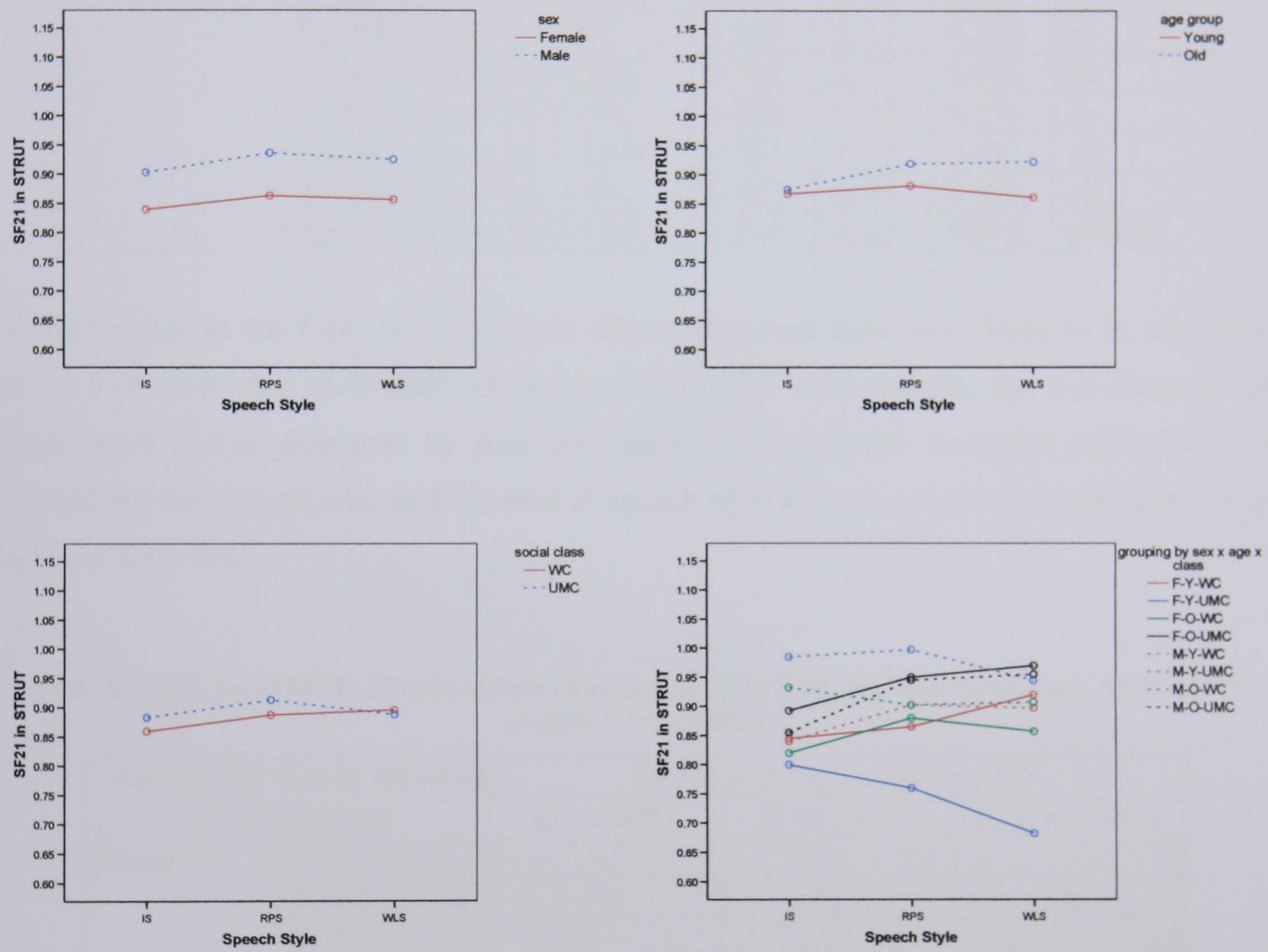


Figure 75 SF21 in STRUT: Interaction graphs for speech style x sex (top left), age (top right), social class (bottom-left), and social groupings (bottom-right)

To break down these interactions in more detail, the data were further explored using simple effects tests; the results are shown in the Table 83:

Table 83 SF21 in STRUT: Simple effects of speech style for each condition of sex, age, social class, and social groupings

Test No.	Simple Effects	F	df	Sig.	
1-1 (sex)	Speech style at females	0.680	2. 29	0.515	ns
	Speech style at males	1.277	2, 29	0.294	ns
1-2 (age)	Speech style at Young	0.410	2, 29	0.668	ns
	Speech style at Old	2.991	2, 29	0.066	ns
1-3 (class)	Speech style at WC	1.369	2, 29	0.27	ns
	Speech style at UMC	1.126	2, 29	0.338	ns
1-4 (groupings)	Speech style at F-Y-WC	2.188	2, 23	0.135	ns
	Speech style at F-Y-UMC	5.401	2, 23	0.012	**p<0.05**
	Speech style at F-O-WC	1.363	2, 23	0.276	ns
	Speech style at F-O-UMC	2.793	2, 23	0.082	ns
	Speech style at M-Y-WC	2.020	2, 23	0.156	ns
	Speech style at M-Y-UMC	0.787	2, 23	0.467	ns
	Speech style at M-O-WC	0.422	2, 23	0.661	ns
	Speech style at M-O-UMC	5.224	2, 23	0.013	**p<0.05**

As can be seen in the Table 83, the simple effects of speech style were found to be significant only at F-Y-UMC and M-O-UMC at the level of $p<0.05$. Subsequently, the significant simple effects were further examined by *post hoc* pairwise comparisons using the LSD. The tests revealed the detailed patterns of difference in speech style at these conditions; those patterns are shown in Table 84:

Table 84 SF21 in STRUT: Simple effects of speech style in T14 (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

Patterns for simple effect of speech style at:		Pairwise comparisons by LSD		
		IS vs. RPS	IS vs. WLS	RPS vs. WLS
Groupings	F-Y-WC ^{ns}	–	–	–
	F-Y-UMC *	ns	>**	ns
	F-O-WC ^{ns}	–	–	–
	F-O-UMC ^{ns}	–	–	–
	M-Y-WC ^{ns}	–	–	–
	M-Y-UMC ^{ns}	–	–	–
	M-O-WC ^{ns}	–	–	–
	M-O-UMC *	<*	<**	ns

Comparing the significant interaction effects with relevant interaction graphs in Figure 75, the possible interacted patterns are shaded in grey in the three right rows, and significant interactions from the first planned contrast (i.e. IS vs. RPS&WLS) are also indicated by shades of the conditions of factors. Observing the relevant parts in the Figure 75, the profile across three speech styles for the F-Y-UMC is different from those of others, particularly that of the M-O-UMC; for the F-Y-UMC, the SF21 values decrease from spontaneous to non-spontaneous speech styles, whereas for the M-O-UMC, the values increase from spontaneous to non-spontaneous speech styles.

As a whole, the patterns for the significant effects (i.e. main effects and simple effects) of speech style on the SF21 values of STRUT vowels from these results are summarised as follows:

- Spontaneous speech (IS) = non-spontaneous speech (RPS&WLS), RPS = WLS: the pattern from planned contrasts (in T11, T12 and T13)
- Spontaneous speech (IS) < non-spontaneous speech (RPS&WLS), RPS = WLS: the pattern from planned contrasts (in T14)
- IS = RPS = WLS: as the general pattern (in T11, T12, T13 and T14), as the patterns for male, female, young, old, WC, UMC, F-Y-WC, F-O-WC, F-O-UMC, M-Y-WC, M-Y-UMC, and M-O-WC,
- IS < RPS = WLS: as the pattern for M-O-UMC
- IS > WLS: as the pattern for F-Y-UMC
- Interactions: '*grouping x IS-RPS-WLS', '**grouping x IS-RPS&WLS'.

6.4.8.2 SF21 in STRUT: phonetic environments

Let us now move on to the results for the effects of another within-subjects variable, phonological factor, in the T21, T22, and T23 in which phonetic environments were compared with one of the social factors (i.e. sex, age, and social class) respectively. As we discussed previously, we especially focus on comparisons for the pairs presented in Table 18. Figure 76 shows the means and their SDs across phonetic environments:

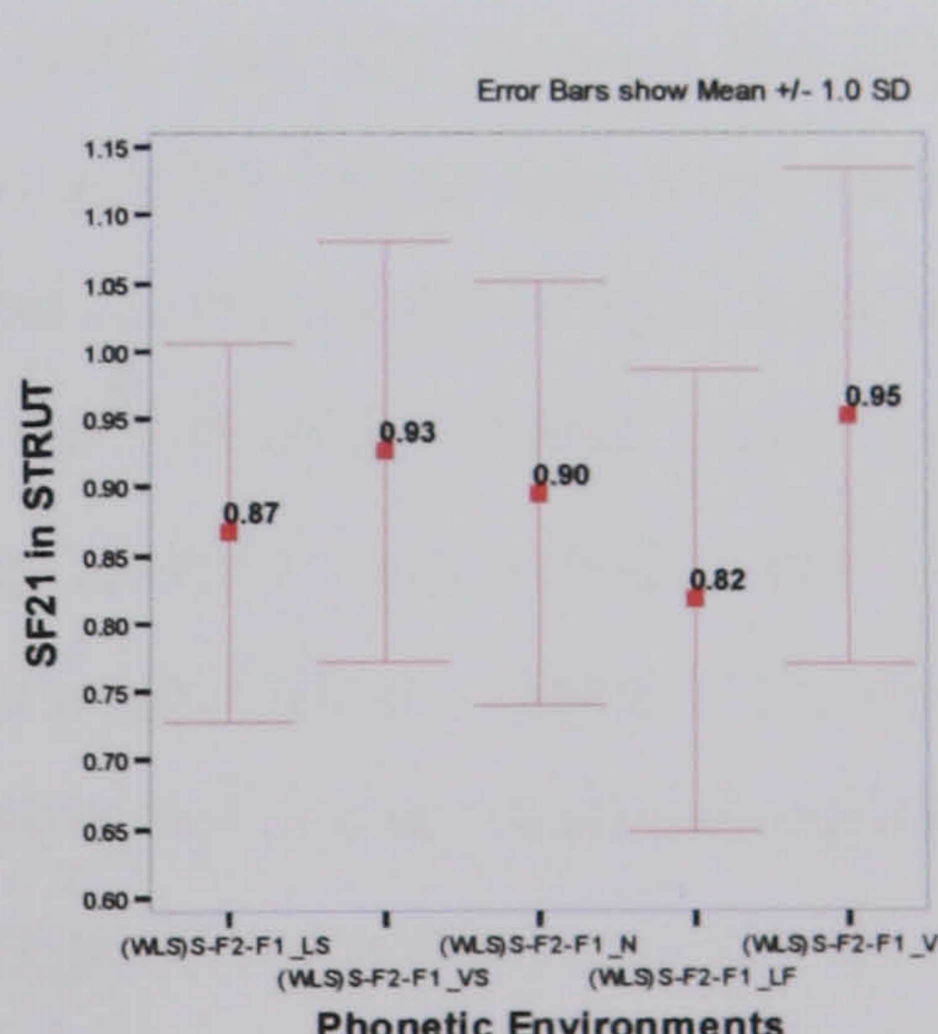


Figure 76 (SF21 in STRUT) Phonetic Environments: Means and SDs

Apparent differences in mean that we can see from the Appendix 10 and Figure 76 would be firstly that the mean SF21 values of STRUT vowels are lower before voiceless obstruents compared to before voiced counterparts, and secondly that the SF21 values of the vowels before nasals are higher than those of the vowels before voiceless obstruents but lower than those of the vowels before voiced obstruents. Looking at the results for the main effect of speech style in Table 81, the difference between these means across phonetic environments was found to be very highly significant for all the tests at the level of $p<0.001$, so that phonetic environments proved to be a significant factor for the SF21 of STRUT vowels. In order to find out how the effects of these five phonetic environments differ, the results were further examined by *post hoc* pairwise comparisons; the comparisons revealed the following general pattern for the effects of following segments on the SF21 values of STRUT vowels:

*(U-SF21: Phonetic environments-pairwise-pattern-1, Test-2-1, Test-2-2 & Test-2-3)****

_LF < _LS < _VS = _VF
_LF < _N < _VF

Table 85 presents the detailed results of the pairwise comparisons, but only contains the results for the particular pairwise comparisons provided in Table 18 above:

Table 85 SF21 in STRUT: General patterns for the main effects of phonetic environments by post hoc pairwise comparisons by LSD (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

General patterns for:	(1)voiceless or voiced		(2)stops or fricatives		(3)nasals – stops – fricatives			
	LS – _VS	LF – _VF	LS – _LF	VS – _VF	N – _LS	N – _VS	N – _LF	N – _VF
Test-2-1(by sex)***	<*	<***	>*	ns	ns	ns	>***	<*
Test-2-2(by age)***	<*	<***	>*	ns	ns	ns	>**	<*
Test-2-3(by class)***	<*	<***	>*	ns	ns	ns	>***	<*

The pattern found in the T21, T22, and T23 showed that (1) STRUT vowels before voiceless obstruents had significantly lower SF21 values than those before their voiced counterparts in the same manner of articulation, that (2) the vowels before stops had significantly higher values than those before fricatives when the following sounds were voiceless, while there was no such difference when the following sounds were voiced, and (3) the vowels before nasals had significantly higher values than those before voiceless fricatives, and significantly lower values than those before voiced fricatives, but did not have any significantly different values from those before voiceless and voiced stops. Comparing these results with those of DRESS and TRAP vowels, the first result is the same as the one for the SF21 values of DRESS and TRAP vowels (§6.4.2.2 and §6.4.5.2). The second result is the same as the one for the SF1 values for TRAP vowels (§6.4.4.2), and partially similar to the one for the SF21 of DRESS vowels in that the vowel before stops had higher SF21 (§6.4.2.2).

We turn now to the results for the interaction effects between phonetic environments and one of the social factors. The graphs in Figure 77 show the interaction graphs for all these interactions:

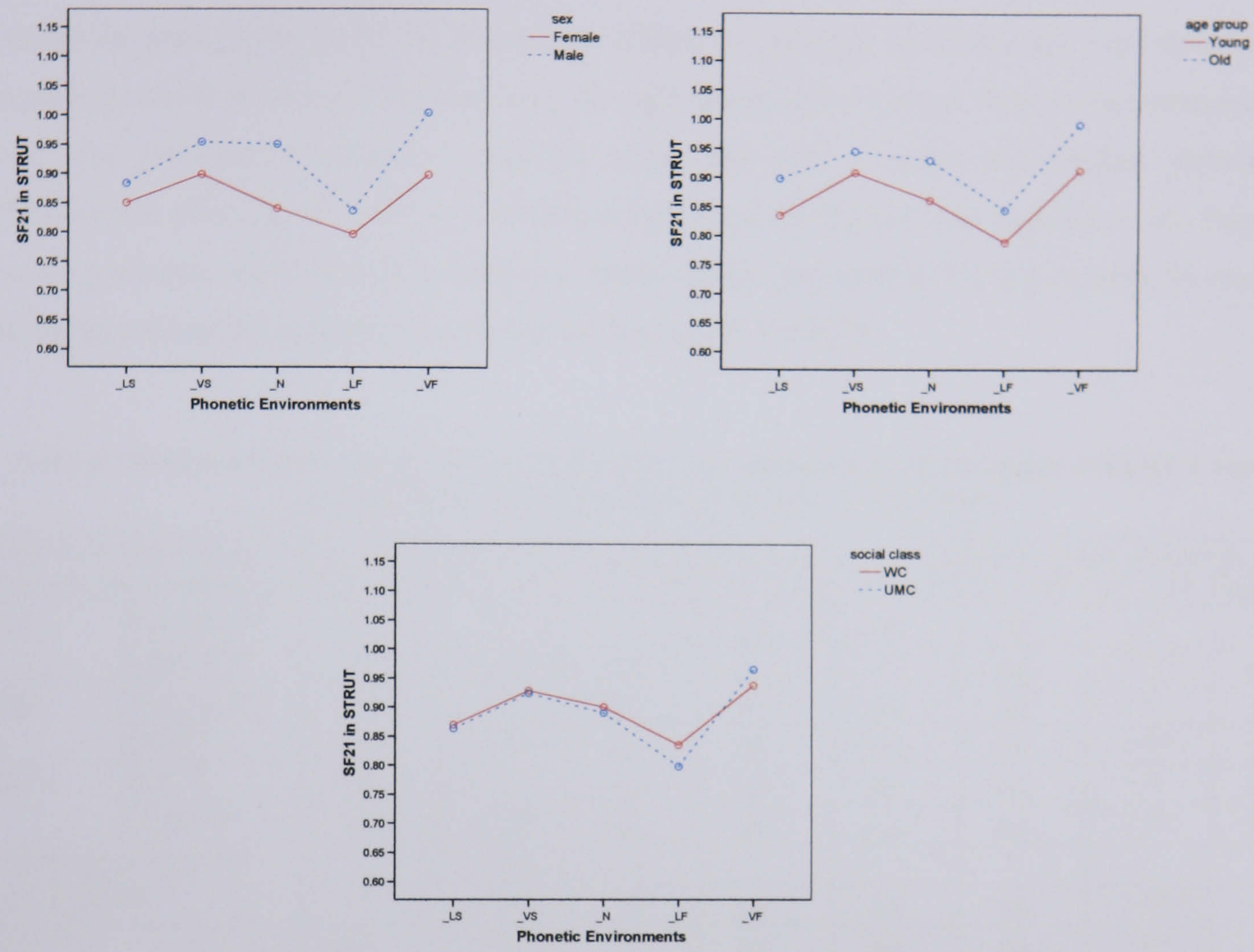


Figure 77 (SF21 in STRUT) Phonetic environments x sex (top left), age (top right), social class (bottom)

Looking at the results for the interactions in Table 81, none of the interactions were significant (i.e. $p>0.05$), indicating that the way in which SF21 values were affected by phonetic environments did not significantly differ for the young and the old, for the young and the old, and for the WC and the UMC.

To break down these non-significant interactions in more detail, the data were further explored using simple effects tests; the results are displayed in the Table 86:

Table 86 SF21 in STRUT: Simple effects of phonetic environments for each condition of sex, age, and social class

Test No.	Simple Effects	F	df	Sig.	
2-1 (by sex)	PhonEn. at females	2.872	4, 27	0.042	***p*<0.05**
	PhonEn. at males	9.643	4, 27	0.000	***p*<0.001**

2-2 (by age)	PhonEn. at Young	4.263	4, 27	0.008	***p*<0.01**
	PhonEn. at Old	5.153	4, 27	0.003	***p*<0.01**
2-3 (by class)	PhonEn. at WC	3.125	4, 27	0.031	***p*<0.05**
	PhonEn. at UMC	6.913	4, 27	0.001	***p*<0.01**

As can be seen in the Table 86, the simple effects of phonetic environments were found to be significant in all conditions. Subsequently the significant simple effects were further examined by *post hoc* pairwise comparisons using the LSD. The tests revealed the detailed patterns of difference in phonetic environments at each condition of the factors. The detailed results focusing on the particular pairwise comparisons (cf. Table 18) are provided in Table 87 which for the sake of clarity repeats the general patterns that we saw in the Table 85:

Table 87 Patterns for the simple effects of phonetic environments on SF21 values of STRUT vowels (ns: non-significant, *p<0.05, ** p<0.01, ***p<0.001)

Patterns for simple effects of Phonetic Environments at:		(1)voiceless or voiced		(2)stops or fricatives		(3)nasals – stops – fricatives			
		_LS – _VS	_LF – _VF	_LS – _LF	_VS – _VF	_N – _LS	_N – _VS	_N – _LF	_N – _VF
Sex	Female *	ns	<**	ns	ns	ns	ns	ns	ns
	Male ***	<*	<***	ns	ns	>*	ns	>***	ns
Age	Young **	<*	<**	ns	ns	ns	ns	>*	ns
	Old**	ns	<***	ns	ns	ns	ns	>**	ns
Class	WC *	ns	<**	ns	ns	ns	ns	>*	ns
	UMC**	ns	<***	ns	ns	ns	ns	>**	<*
General patterns for:									
T21, T23***		<*	<***	>*	ns	ns	ns	>***	<*
T22***		<*	<***	>*	ns	ns	ns	>**	<*

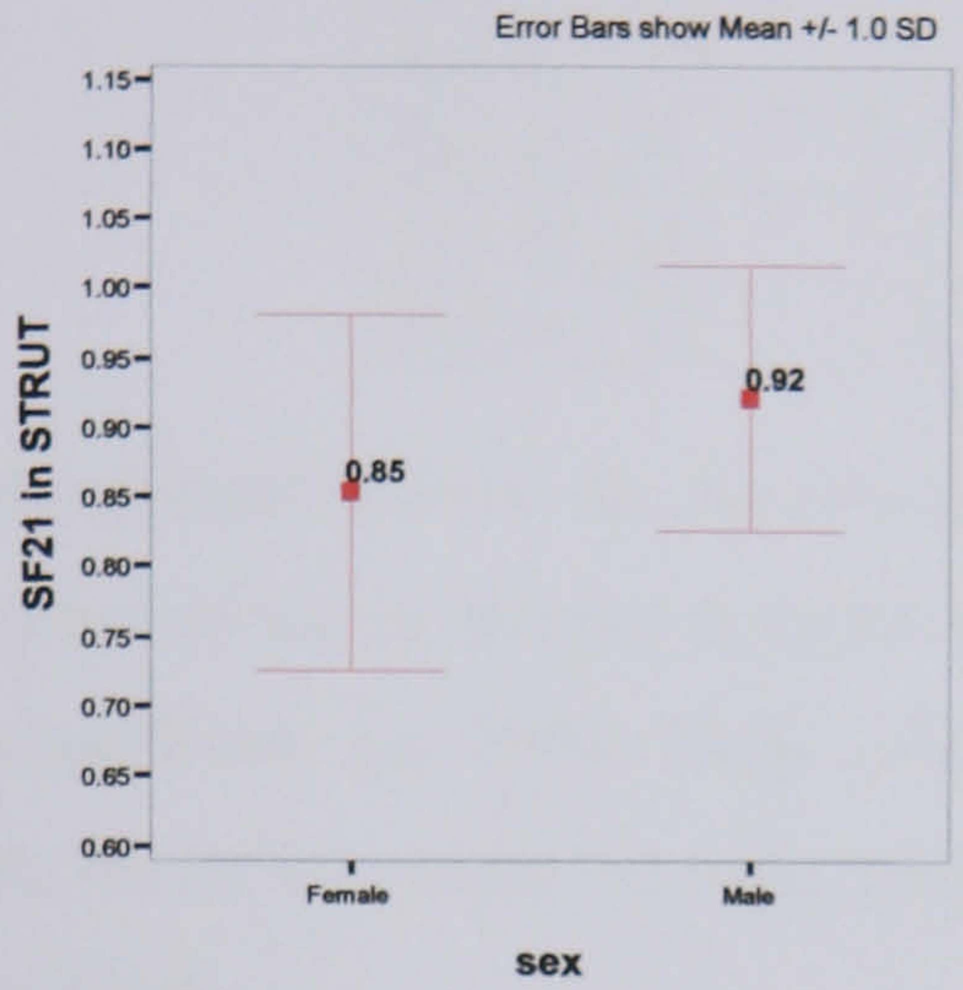
As a whole, the patterns for all the significant effects (i.e. main effects and simple effects) of phonetic environments on the SF21 values of TRAP from these results are summarised as follows:

- (1) _LS < _VS, _LF < _VF: as the general pattern, and as the patterns for the males, and the young,
- (1) _LS = _VS, _LF < _VF: as the patterns for the females, the old, the WC, and the UMC,
- (2) _LS > _LF, _VS = _VF: as the general pattern,
- (2) _LS = _LF, _VS = _VF: as the patterns for the females, the males, the young, the old, the WC, and the UMC,
- (3) _N = _LS, _N = _VS, _N > _LF, _N < _VF: as the general pattern (in T21, T22 and T23), and as the pattern for the UMC,
- (3) _N = _LS, _N = _VS, _N > _LF, _N = _VF: as the patterns for the young, the old, and the WC,
- (3) _N = _LS, _N = _VS, _N = _LF, _N = _VF: as the pattern for the females
- (3) _N > _LS[55], _N = _VS, _N > _LF, _N = _VF: as the pattern for the males.

[55] This is also found for the SF21 values of DRESS vowels in the old (§6.4.2.2).

6.4.8.3 SF21 in STRUT: sex

Now we turn to the results for the effects of sex in the T11 and T21 in which sex was compared with speech style in whole data and with phonetic environments in WLS data respectively. Let us firstly begin with the main effect of sex in both tests. The distributions of the SF21 values by sex are shown in Figure 78 below in which their means and SDs are displayed:



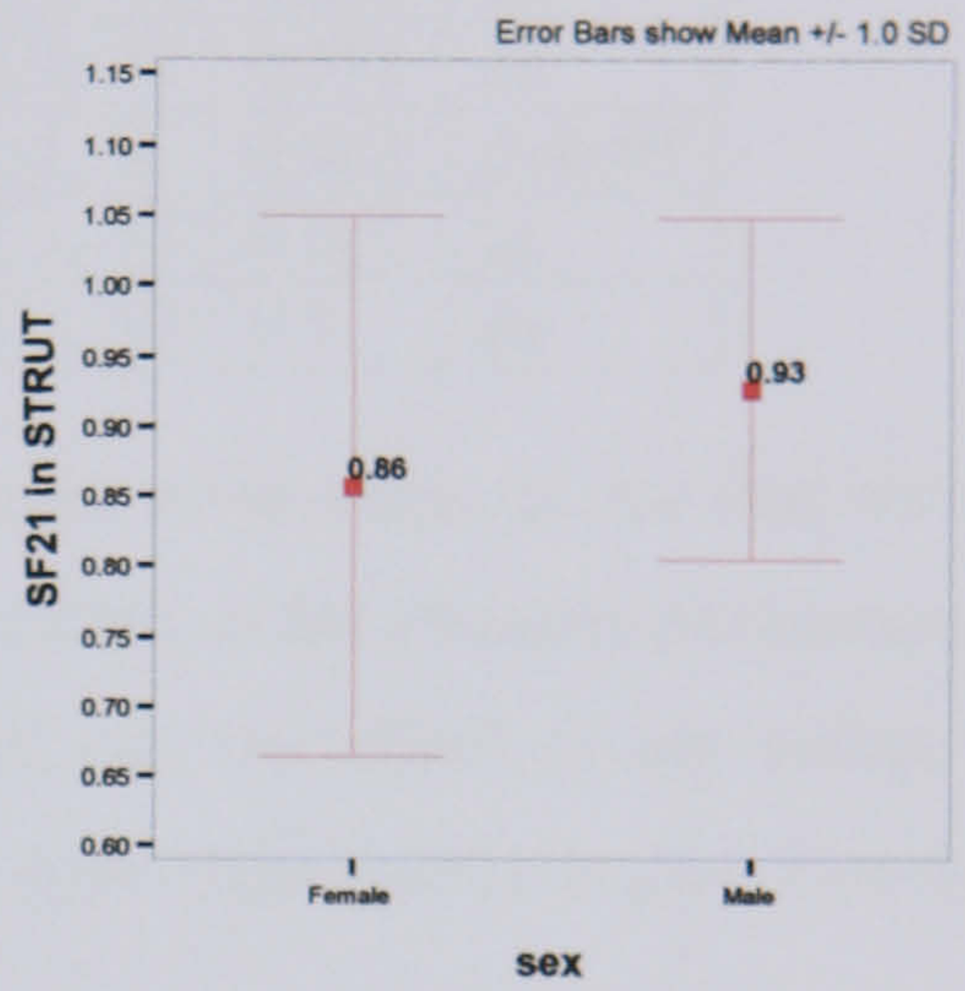


Figure 78 (SF21 in STRUT) Sex: Means and SDs in all speech styles in all speech styles for T11 (left) and in WLS for T21 (right)

In both tests, the means of the SF21 values for females are lower than those for males as found for the SF21 values of TRAP vowels (§6.4.5.3). Moreover, the SDs and the ranges between maximum and minimum values are greater for the females than for the males (cf. Appendix 10), indicating that the SF21 values for the females were more varied than for the males. These greater SDs and wider range for the females are also found for the SF21 values of DRESS and TRAP vowels (§6.4.2.3 and §6.4.5.3). Looking at the Table 81, the main effects of sex in T11 and T21 were both shown to be non-significant: $F(1, 30)= 3.616$, $p=0.067$ in T11, and $F(1, 30)= 2.057$, $p= 0.162$ in T21. These results indicate that there was no significant effect of sex on the SF21 values of STRUT vowels for entire data in general and for WLS in particular as well. Therefore, the following general pattern for the effect of sex on the SF21 of STRUT vowels can be obtained:

(U-SF21: Sex-pattern-1) Female = Male

As discussed in §6.4.8.1 and §6.4.8.2, there was no significant interaction effect either between sex and speech styles or between sex and phonetic environments, indicating that the way in which the SF21 values were affected by sex did not significantly differ either across speech styles or across phonetic environments (cf. Figure 75 and Figure 77).

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 88:

Table 88 SF21 in STRUT: Simple effects of sex for each condition of speech style and phonetic environments

Simple Effects	F	df	Sig.	
Sex at IS	3.751	1, 30	0.062	ns
Sex at RPS	3.466	1, 30	0.072	ns
Sex at WLS	2.052	1, 30	0.162	ns
Sex at _LS	0.472	1, 30	0.497	ns
Sex at _VS	1.049	1, 30	0.314	ns
Sex at _N	4.454	1, 30	0.043	**p<0.05**
Sex at _LF	0.451	1, 30	0.507	ns
Sex at _VF	2.878	1, 30	0.1	ns

Similar to the general pattern for the non-significant main effect of sex that we saw above (i.e. F=M), the effect of sex in all speech styles and in most of the phonetic environments were found to be non-significant, i.e. F=M. Only significant was the effect of sex before nasals; in this environment, the SF21 values for male speakers were significantly higher than those for female speakers, i.e. F<M.

Thus, for the sex factor, in addition to a non-significant main effect, we see non-significant results for the effect of sex in all speech styles; when the simple effects analyses were tested for sex at each phonetic environment within WLS data, however, the effect of sex did exist (i.e. F<M) only when the vowels were followed by nasals. These results are summarised as follows:

- F = M: as the general patterns (for entire data and for WLS data), and as the patterns for IS, RPS, WLS, _LS, _VS, _LF and _VF
- F < M: as the pattern for _N

6.4.8.4 SF21 in STRUT: age

We turn now to the results for the effects of age in the T12 and T22 in which age was compared with speech style in whole data and with phonetic environments in WLS data respectively. Let us begin with the main effect of age in both tests. The distributions of the SF21 values by age are shown in Figure 79 which displays their means and SDs:

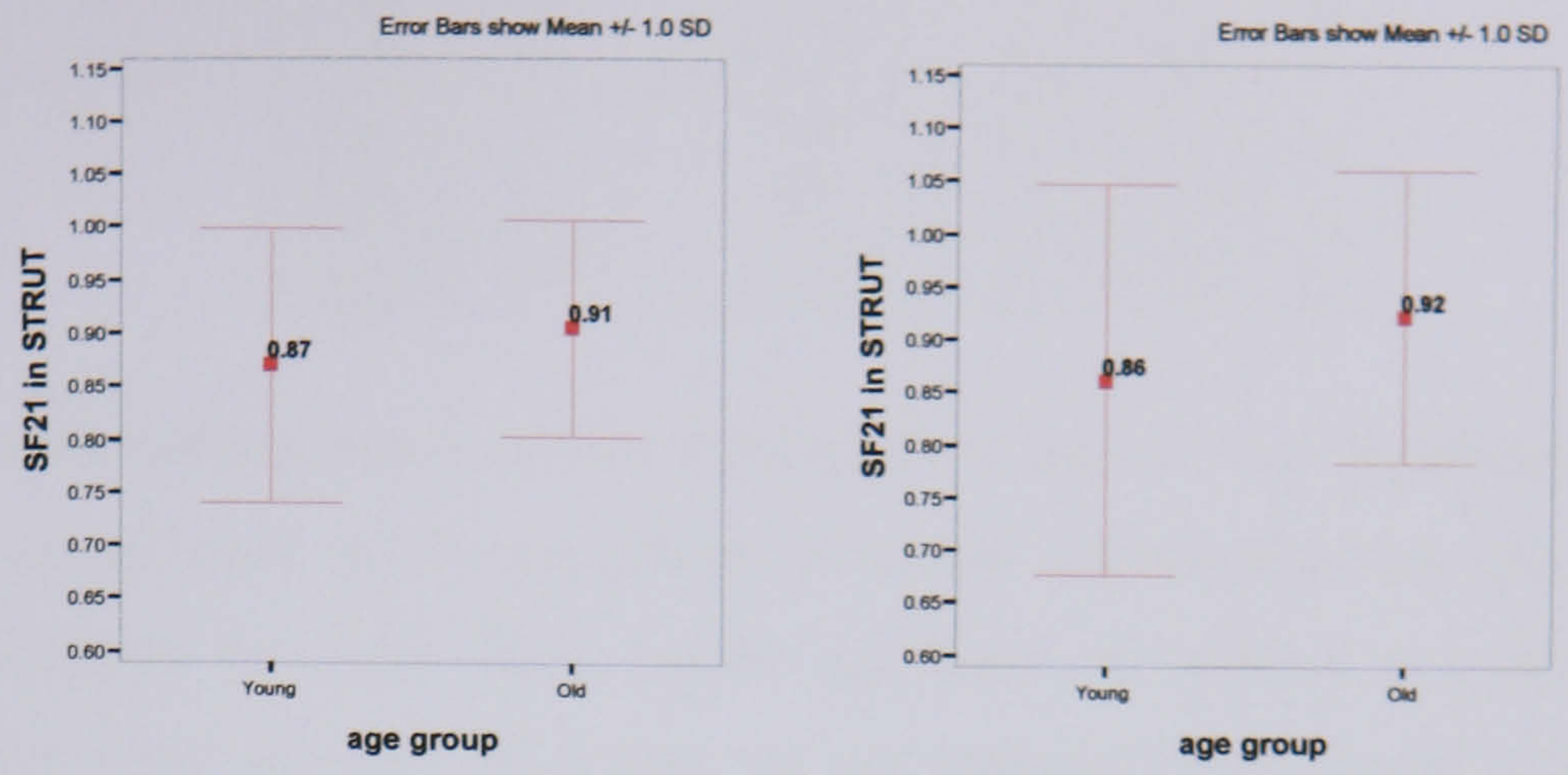


Figure 79 (SF21 in STRUT) Age: Means and SDs in all speech styles for T12 (left) and in WLS for T22 (right)

In both tests, the means of the SF21 values are higher for old speakers than for young speakers as found for the SF21 vowels of DRESS and TRAP vowels (§6.4.2.4 and §6.4.5.4). The SDs are greater for the young than for the old, which is the similar tendency to the one for the SF21 values of TRAP vowels (§6.4.5.4) but opposite to the one for the SF21 of DRESS vowels (§6.4.2.4). Looking at the ANOVA table in Table 81, the main effects of age in T12 and T22 were both shown to be non-significant: F(1, 30)= 0.898, p=0.351 in T12 and F(1, 30)= 1.558, p=0.222 in T22. These results indicate that the mean difference between young and old speakers was not significant both for entire data in general and for WLS in particular. Therefore, the following general pattern for the effect of age on the SF21 of STRUT vowels can be obtained:

(U-SF21: Age-pattern-1) Young = OLD

As discussed in §6.4.8.1 and §6.4.8.2, there was no significant interaction effect either between age and speech styles or between age and phonetic environments, indicating that the way in which the SF21 values were affected by age did not significantly differ either across speech styles or across phonetic environments (cf. Figure 75 and Figure 77).

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 89:

Table 89 SF21 in STRUT: Simple effects of age for each condition of speech style and phonetic environments

Simple Effects	F	df	Sig.	
Age at IS	0.046	1, 30	0.831	ns
Age at RPS	0.869	1, 30	0.359	ns
Age at WLS	1.606	1, 30	0.215	ns

Age at _LS	1.754	1, 30	0.195	ns
Age at _VS	0.452	1, 30	0.507	ns
Age at _N	1.596	1, 30	0.216	ns
Age at _LF	0.857	1, 30	0.362	ns
Age at _VF	1.516	1, 30	0.228	ns

As we saw that the general pattern of the main effect of age was not significant (i.e. Y = O), the simple effects of age were all non-significant at all the conditions of the speech styles and the phonetic environments (*p*>0.05). Thus, for the age factor, in addition to a non-significant main effect both in the whole data and WLS data, we saw non-significant results at the level of simple effects as summarised below:

- Y = O: as the general pattern (for entire data and WLS data), and as the patterns for IS, RPS, WLS, _LS, _VS, _N, _LF and _VF.

6.4.8.5 SF21 in STRUT: social class

We turn now to the results for the effects of social class in the T13 and T23 in which social class was compared with speech style in whole data and with phonetic environments in WLS data respectively. Let us begin with the main effect of social class in both tests. The distributions of the SF21 values by social class are provided in Figure 80 which shows their means and SDs:

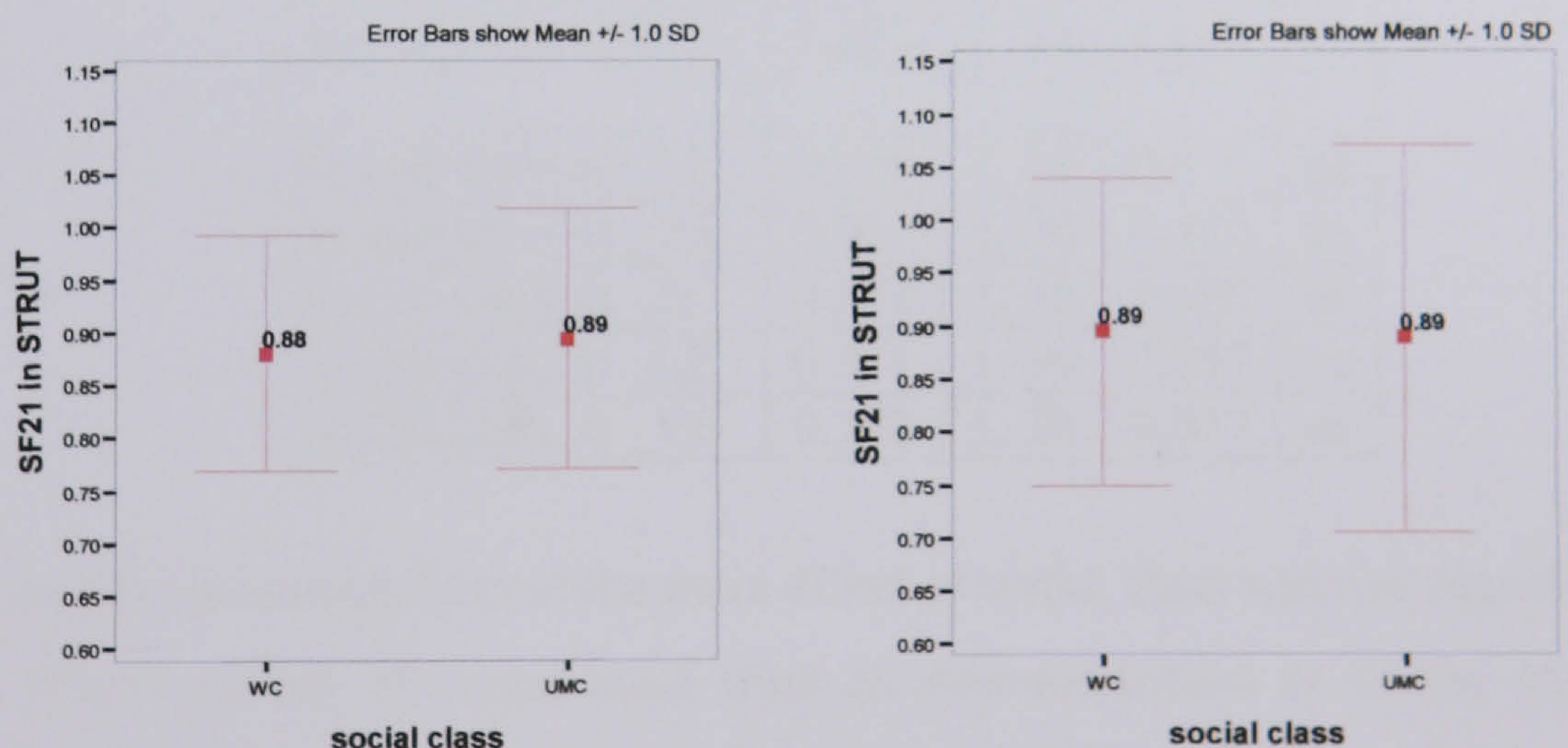


Figure 80 (SF21 in STRUT) Social class: Means and SDs in all speech styles for T13 (left) and in WLS for T23 (right)

In both tests, the means of the SF21 values are almost same for WC and UMC speakers. The slightly greater SDs and wider range between maximum and minimum values for the UMC (cf. Appendix 10) indicate that the SF21 values for the UMC were more varied than for the WC. This tendency is the same as the ones for the SF21 values of DRESS and TRAP vowels (§6.4.2.5 and

§6.4.5.5). Looking at the ANOVA table in Table 81, the main effects of social class in T13 and T23 were both non-significant: $F(1, 30)=0.134$, $p=0.716$ in T13 and $F(1, 30)=0.014$, $p=0.905$ in T23. These results indicate that there was no significant effect of social class on the SF21 values of STRUT vowels both for entire data in general and for WLS in particular. Therefore, the following general pattern for the effect of social class on the SF21 of STRUT vowels can be obtained:

(U-SF21: Social class-pattern-1) WC = UMC

As discussed in §6.4.8.1 and §6.4.8.2, there was no significant interaction effect either between social class and speech styles or between social class and phonetic environments, indicating that the way in which the SF21 values were affected by social class did not significantly differ either across speech styles or across phonetic environments (cf. Figure 75 and Figure 77).

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 90:

Table 90 (SF21 in STRUT) Simple effects of social class for each condition of speech styles and phonetic environments

Simple Effects	F	df	Sig.	
Social class at IS	0.47	1, 30	0.498	ns
Social class at RPS	0.386	1, 30	0.539	ns
Social class at WLS	0.023	1, 30	0.881	ns
Social class at _LS	0.016	1, 30	0.9	ns
Social class at _VS	0.006	1, 30	0.937	ns
Social class at _N	0.032	1, 30	0.859	ns
Social class at _LF	0.371	1, 30	0.547	ns
Social class at _VF	0.177	1, 30	0.677	ns

As we saw that the general pattern of the main effect of social class was not significant (i.e. WC = UMC), the simple effects of social class were all non-significant at all the conditions of the speech styles and the phonetic environments ($p>0.05$). Thus, for the social class factor, in addition to a non-significant main effect both in the whole data and WLS data, we saw non-significant results at the level of simple effects as summarised below:

- WC = UMC: as the general pattern (for entire data and WLS data), and as the patterns for IS, RPS, WLS, _LS, _VS, _N, _LF and _VF.

6.4.8.6 SF21 in STRUT: social grouping (by sex, age and social class)

Let us now look at the results for the effects of social groupings in the T14 in which social grouping factor was compared with speech style in whole data. Let us begin with the main effect of social grouping. The distribution of the SF21 values by social grouping is provided in Figure 81 which shows their means and SDs:

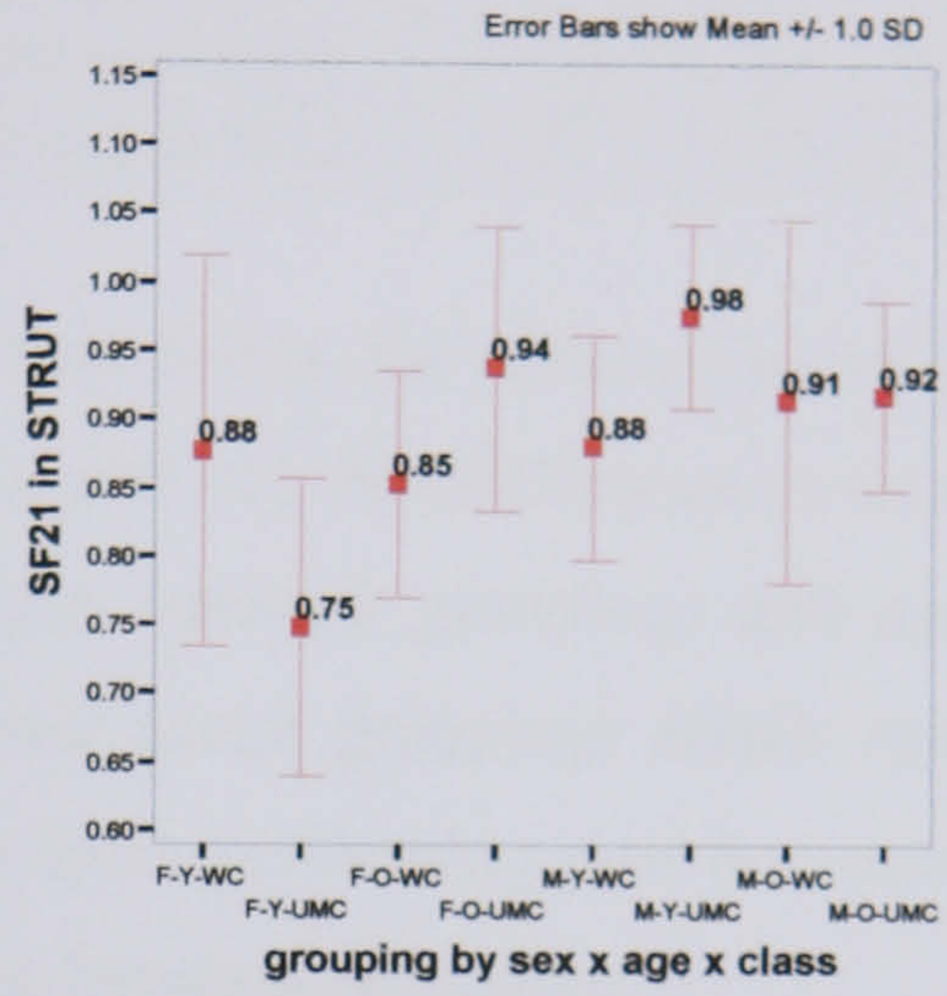


Figure 81 (SF21 in STRUT) Social grouping: Means and SDs in all speech styles for T14

There are a few noticeable differences that we can see from the figure and the Appendix 10. Firstly, the SF21 values for the F-Y-UMC speakers are much lower than any other groups, as found for the SF21 values of DRESS and TRAP vowels (§6.4.2.6 and §6.4.5.6). Secondly, the SDs and the ranges between maximum and minimum values for F-Y-WC, F-Y-UMC, F-O-UMC and M-O-WC look greater and wider than the other groups; this indicates that the SF2values are more varied for these groups than the others. Looking at the ANOVA results in Table 81, the main effect of social grouping in the T14 was not significant, F(7, 24)= 2.078, p=0.086. This result indicates that there was no significant effect of social grouping on the SF21 values of STRUT vowels. Therefore, the data could not be further examined for the difference between these groupings.

As discussed in §6.4.8.1, there were significant interaction effects between social groupings and speech styles (i.e. IS vs. RPS vs. WLS, and IS vs. RPS&WLS). The significant result was interpreted in §6.4.8.1 that the way in which SF21 values were affected by speech styles (both across three speech styles and between spontaneous and non-spontaneous speech) significantly differed for different groupings, and in particular, the pattern for the F-Y-UMC compared to the M-O-UMC and the others as can be seen in the Figure 75. These significant interactions, however, can be interpreted in the following way; the way in which SF21 values were affected by social groupings significantly differed in different speech styles.

To break down these interactions, the simple effects tests were further performed; the results from the tests are shown in Table 91:

Table 91 (SF21 in STRUT) Simple effects of social grouping at each speech style

Simple Effects	F	df	Sig.	
grouping at IS	1.98	7, 24	0.1	ns
grouping at RPS	1.778	7, 24	0.138	ns
grouping at WLS	2.281	7, 24	0.062	ns

Similar to the non-significant main effect, the effect of social grouping in all speech styles were found to be non-significant (i.e. $p>0.05$). No difference in social groupings across speech styles may confirm that the interaction between groupings and speech styles is simply due to the difference in profiles of different social groupings across speech styles. These non-significant results, therefore, prevented us from performing *post hoc* pairwise comparisons by LSD to see more detailed internal difference between groupings.

The result of the social grouping effect on the SF21 of STRUT is summarised as follows:

- Interactions: '*grouping x IS-RPS-WLS', '**grouping x IS-RPS&WLS'.

6.4.9 Provisional Summary for STRUT

In this section, both SF1 and SF21 will be considered together on a vowel scatter plot for a provisional summary as in §6.4.3 and §6.4.6. Overall summary and discussions of STRUT in relation to DRESS and TRAP will be left for a later section, §6.5.

6.4.9.1 STRUT and speech style

Speech style proved to be a significant factor for the SF1 of STRUT vowels both in general and for many sub groups, but not for the SF21 of the vowels except for a few conditions. The statistical results are summarised in the following schematic graphs:

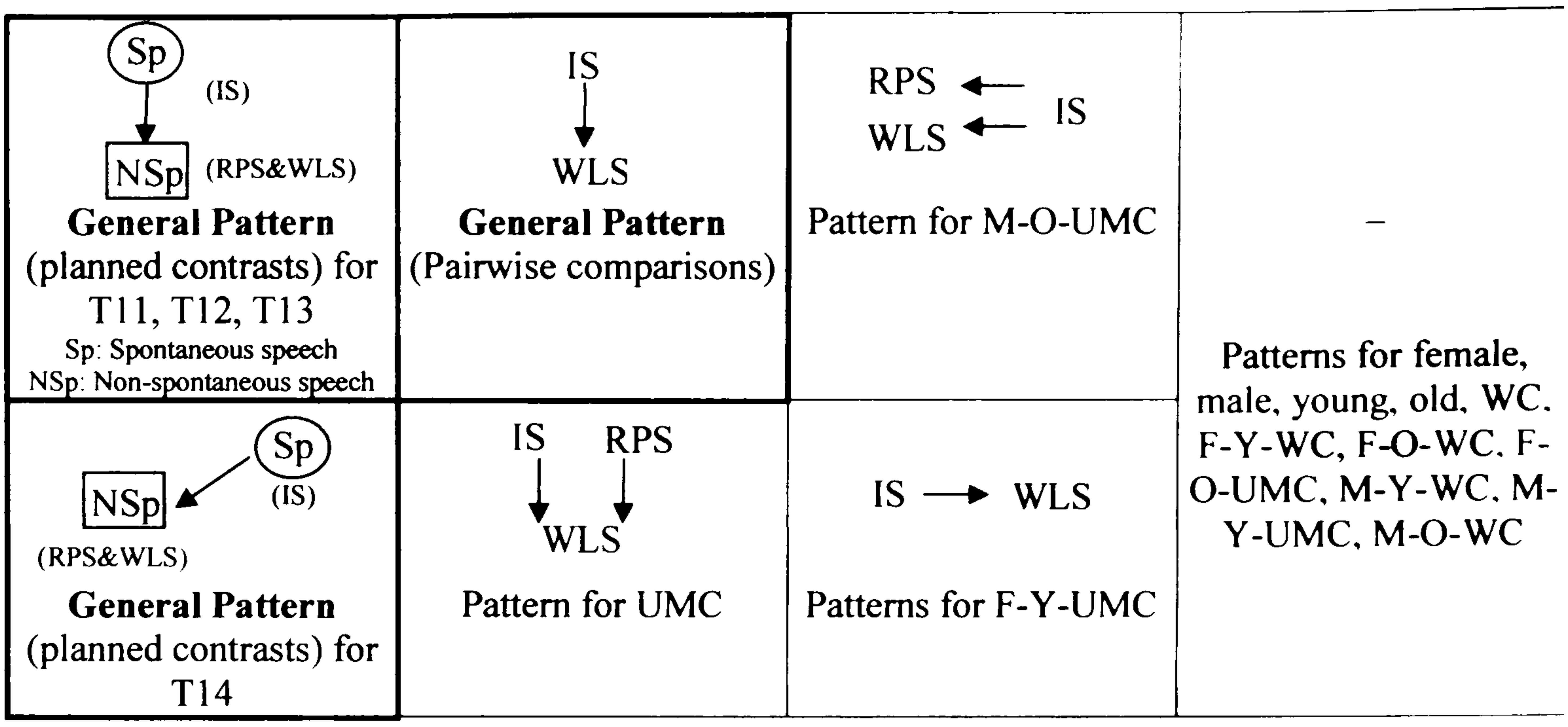
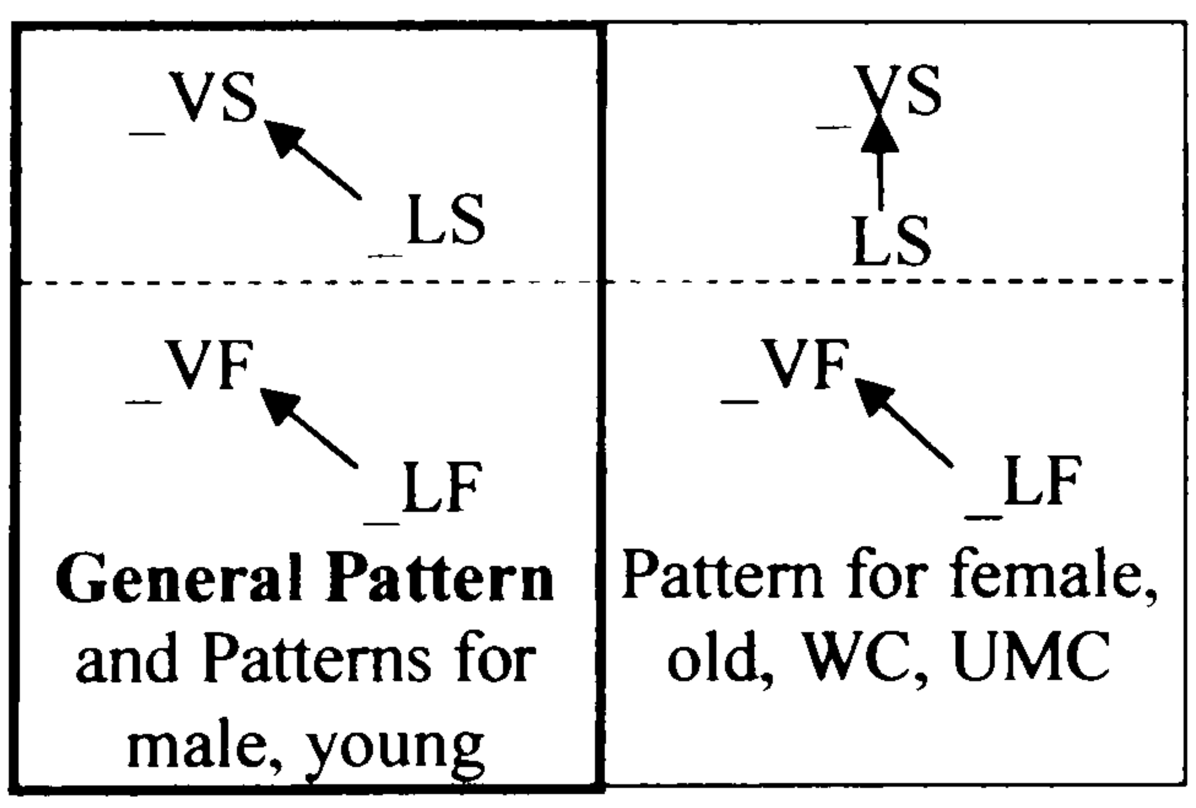


Figure 82 STRUT by speech style: schematic patterns

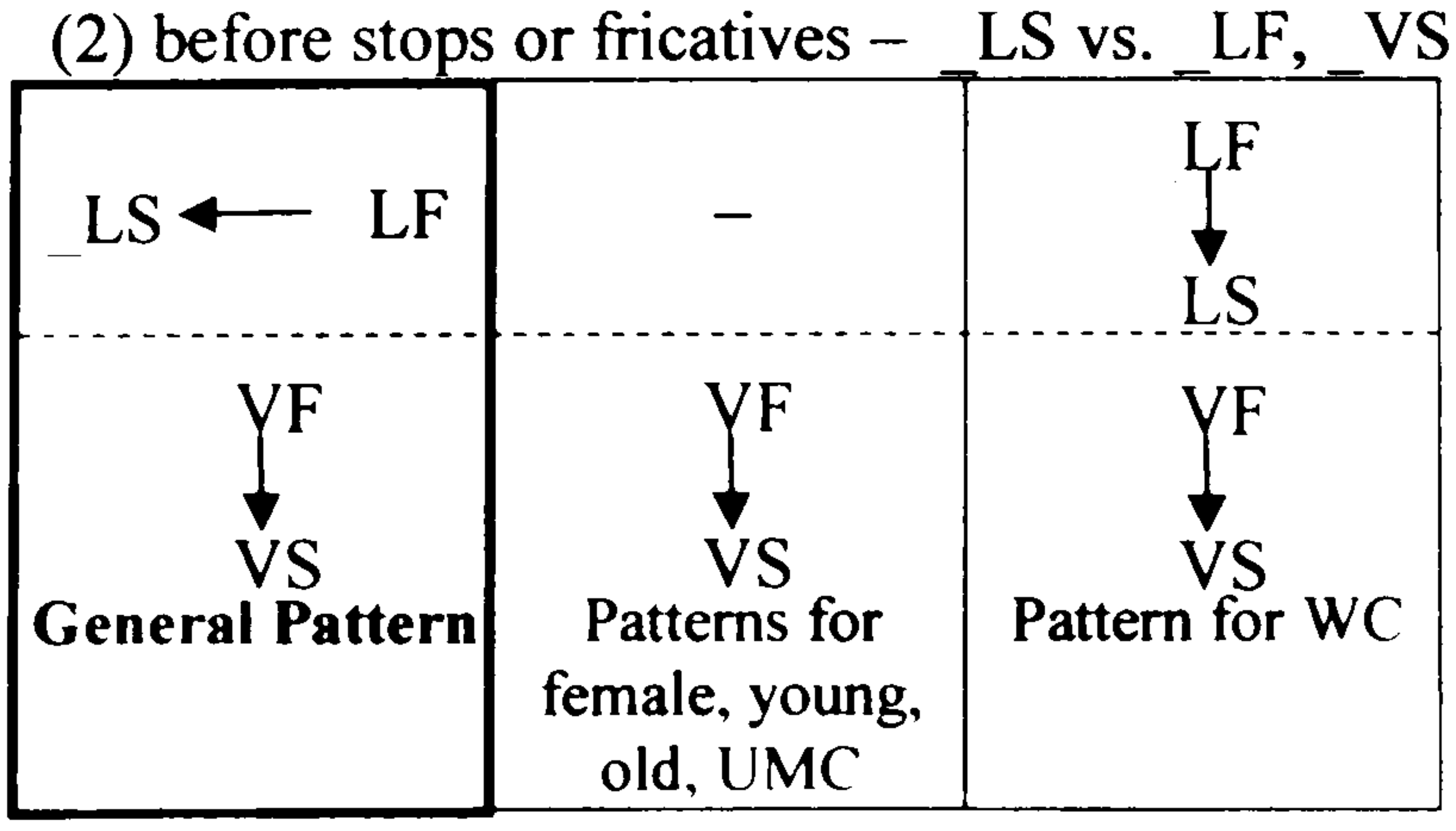
6.4.9.2 STRUT and phonetic environments

Phonetic environments proved to be a very highly significant factor both for the SF1 and SF21 of STRUT vowels not only in general, but also for most subgroups. Comparison focussed on: (1) before voiceless or voiced obstruents, (2) before stop or fricative, and (3) before nasal or obstruent. The statistical results are summarised in the following schematic graphs:

(1) before voiceless or voiced obstruents – _LS vs. _VS, _LF vs. _VF



(2) before stops or fricatives – _LS vs. _LF, _VS vs. _VF



(3) before nasals, stops or fricatives – _N vs. _LS, _N vs. _VS, _N vs. _LF, _N vs. _VF

General Pattern1 (T21, T22, T23)	Pattern for young	Pattern for female	Pattern for WC	Patterns for male	Pattern for old	Pattern for UMC
–	–	–	–	N ← LS	N ↑ LS	_N ↑ LS
VS ↓ N	_VS ↓ N	VS ↓ N	_VS ↓ N	–	–	–
N ← LF	_N ← _LF	–	_LF ↙ _N		_N ← _LF	_N ← _LF
VF ↘ N	VF ↓ N	_VF ↓ N	VF ↓ N	VF ↓ N	VF ↓ N	_VF ↘ N

Figure 83 STRUT by phonetic environments: schematic patterns

6.4.9.3 STRUT and sex

The relationship between sex and vowel openness was F = M for all conditions. The relationship between sex and vowel frontness was also F = M except for one environment, _N: in this condition, the relationship was M > F.

These results are summarised in the following schematic graphs:

General Pattern (for entire & WLS data) & patterns for IS, RPS, WLS, _LS, _VS, _LF, _VF	Pattern for _N
–	M ← F

Figure 84 STRUT by sex: schematic patterns

6.4.9.4 STRUT and age

The relationship between age and vowel openness was O > Y for entire data, but particularly in IS and WLS data, and within WLS data, particularly before stops. The relationship between age and vowel frontness was, on the other hand, Y = O for all conditions.

These results are summarised in the following schematic graphs:

Y ↑ O **General Pattern** (for entire & WLS data), IS, WLS, _LS, _VS	– Patterns for RPS, _N, _LF, _VF

Figure 85 STRUT by age: schematic patterns

6.4.9.5 STRUT and social class

The relationship between social class and vowel openness, on the one hand, was WC > UMC in less formal speech styles, but WC = UMC in more formal non-spontaneous style. Even within WLS, however, the relationship, WC > UMC, was found before nasals. The relationship between social class and vowel frontness was, however, WC = UMC at all the conditions.

These results are summarised in the following schematic graphs:

UMC ↓ WC **General Pattern** (for entire data) & patterns for IS, RPS, _N	– General Pattern (for WLS data) & patterns for WLS, _LS, _VS, _LF, _VF

Figure 86 STRUT by social class: schematic patterns

6.4.9.6 STRUT and social groupings

In terms of vowel openness, there were a few noticeable differences between social groupings. Firstly, the vowels for old WC speakers were more open than any other groups. Secondly, the vowels for the Y-UMC were much closer than any other groups, with the F-Y-UMC having the greater SDs and wider distributions. The statistical tests revealed the following patterns:

(1) sex comparison:
F = M for all the pairs of groups in general and in all conditions of speech style,
(2) age comparison:
O > Y for the F-UMC both in general and in IS,
O > Y for the M-UMC in IS
Y = O for all other groups in all other conditions,
(3) social class comparison:
WC > UMC for the M-Y both in general and in IS,
WC > UMC for the F-Y in IS
WC = UMC for all other groups in all other conditions.

In terms of vowel frontness, a noticeable difference between social groupings is that the vowels for the F-Y-UMC are more back than those for any other groups. Despite this apparent difference the effect of social groupings on vowel frontness was not significant either as a main effect or as a simple effect for all conditions of speech style.

These results are summarised in the following schematic graphs:

Sex comparisons	Age comparisons		Social class comparisons	
–	Y ↑ O	–	UMC ↓ WC	–
All groups in general & in all conditions (Y-WC, Y-UMC, O-WC, O-UMC in general and in IS, RPS, WLS)	•F-UMC (in general, IS), •M-UMC (in IS)	All other groups	•M-Y (in general, IS), •F-Y (in IS)	All other groups

Figure 87 STRUT by social groupings: schematic patterns

6.5 Summary and discussions

This section considers all results together on an S-transformed formant vowel space to see the relative positions of DRESS, TRAP and STRUT in relation to each factor. Although all the detailed patterns found from the statistical tests will be presented, the main aim in this section will be to highlight particular patterns which can provide possible answers to the research questions presented above (§5.1). Particular interests lie not only in the general patterns of each factor, but also in the patterns of interaction between two factors, since a pattern which is unique to a particular condition is unlikely to be governed by internal factors (such as phonetic environments) or general social factors (such as a general stylistic factor) and may suggest social significance.

At the beginning of each section are shown vowel plots of mean frequencies of SF1 and SF21 from all 32 speakers in three speech styles and/or in the five phonetic environments for the DRESS, TRAP and STRUT vowels distinguished in colours and shapes for different vowels and conditions, and vowel plots for their grand means[56] and their SDs for the three vowels[57]. Subsequently, all the patterns of all three vowels due to a factor revealed in the previous sections in this chapter are diagrammed for each condition of the other factor in a vowel space where an arrow indicates each significant pairwise result in terms of openness (by a vertical arrow), frontness (by a horizontal arrow), and combination of both (by a diagonal arrow) in the same manner as in the schematic graphs above; additionally, a grey arrow indicates that the pattern was significant in some occasions, but not significant in some other occasions.

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[56] A grand mean is a mean of the means from each speaker in each condition. For example, the grand mean of IS in a figure indicates that the mean of the 32 means from the 32 speakers in a condition.
[57] Raw means, grand means and their SDs are provided in Appendix 10.

6.5.1 By speech style

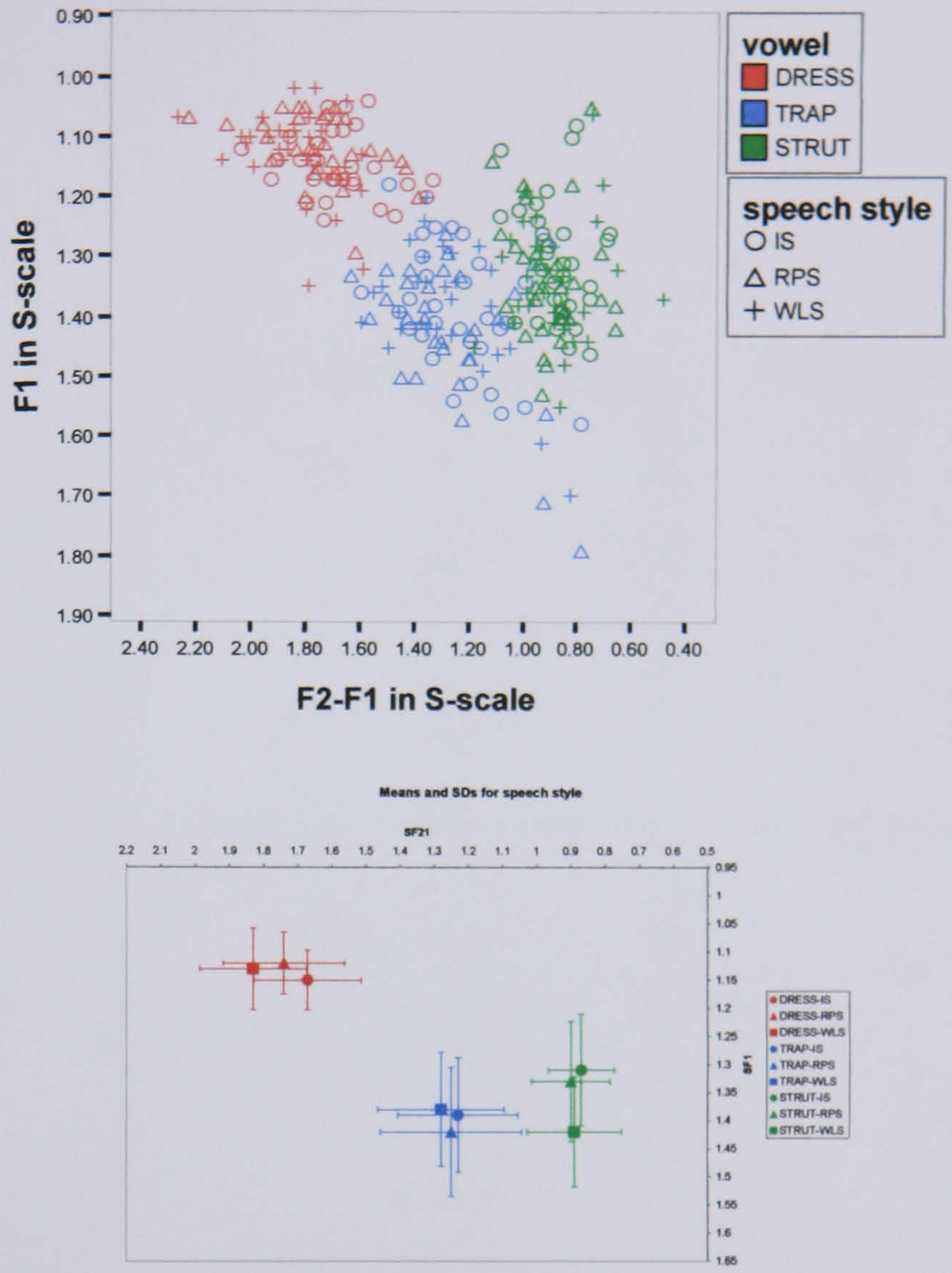


Figure 88 Mean distributions of DRESS, TRAP and STRUT vowels for all 32 speakers in three speech styles (above) and grand mean distributions of the three vowels and their SDs for speech styles (below)

Planned contrasts compared vowels in spontaneous speech with those in non-spontaneous speech revealed the following tendencies. DRESS vowels were generally more front and closer in RPS&WLS than in IS. STRUT vowels were more open in RPS&WLS than in IS in general, and also more front in RPS&WLS than in IS only when the vowels were compared in relation to the social groupings in the T14. There does not seem to be a consistency in the tendencies of these vowels between spontaneous and non-spontaneous speech styles. Considering peripherality, however, all the vowels tended to be realised more peripherally in non-spontaneous speech style. This indicates that more peripheral realisations are associated with the greater formality for these three vowels in general.

Pairwise comparisons (IS vs. RPS, RPS vs. WLS, IS vs. WLS) revealed more detailed vowel patterns, which are summarised in graphs in Figure 89:

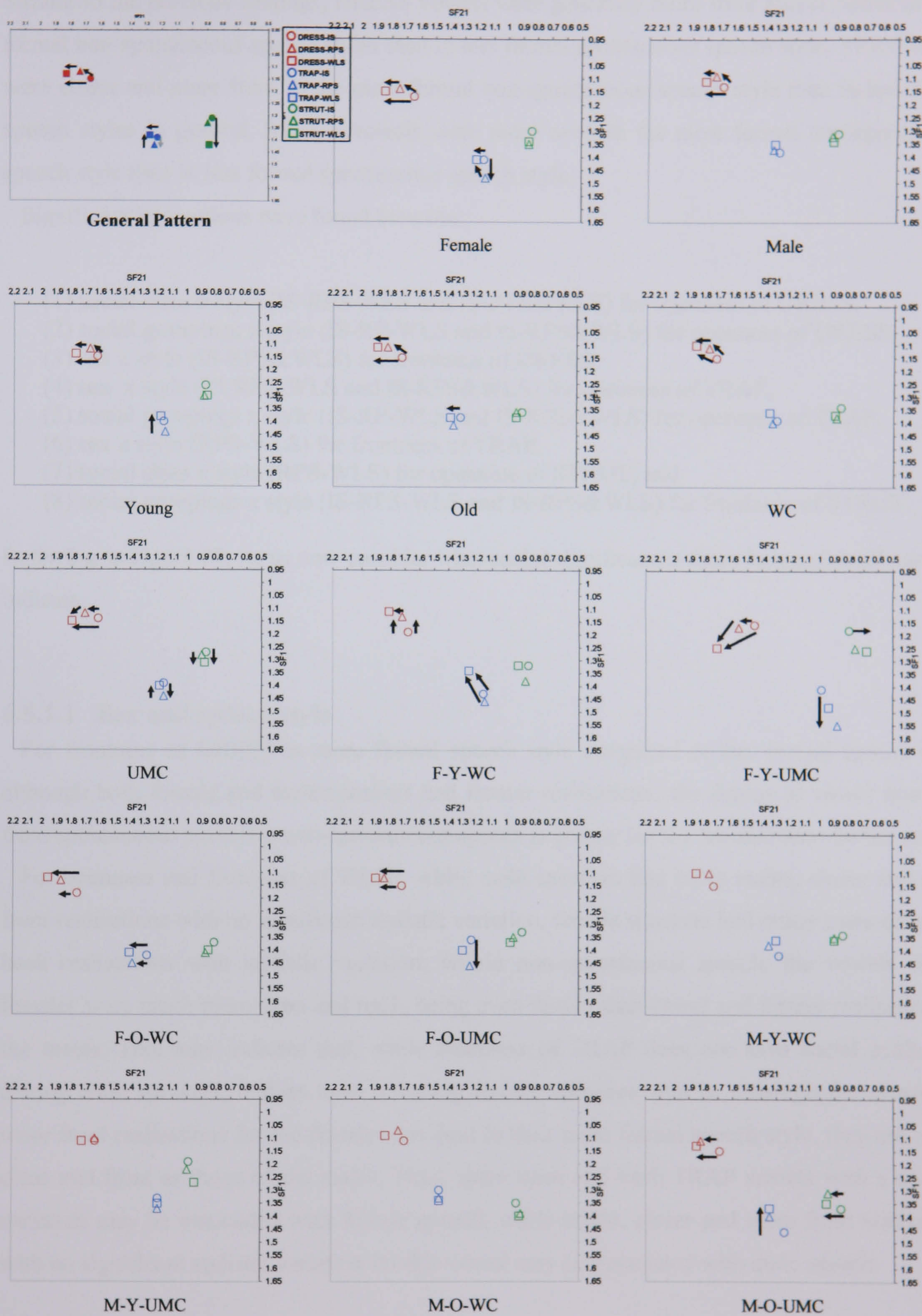


Figure 89 Patterns of means for three vowels across speech styles in general and in each condition

Similar to the previous findings, DRESS vowels were generally more front and/or closer in mor formal non-spontaneous speech styles than in less formal spontaneous speech style. TRAP vowel were closer and more front in the most formal non-spontaneous speech style than in less forma speech styles in general. STRUT vowels were more open in the most formal non-spontaneou speech style than in less formal spontaneous speech style.

Significant interactions were found between:

(1) social class x style (IS-RPS-WLS and IS-RPS&WLS) for openness of DRESS,
(2) social groupings x style (IS-RP-WLS and IS-RPS&WLS) for openness of DRESS,
(3) sex x style (IS-RPS&WLS) for frontness of DRESS,
(4) sex x style (IS-RPS-WLS and IS-RPS&WLS) for openness of TRAP,
(5) social groupings x style (IS-RP-WLS and IS-RPS&WLS) for openness of TRAP,
(6) sex x style (RPS-WLS) for frontness of TRAP,
(7) social class x style (RPS-WLS) for openness of STRUT, and
(8) social groupings x style (IS-RPS-WLS and IS-RPS&WLS) for frontness of STRUT.

Referring to Figure 89, let us now consider what social significances these interaction effects may indicate.

6.5.1.1 Sex and speech style

For frontness of DRESS in more formal speech style compared to less formal speech style, although both female and male speakers had fronter realisations, the degree of vowel frontness from spontaneous speech to non-spontaneous speech is greater for the females than for the males.

For openness and frontness of TRAP, while male speakers had fairly stable, closer and more front realisations with no significant stylistic variation, female speakers had rather more open and back realisations with stylistic variation; within non-spontaneous speech, the vowels of the females were much more open and back, being even farther than closer and fronter realisations of the males. This may indicate that, while frontness of TRAP does not have social evaluatior among male speakers, it does have it among female speakers; that is, although the closer and more front realisations for the females are used in their most formal speech style, they are not as close and front as those of the males. Thus, more open and back TRAP vowels with a stylistic variation may be associated with female speech, while stable, closer and more front realisations with no significant stylistic variation for this vowel may be associated with male speech.

6.5.1.2 Social class x speech style

For openness of DRESS, while WC speakers tended to have closer realisations in more formal speech style, UMC speakers tended to have more open realisations in more formal speech style. That is, closer DRESS vowels may be associated with the greater formality for the WC speakers, whereas more open DRESS may be associated with the greater formality for the UMC speakers. For openness of STRUT, while WC speakers had fairly stable and more open realisations – which are located behind their TRAP being on the similar level to the TRAP – throughout speech styles, UMC speakers had closer realisations – which are located behind and slightly higher than their TRAP vowels – with stylistic variations in which their vowels were comparatively more open in the most formal non-spontaneous speech. In other words, more open STRUT without stylistic variation may be associated with the WC speech, while closer STRUT with downward stylistic variation to formal speech may be associated with the UMC speech.

6.5.1.3 Social groupings and speech style

For openness of DRESS, the F-Y-UMC showed a unique stylistic variation: the more formal the speech style, the more open the vowel. This is different from that of the F-Y-WC who, as in the general pattern, showed closer realisations in more formal speech styles, and all the other groups which did not show any stylistic variation in openness. This interaction may indicate that more open DRESS vowels may be associated with the greater formality peculiarly for the F-Y-UMC, while closer DRESS vowels may be associated with the greater formality particularly for the F-Y-WC.

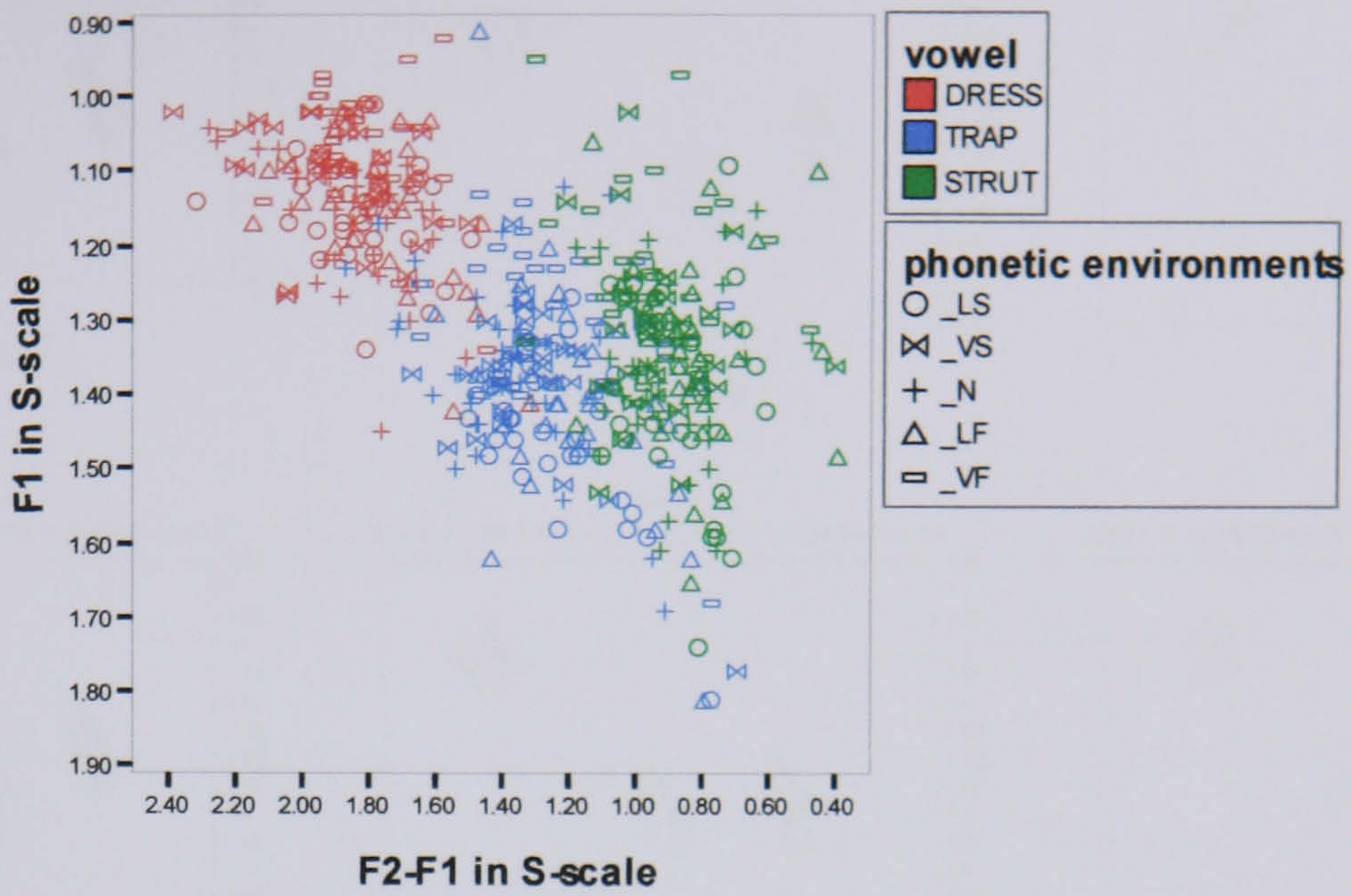
For openness of TRAP, the F-UMC group (i.e. F-Y-UMC and F-O-UMC) showed a unique stylistic variation: their vowels were more open in the most formal non-spontaneous speech compared to less formal spontaneous speech. The tendency is different from that of the F-Y-WC and the M-O-UMC who, similar to the general patterns, showed closer realisations in the most formal non-spontaneous speech compared to less formal non-spontaneous and/or spontaneous speech, and all the other groups who did not show any stylistic variation in openness. This interaction therefore may indicate that more open TRAP vowels may be associated with the greater formality peculiarly for the F-UMC, while closer TRAP vowels may be associated with the greater formality particularly for the F-Y-WC and the M-O-UMC.

For frontness of STRUT, the F-Y-UMC and the M-O-UMC showed two different unique stylistic variations. While the F-Y-UMC had more back realisation in more formal non-spontaneous speech compared to less formal spontaneous speech, the M-O-UMC had more centralised (fronter) realisation in more formal non-spontaneous speech styles compared to less formal spontaneous speech. This interaction therefore may indicate that more back STRUT vowels may be associated with the greater formality for the F-Y-UMC, while fronter STRUT vowels may be associated with the greater formality for the M-O-UMC.

6.5.1.4 Other notable findings

With regard to the relative positions of the three vowels, the Y-UMC group – particularly the F-Y-UMC – showed relatively closer STRUT vowels compared to the other groups, especially to the M-O-WC who showed more open STRUT vowels than any other group. The F-Y-UMC also had fairly open and more back TRAP vowels compared to the other groups, especially to the M-O-WC whose TRAP vowels were much fronter and closer. These differences in relative positions in different social groupings bring about different juxtapositions of these two vowels. The configuration for the Y-UMC (i.e. young London UMC speakers) clearly shows 'TRAP/STRUT rotation' (Fabricius 2006: 3, 2007: 310, see §4.6) with steeper positive angles compared to that of their older counterpart, the O-UMC, with shallow positive angles. The current data also show that the configuration of TRAP and STRUT vowels for the M-O-WC are similar to that of Fabricius' older RP speakers born before 1945, with negative angles. Looking at the F-Y-WC, M-Y-WC, F-O-WC speakers, their configurations are more similar to the O-UMC rather than to the M-O-WC. The detailed configurational analysis in the later chapter (Ch.8) will reveal more of this TRAP/STRUT rotation.

6.5.2 By phonetic environments



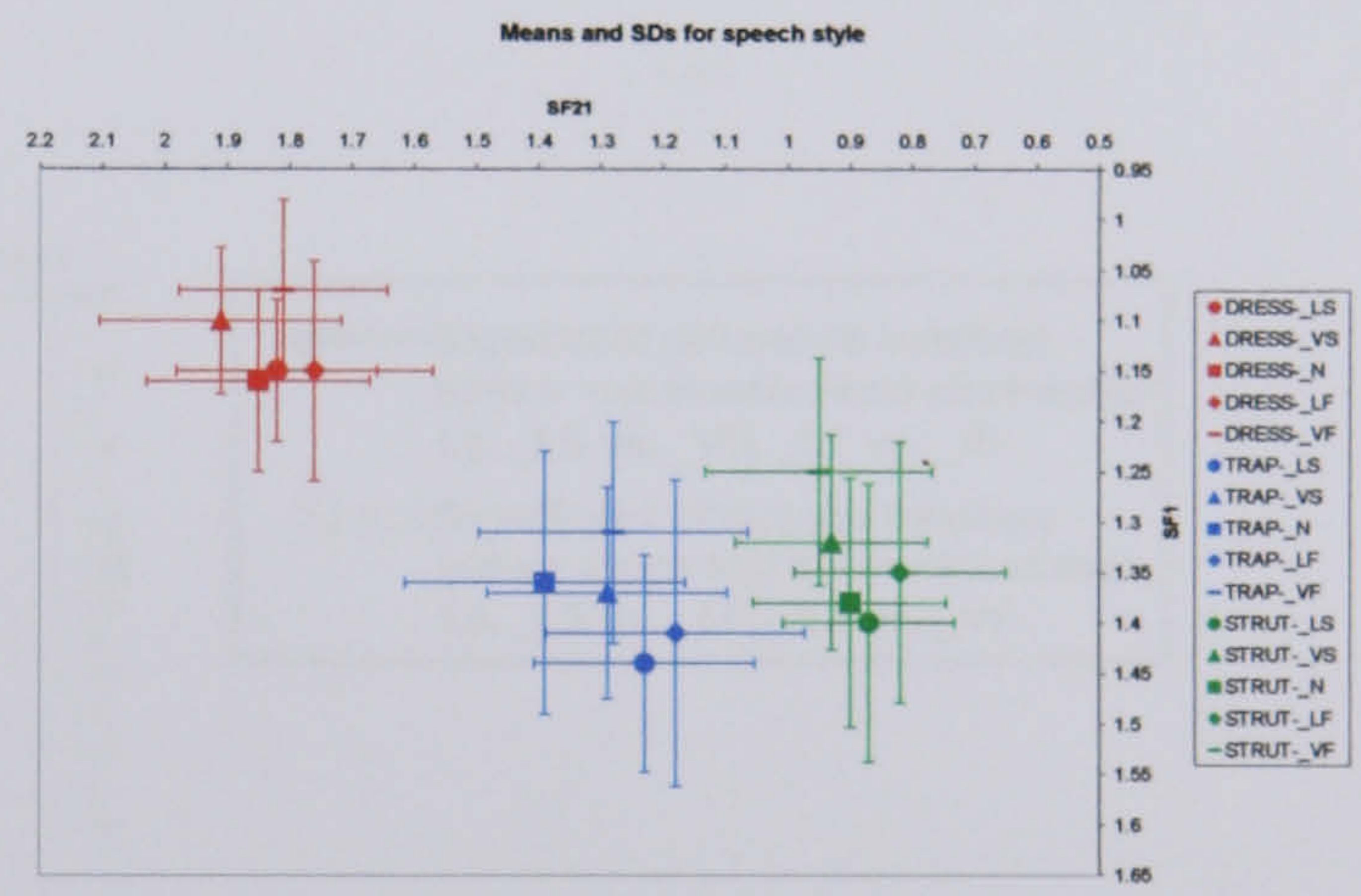


Figure 90 Mean distributions of DRESS, TRAP and STRUT vowels for all 32 speakers in phonetic environments (above) and grand mean distributions of the three vowels and their SDs for phonetic environments (below)

All the patterns from comparisons before voiced or voiceless obstruents and comparisons before stops or fricatives are summarised in graphs in Figure 91, in which a black arrow indicates a significant pairwise difference between _LS and _VS or between _LF and _VF, and a white arrow indicates a significant pairwise difference between _LS and _LF or between _VS and _VF:

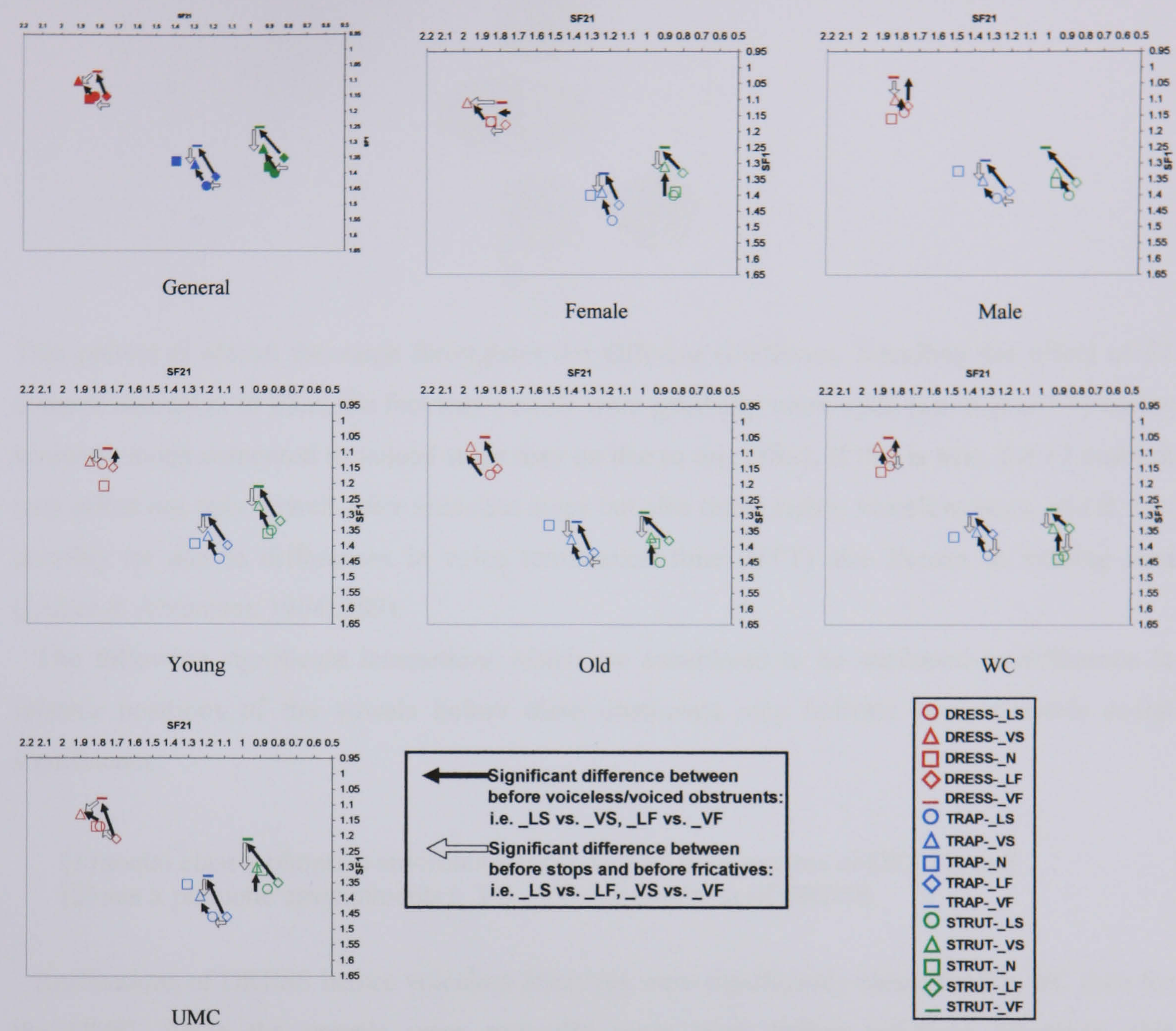
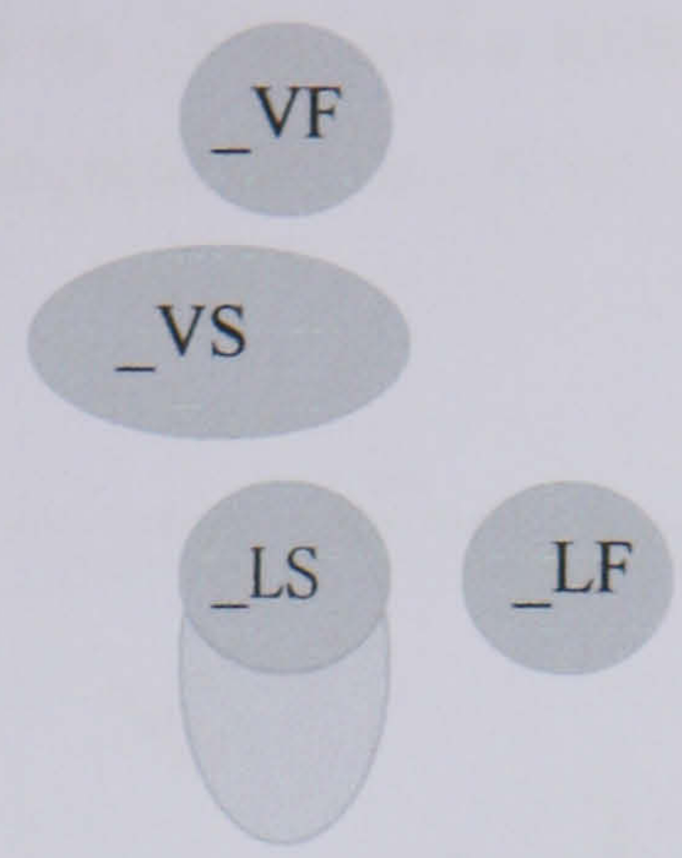


Figure 91 Patterns of means for three vowels across phonetic environments in general and in each condition – before voiced/voiceless obstruents comparisons (significant difference indicated by black arrows) and before stops/fricatives comparisons (significant difference indicated by white arrows)

All three vowels were generally closer and more front before voiced obstruents compared to before voiceless obstruents. Moreover, they were generally more open before voiced stops compared to before voiced fricatives, while they were generally more front before voiceless stops compared to before voiceless fricatives; in the case of DRESS vowels, the realisations were also more front before voiced stops compared to before voiced fricatives. These general patterns therefore lead us to the following schematic relative relation between _LS, _LF, _VS and _VF:



This pattern is almost the same throughout the different conditions. Recalling the effect of F1 cutback discussed in §3.2, the fact that vowels were generally more open (i.e. higher F1) before voiceless stops compared to voiced stops may be due to this effect. If this is true, the F1 cutback may affect not only vowels *after* voiceless stops but also those *before* voiceless stops, and it may possibly be due to differences in voice termination time (VTT) also known as voicing lead (Lisker & Abramson 1964: 389).

The following significant interactions which are considered to be attributed to difference in relative positions of the vowels before these obstruents may indicate some possible social significance:

(1) social class x phonetic environments (_LS-_LF) for openness of DRESS, and
(2) sex x phonetic environments (_VS-_VF) for frontness of DRESS.

Realisations of DRESS before voiceless fricatives were significantly closer for the WC than for the UMC. Since the vowels were generally more open before voiceless fricatives, this significantly closer DRESS before voiceless fricatives compared to before voiceless stops was peculiar to the WC, so that it may not be motivated by general phonetic constraints, but by a social factor which in this case is associated with this social group.

Realisations of DRESS before voiced stops compared to before voiced fricatives were significantly fronter for the females compared to the males. Therefore, the fronter realisations before voiced stops may be associated with the females, whereas the centralised realisations before voiced stops may be associated with the males.

Comparisons between pre-nasal and pre-obstruent environments are summarised in graphs in Figure 92, in which a black arrow indicates a significant pairwise difference in pre-nasal/stop comparisons (i.e. _N vs. _LS, _N vs. _VS), and a white arrow indicates a significant pairwise difference in pre-nasal/fricative comparisons (i.e. _N vs. _LF, _N vs. _VF) [58]:

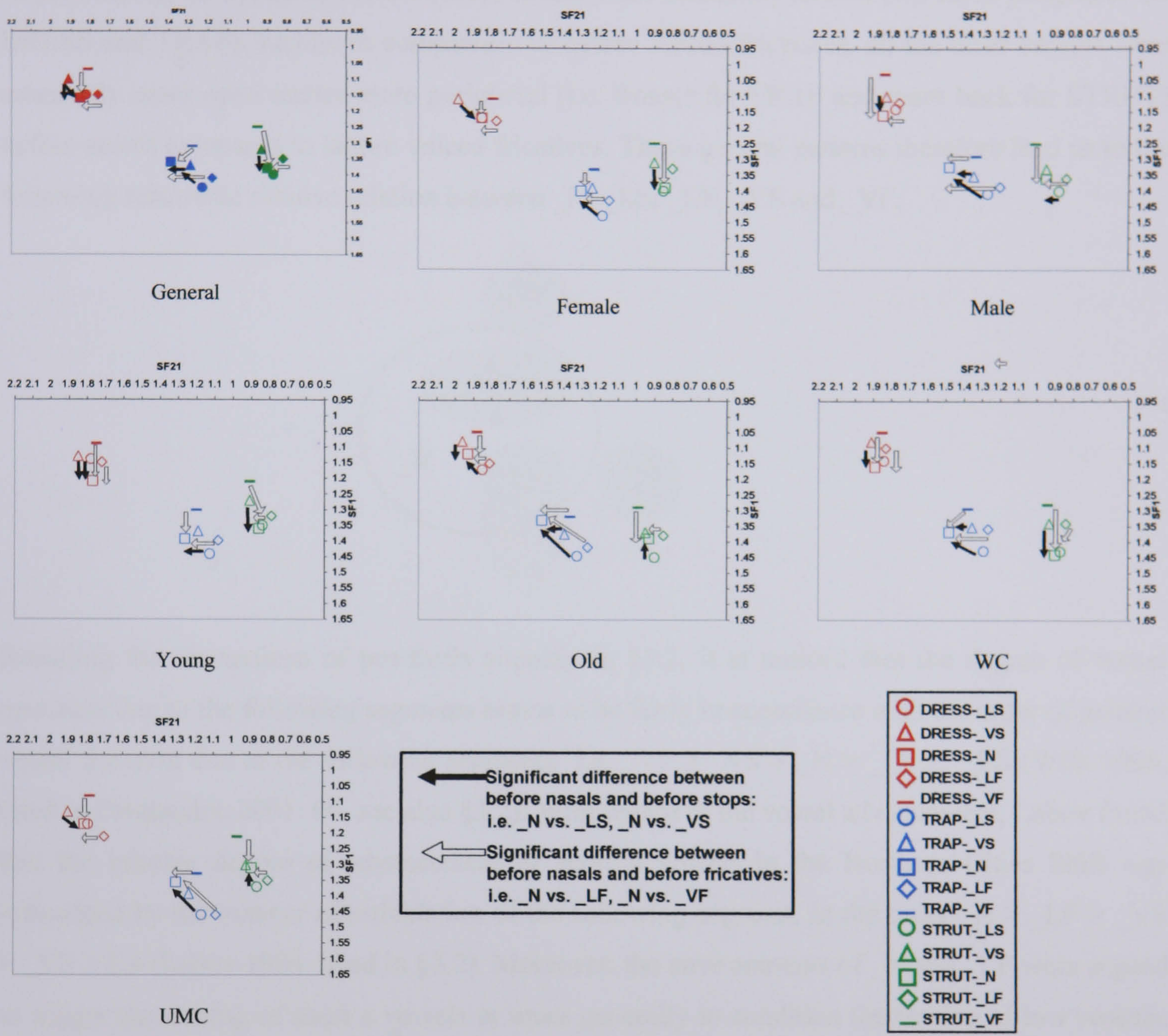


Figure 92 Patterns of means for three vowels across phonetic environments in general and in each condition – before nasals/stops comparisons (significant difference indicated by black arrows) and before nasals/fricatives comparisons (significant difference indicated by white arrows)

Although the relative position of the vowel realisations before nasals was not as fixed as the positions of those before obstruents, it was rather considered to be subject to vowel peripherality. General tendencies are as follows. Firstly, TRAP vowels were fronter (more peripheral) and closer before nasals than before voiceless stops, while DRESS and STRUT vowels before nasals

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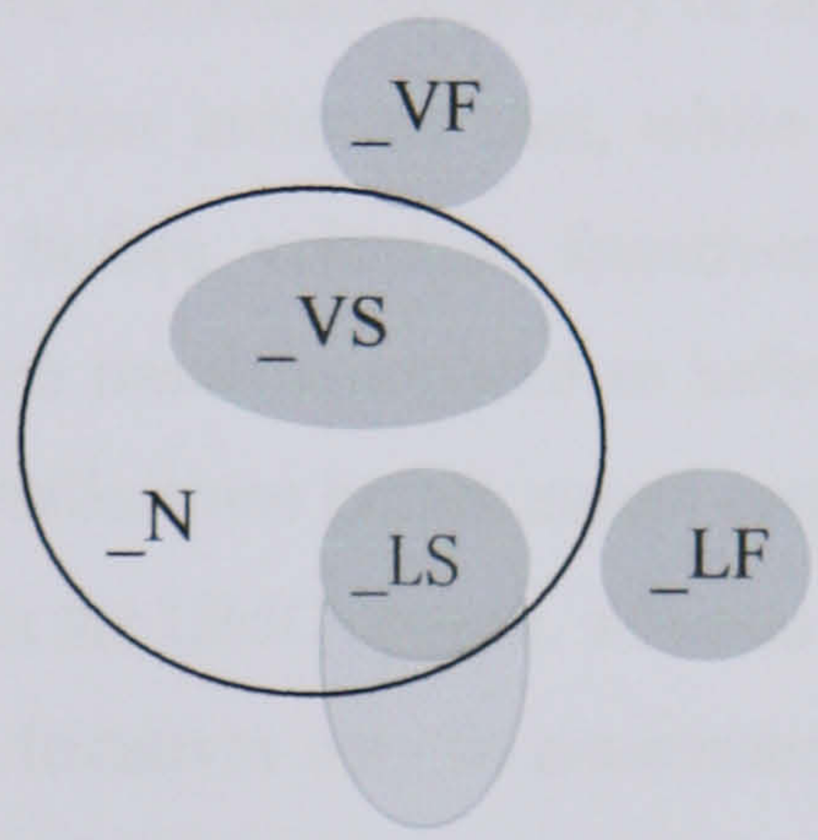
[58] In the Figure 92, there are cases in which more than one arrow is shown for a single pairwise comparison for the general pattern; these indicate that there was more than one significant difference for that particular pairwise comparison depending on the type of tests. Detailed information of significant results from all the pairwise comparisons can be found in Figure 40, Figure 61, and Figure 83 above.

were not different from those before voiceless stops, Secondly, TRAP vowels were fronter before nasals than before voiced stops, whereas DRESS and STRUT vowels were more open and/or slightly more back (i.e. more pheripheral for STRUT) before nasals compared to before voiced stops. Thirdly, all the three vowels before nasals were constantly fronter (i.e. more peripheral for DRESS and TRAP). Lastly, in comparison to before voiced fricatives, all the three vowels were constantly more open and/or more peripheral (i.e. fronter for TRAP and more back for STRUT) before nasals compared to before voiced fricatives. These general patterns therefore lead us to the following schematic relative relation between _N, _LS, _LF, _VS and _VF:



Recalling the discussions of pre-fortis clipping in §3.2, it is noticed that the degree of vowel openness due to the following segments seems to be fairly in accordance with the order of general vowel duration due to the following segments i.e. _VF ≥ _VS > _N > _LF ≥ _LS (Wiik 1965, cited in Cruttenden 2001: 96, see also §3.2). With regard to the vowel advancement, Labov found that the relative degree of advancement of short **a** vowels in the Northern Cities Shift was influenced by the manner of articulation of the following segment, in the order _N > _LF > _VS > _VF > LS (Labov 1994, cited in §3.2). Moreover, the environments of _N and _LF were argued to trigger the tensing of short **a** vowels or more generally to condition the tensing of low vowels. The current data partially follow his findings for the order of vowel advancement due to the following segment, and if the tensing is related to vowel peripherality, our data also indicate that the environment of _N triggers vowel peripherality. The environment of _LF, however, did not affect the vowels in the same way as that of _N; instead, it seems to cause more retracted realisations for all the three short vowels. Thus, the findings here partially support and partially disagree with Labov's findings. There was apparently no evidence for shrinking of vowel space before nasals as suggested in Johnson (2003: 165).

The following significant interactions which are considered to be attributed to difference in relative positions of the vowels before nasals and the obstruents may indicate some possible social significance:

(3) age x phonetic environments (_N-_LS, _N-LF) for openness of DRESS,
(4) social class x phonetic environments (_N-_LF) for openness of DRESS, and
(5) sex x phonetic environments (_N-_VS) for frontness of DRESS.

Realisations of DRESS were significantly more open before nasals than before voiceless obstruents for the young, whereas, for the old, they were significantly closer before nasals than before voiceless stops but they were not different between before nasals and before voiceless fricatives. Therefore, the more open realisation before nasals compared to before voiceless obstruents may be associated with the young speech, while the closer realisations before nasals compared to particularly before voiceless stops may be associated with the old speech.

Similarly, the fourth interaction indicated that, while DRESS vowels were apparently closer before nasals compared to before voiceless fricatives for the UMC, the realisations were significantly more open before nasals compared to before voiceless fricatives for the WC. This may suggest that, the closer realisations before nasals compared to before voiceless fricatives may particularly be associated with the UMC speech, whereas the more open realisations before nasals compared to before voiceless fricatives may be associated with the WC speech.

While there was no significant difference in the vowel frontness of DRESS vowels between before nasals and before voiced stops for the males, the realisations were significantly fronter before voiced stops than before nasals for the females. This significantly fronter DRESS before voiced stops compared to before nasals was peculiar to the females, so that the tendency may not be governed by general phonetic rules, but by a social factor which in this case is the females.

6.5.3 By sex

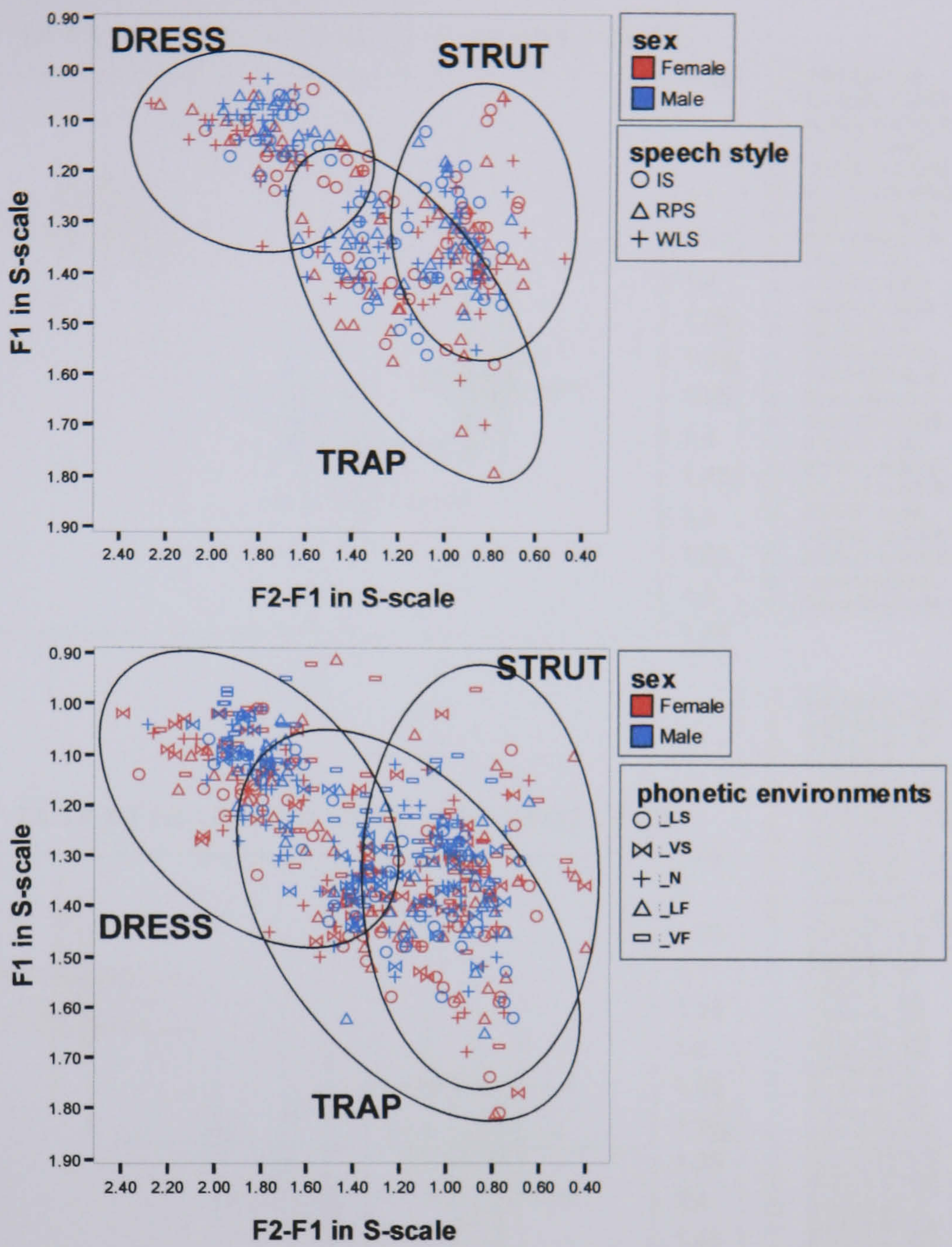


Figure 93 Mean distributions of DRESS, TRAP and STRUT vowels by sex for all 32 speakers in three speech styles for the entire data (above) and in five phonetic environments for the WLS data (below)

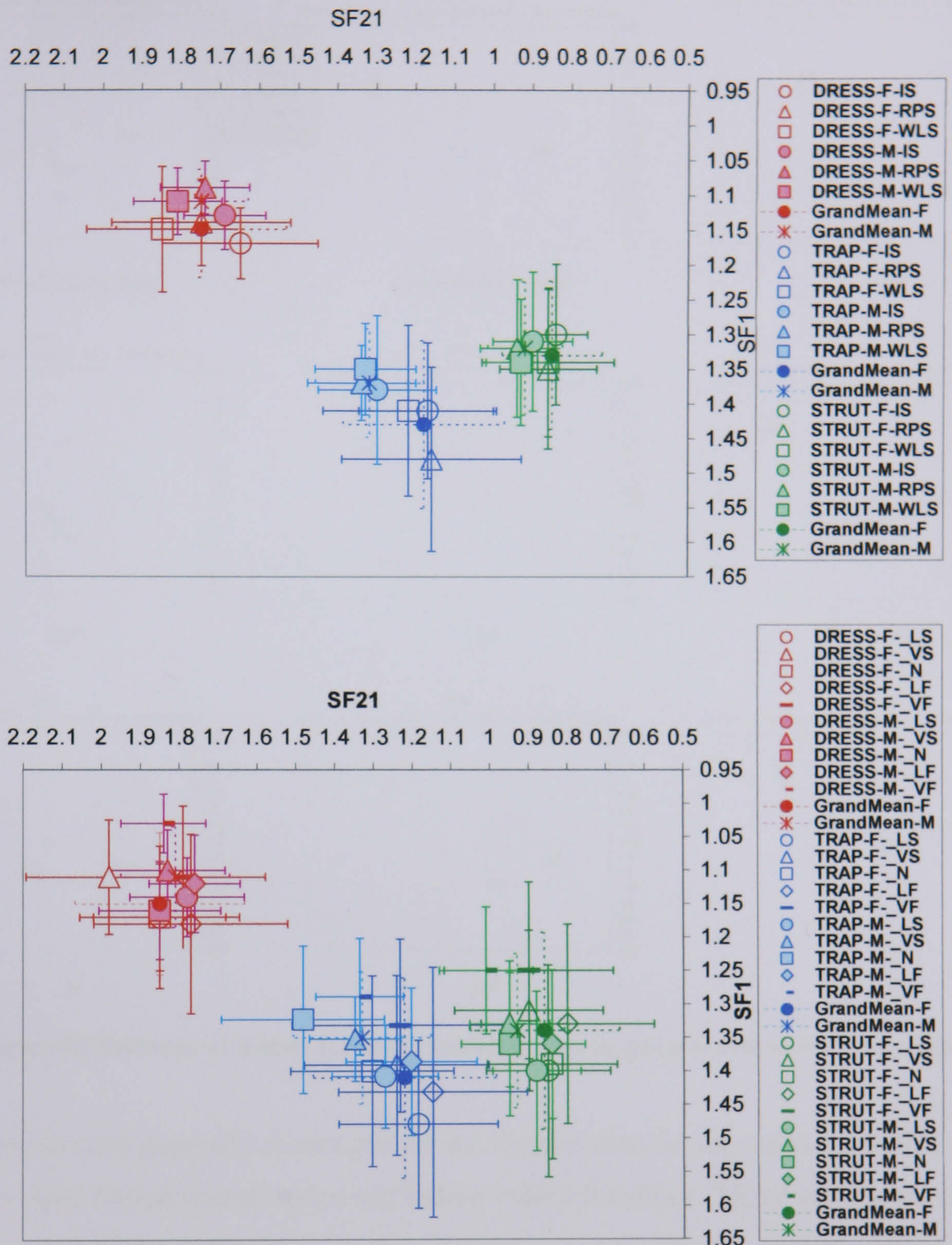


Figure 94 Grand mean distributions of the three vowels by sex and their SDs for speech styles (above) and for phonetic environments (below)

All the patterns are summarised in graphs in Figure 95:

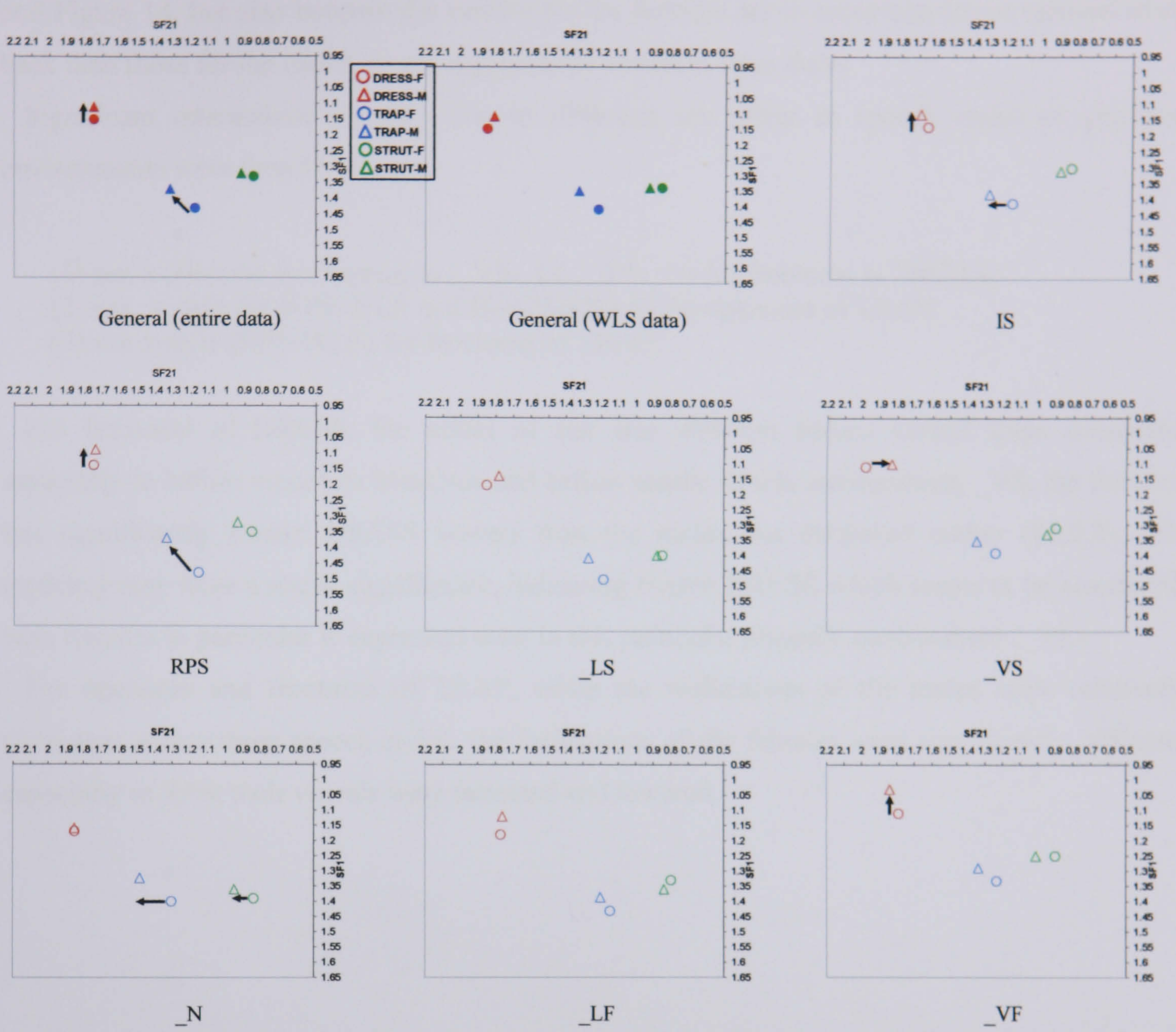


Figure 95 Patterns of means for three vowels by sex in general and in each condition

DRESS vowels were generally more open for the females than for the males, and this pattern was also true in more formal speech styles and before voiced fricatives. TRAP vowels were generally more open and back, particularly in less formal non-spontaneous speech, for the females compared to the males; the vowels were more back but not more open in spontaneous speech, and before nasals. For the STRUT vowels, there was no effect of sex except before nasals, where the vowels were more back for the females compared to the males. This sex effect for STRUT before nasals runs counter to the sex effect found in the study of teenagers from adjacent Home counties by Przedlacka (2002: 76-7).

There is a possibility that significantly more open and/or fronter vowel realisations for the females compared to the males could be the residue of imperfect normalisation. However, this appears to be unlikely for the current data, not only because the vowel triangles on the S-normalised scale for different speakers have been shown to match extremely well in Figure 12 and Figure 14, but also because the vowels for the females are in some conditions realised more back than those for the males, or not significantly different from them.

Significant interactions possibly due to different sex effect in speech styles or phonetic environments were found between:

(1) sex x phonetic environments (_VS-_LF, _VS-_N) for frontness of DRESS,
(2) sex x style (IS-RPS-WLS and IS-RPS&WLS) for openness of TRAP,
(3) sex x style (RPS-WLS) for frontness of TRAP,

For frontness of DRESS, the effect of sex was different before voiced stops compared especially to before voiceless fricatives and before nasals: in this environment, _VS, the females had significantly fronter DRESS vowels than the males. As discussed earlier (§6.5.2), this tendency may have a social significance, indicating fronter DRESS which seems to be associated with females in particular is expressed most in this particular phonetic environment (_VS).

For openness and frontness of TRAP, while the realisations of the males were relatively consistent across three speech styles, the realisations of the females were significantly different especially in RPS; their vowels were retracted and lowered.

6.5.4 By age

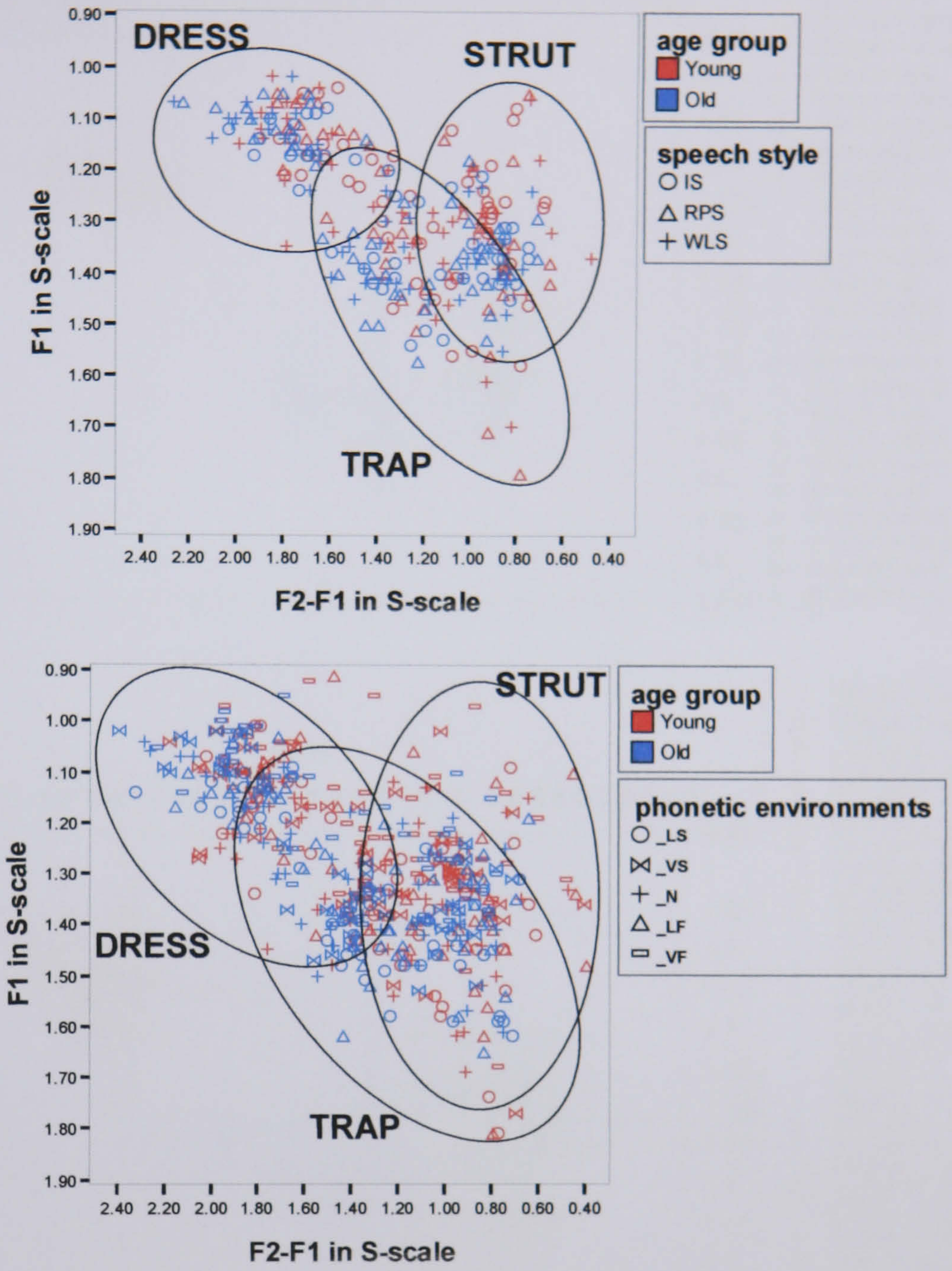


Figure 96 Mean distributions of DRESS, TRAP and STRUT vowels by age for all 32 speakers in three speech styles for the entire data (above) and in five phonetic environments for the WLS data (below)

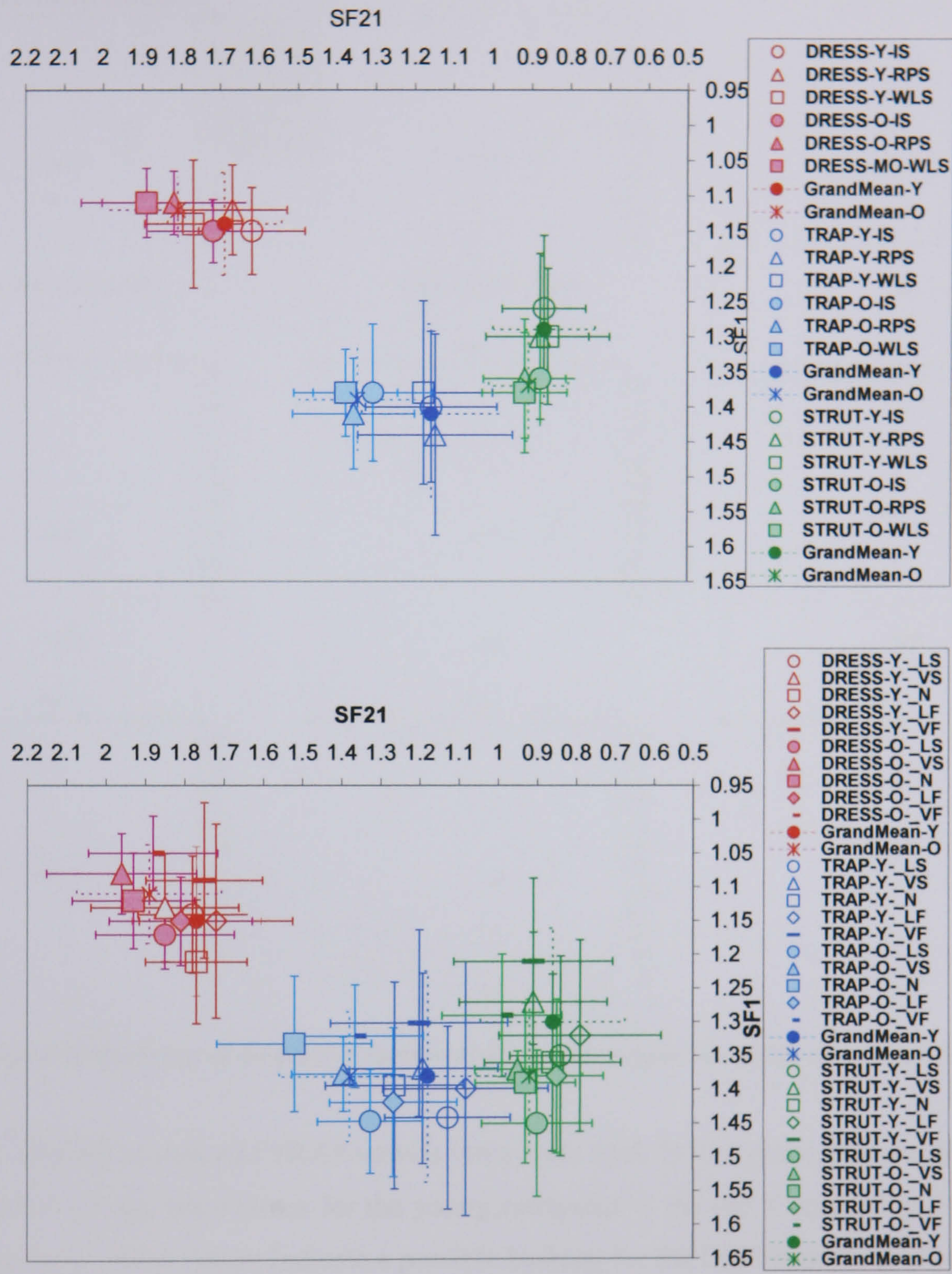


Figure 97 Grand mean distributions of the three vowels by age and their SDs for speech styles (above) and for phonetic environments (below)

All the patterns are summarised in graphs in Figure 98:

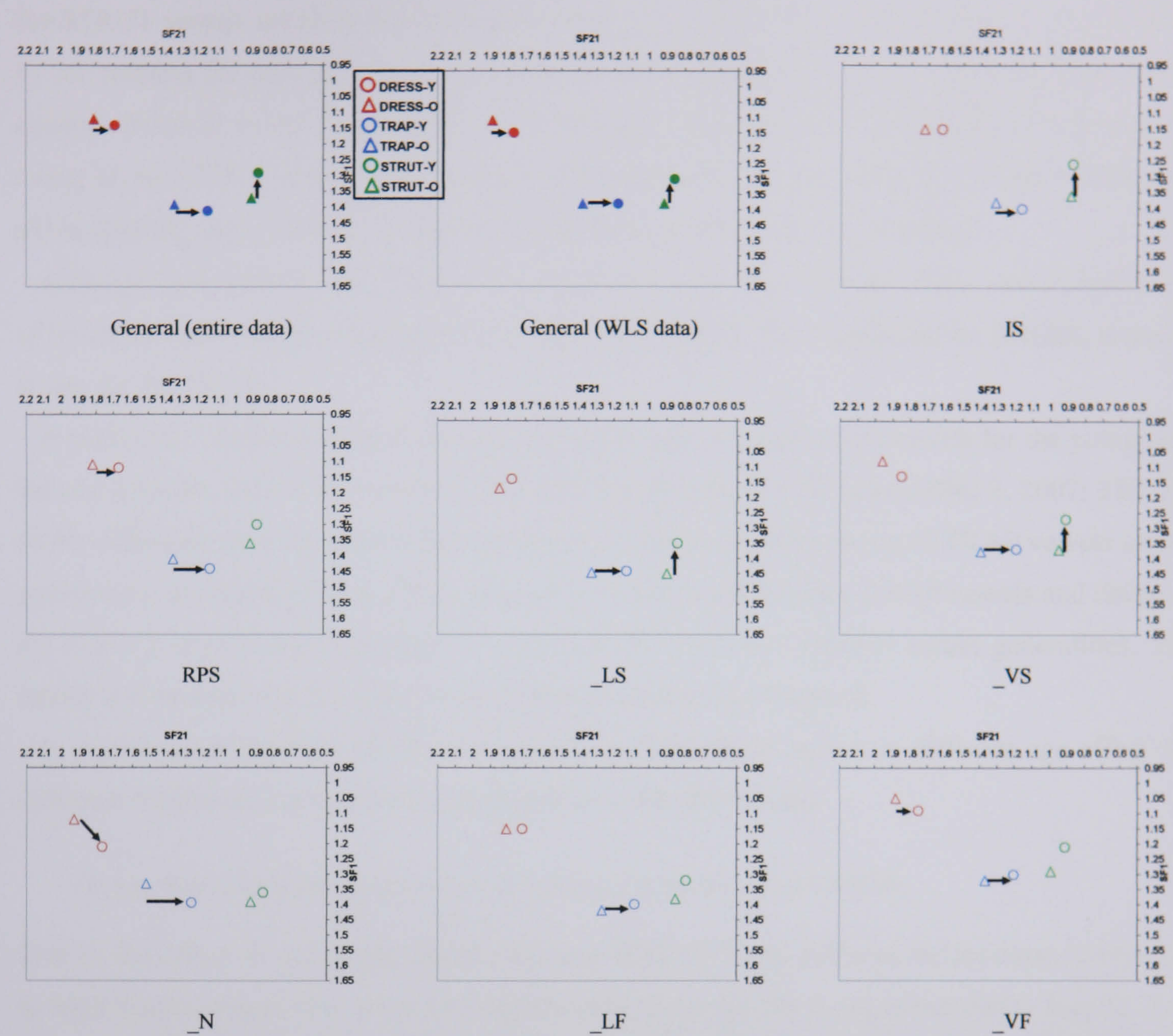


Figure 98 Patterns of means for three vowels by age in general and in each condition

In general, DRESS vowels and TRAP vowels were more back for the young compared to the old, whilst STRUT vowels were closer for the young compared to the old. Considering the apparent time comparisons, these results indicate a possible backing for the DRESS and TRAP vowels and a possible rising of the STRUT vowels in London English as a whole. This, however, does not mean that the same vowel shifts should be happening both within London UMC and London WC speakers. Since the next chapter will be dedicated to exploring each situation of the vowel shift in each of London UMC and London WC, the rest of this section describes only the vowel shift observed for entire London English.

The backing of the DRESS was only found in more formal speech styles, the rising of the STRUT vowels was only found in IS and WLS, but the backing of the TRAP vowels was observed in all the speech styles; this may indicate that, while the backing for the TRAP vowels is more established regardless of speech styles, the backing of the DRESS vowels and the rising of the STRUT vowels are more fluctuating depending on speech styles. This notion can be enhanced by the patterns for each phonetic environment in the WLS; the backing of the TRAP vowels was equally observed in all the phonetic environments, the backing of the DRESS vowels and the rising of the STRUT vowels were found in some phonetic environments (i.e. _VF for the backing of the DRESS, and _LS and _VS for the rising of the STRUT) but not in others.

Although both DRESS and TRAP did not indicate lowering in general, there was an indication of lowering before nasals; the lowering in this environment was significant for DRESS, whereas it was not for TRAP.

In addition, it should be noted that the relative position of these three vowels for the young and the old speakers follows the pattern of TRAP/STRUT rotation (Fabricius 2006: 3, 2007: 310, see §4.6). Although the current data did not show any evidence for lowering of TRAP vowels across generations as Fabricius found, they showed the same backing of the TRAP vowels and rising of the STRUT vowels which seemed to cause the TRAP/STRUT rotation across generations. The details will be explored by a later configurational analysis in Chapter 8.

A significant interaction which was possibly considered to be due to different age effect for different conditions of phonetic environments was found between:

(3) age x phonetic environments (_N-others) for openness of DRESS.

That is, the effect of age on the vowel openness of DRESS was different before nasals compared to other environments; the vowel was significantly closer for the young compared to the old. This age effect difference before nasals may have a social significance, indicating more open DRESS which seems to be associated with young speakers is expressed most in this particular phonetic environment (_N).

6.5.5 By social class

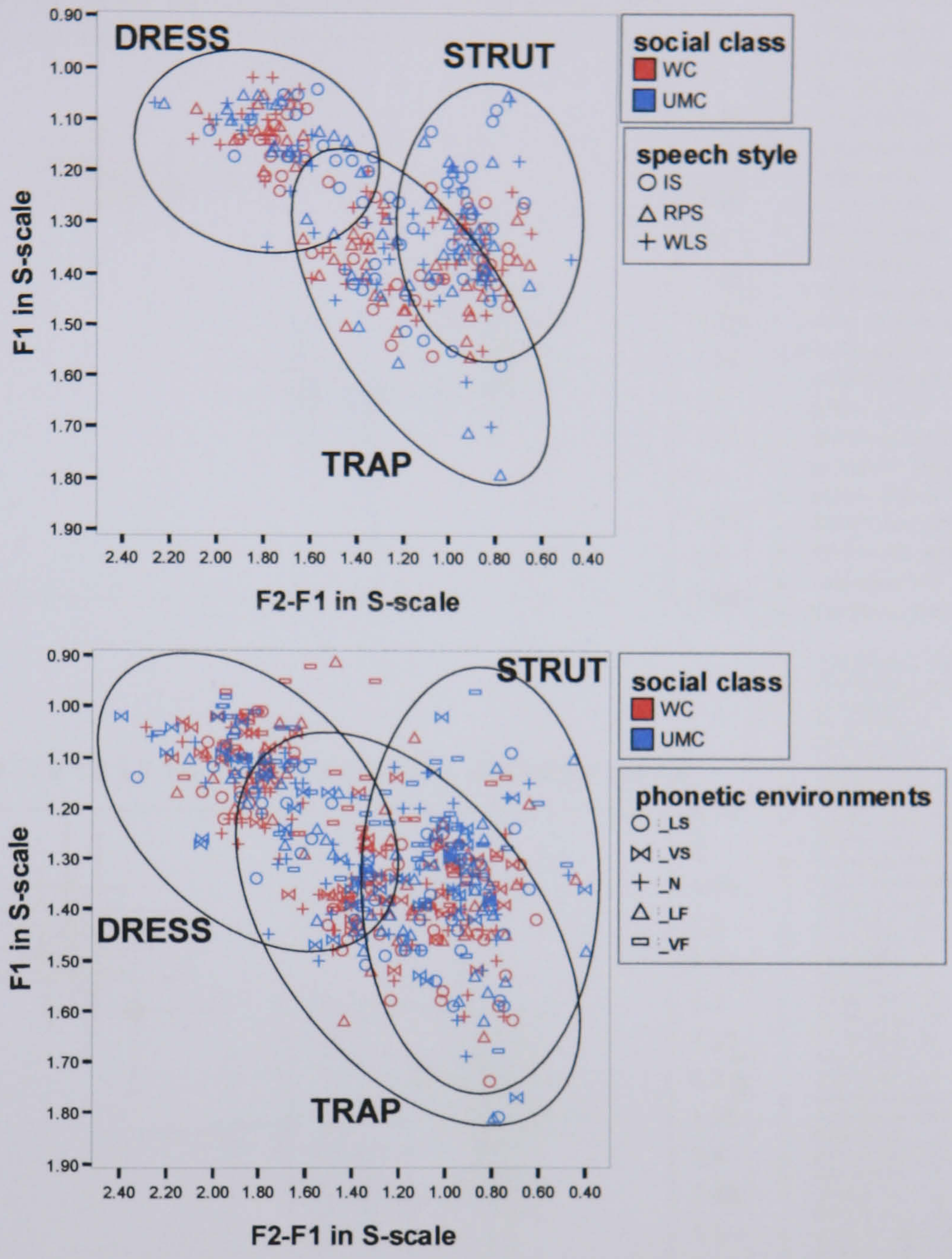


Figure 99 Mean distributions of DRESS, TRAP and STRUT vowels by social class for all 32 speakers in three speech styles for the entire data (above) and in five phonetic environments for the WLS data (below)

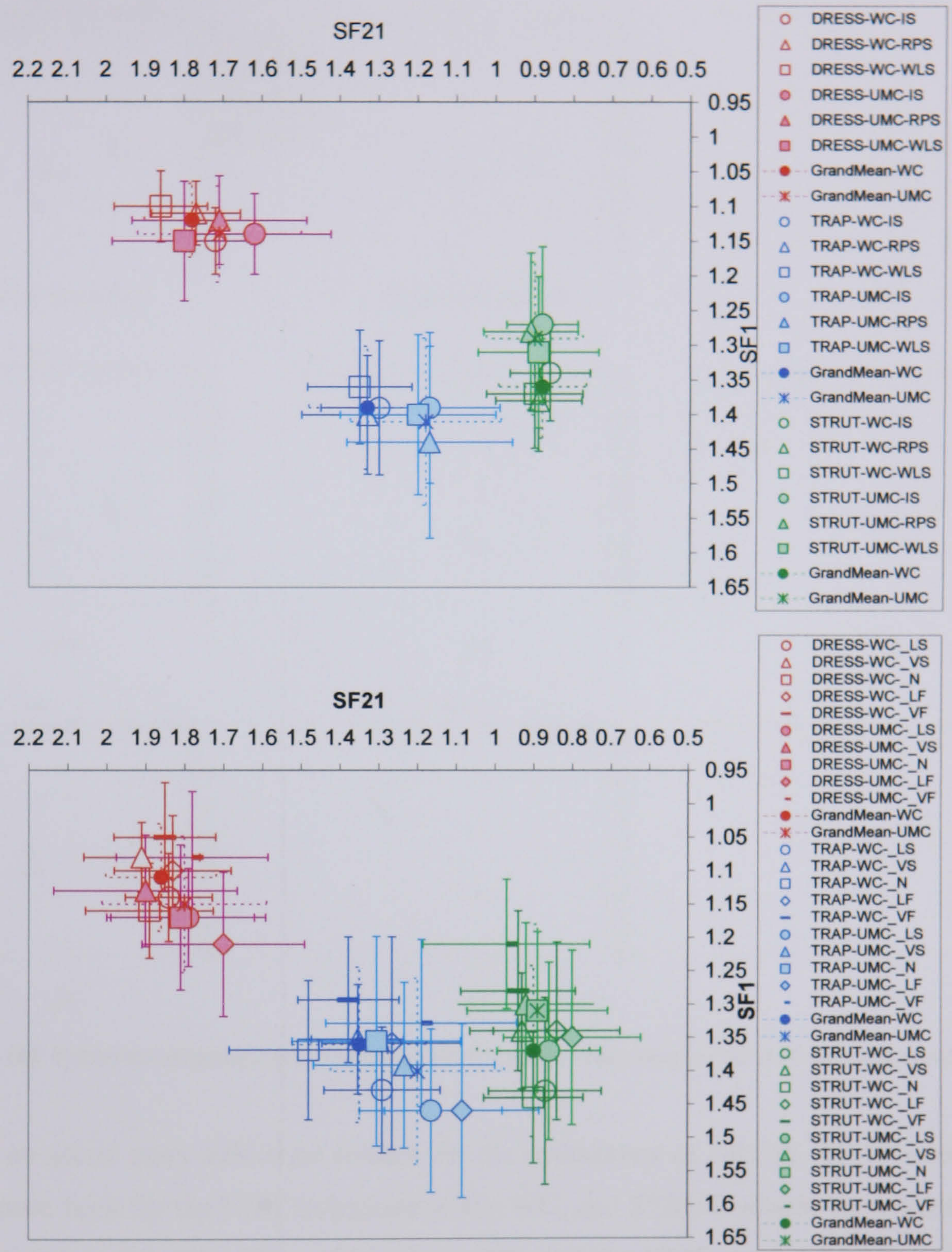


Figure 100 Grand mean distributions of the three vowels by social class and their SDs for speech styles (above) and for phonetic environments (below)

All these patterns are summarised in graphs in Figure 101;

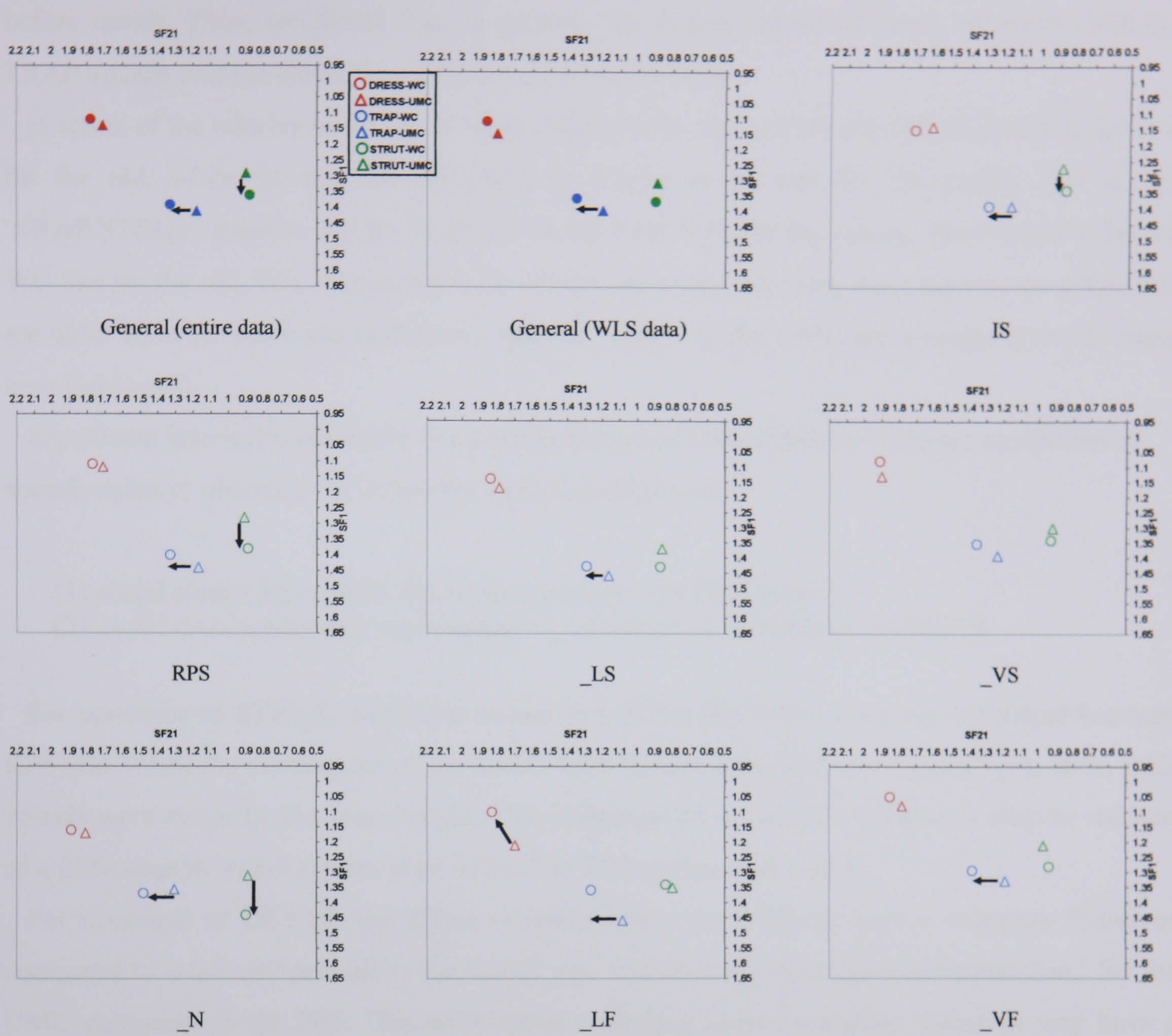


Figure 101 Patterns of means for three vowels by social class in general and in each condition

There was no social class difference evident for the realisations of DRESS. TRAP vowels were generally more back for the UMC compared to the WC, and STRUT vowels were closer for the UMC compared to the WC. This effect of the WC and the UMC on the TRAP and STRUT vowels looks similar to the effect of the old and the young. Looking at more detailed patterns for each condition of speech styles, the effect of social class on TRAP vowels is observed regardless of speech styles, whereas the effect on STRUT vowels is only observed in less formal speech styles. Therefore, similarly to the case in age comparison, these results may indicate that the general pattern for the TRAP (i.e. more back realisations for the UMC compared to the WC) is more fixed, whereas the general pattern for the STRUT (i.e. closer realisations for the UMC compared to the WC) is more varied. This notion can again be enhanced by the patterns in each phonetic environment in the WLS; the general pattern of the TRAP vowels was observed in all the environments but one (i.e. _VS), but the general pattern of the STRUT vowels was found only before nasals. Thus, we found that, in general. the higher the social class, the more back the TRAP vowels and the closer the STRUT vowels in our data.

In terms of the relative positions of these three vowels, the one for the WC is similar to the one for the old, while the one for the UMC is similar to the one for the young; that is, the 'TRAP/STRUT' rotation can be observed for the UMC like for the young, while it is not for the WC like for the old. This may possibly be interpreted in the following way; the vowels of the WC are older style (or more old-fashioned), and the vowels of the UMC are younger style (or more new-fashioned).

Significant interactions possibly due to different social class effect for different conditions of speech styles or phonetic environments were found between:

(1) social class x style (RPS-WLS) for openness of STRUT, and
(2) social class x phonetic environments (_LF-others) for openness of DRESS.

For openness of STRUT, while the realisations of the WC were relatively consistent between RPS and WLS, the realisations of the UMC were significantly different especially in RPS; their vowels were closer in this speech style. This indicates that social class difference may be realised as a difference in vowel openness of STRUT in RPS compared to WLS.

For openness of DRESS, the effect of social class was different before voiceless fricatives compared to other environments; the vowel was significantly more open and centralised for the UMC compared to the WC. This social class difference before voiceless fricatives may have a social significance, indicating more open DRESS which seems to be associated with UMC is expressed most in this particular phonetic environment (_LF).

6.5.6 By social groupings

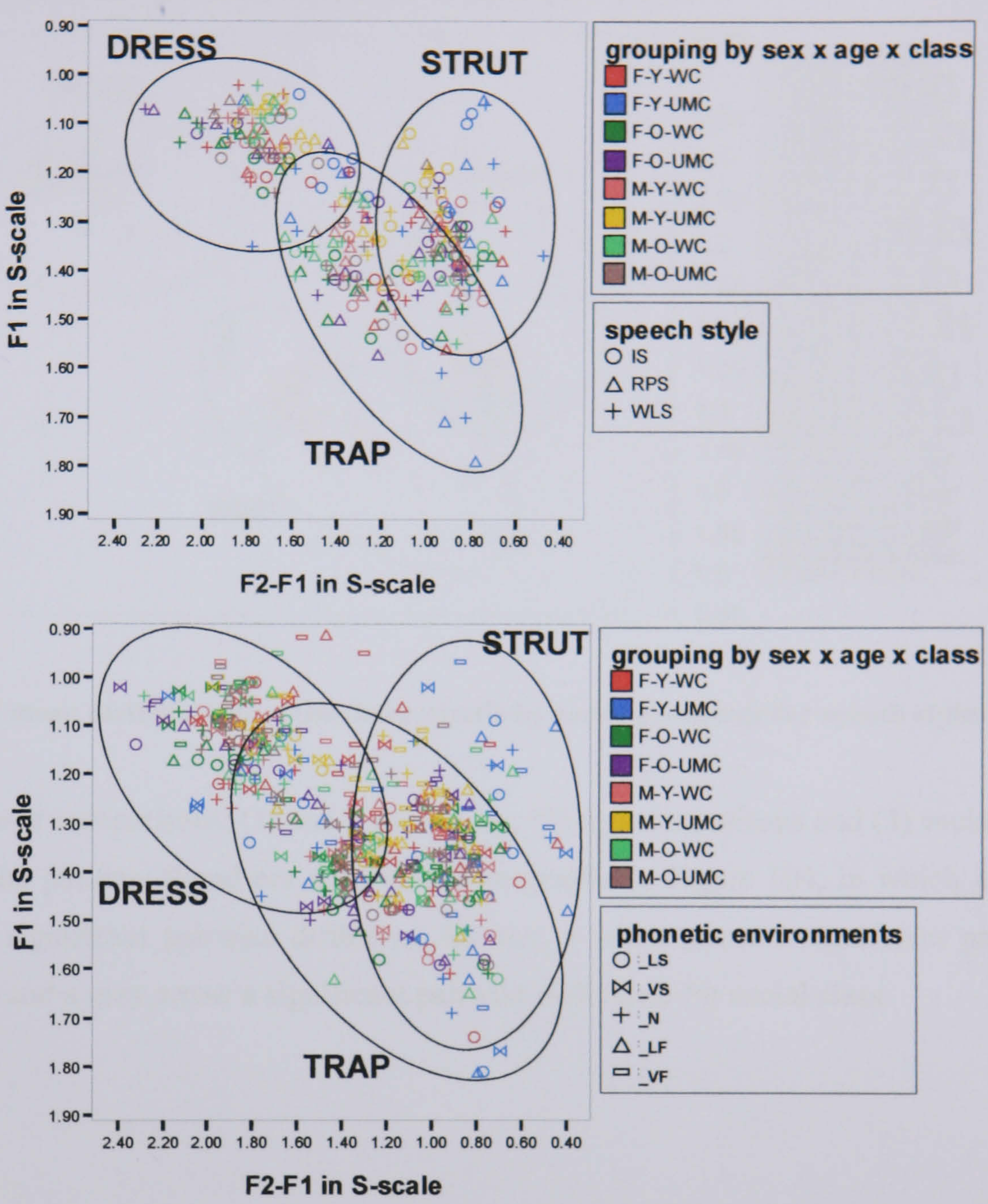


Figure 102 Mean distributions of DRESS, TRAP and STRUT vowels by social groupings for all 32 speakers in three speech styles for the entire data (above) and in five phonetic environments for the WLS data (below)

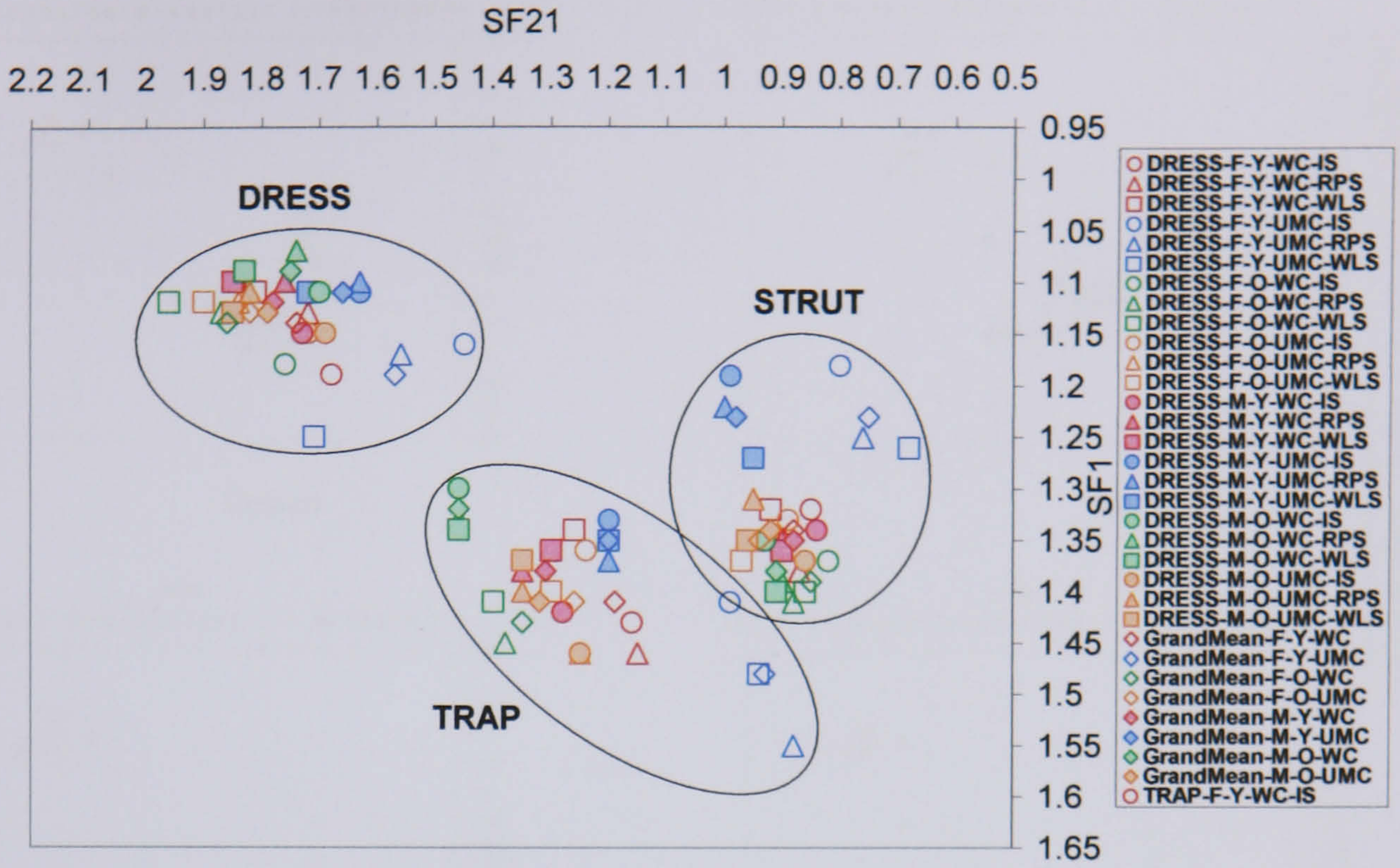


Figure 103 Grand mean distributions of the three vowels by social groupings for speech styles (left)

Focusing on the three comparisons: (1) sex comparisons, (2) age comparisons and (3) social class comparisons, all the patterns found are summarised in graphs in Figure 104, in which a black arrow indicates a significant pairwise difference for sex, a white arrow a significant pairwise difference for age, and a grey arrow a significant pairwise difference for social class:

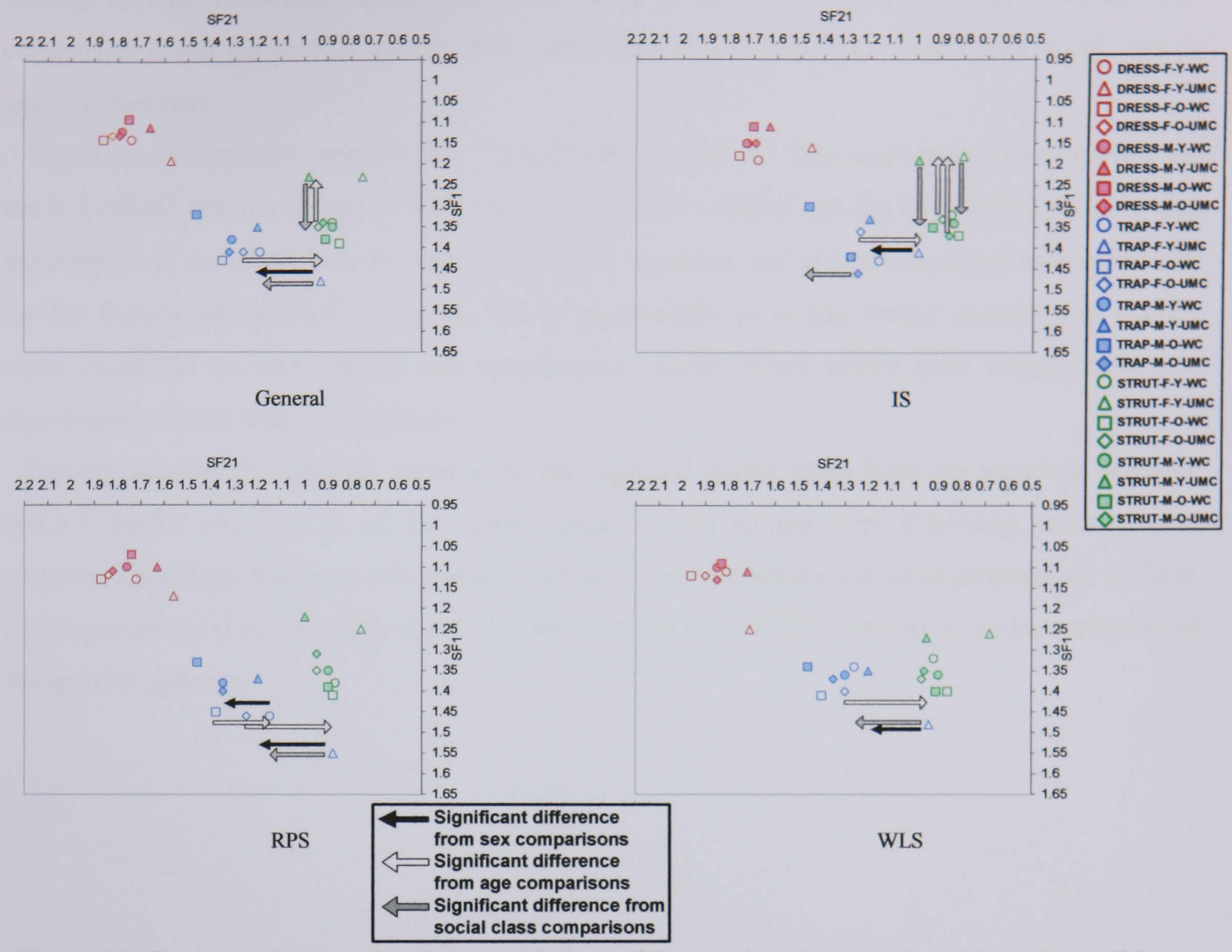


Figure 104 Patterns of means for three vowels by social groupings in general and in each condition

Firstly for DRESS vowels, although the mean of the F-Y-UMC apparently looks more open and back in Figure 104, there was no significant effect of social groupings, indicating that none of the groups were different from their counter groups in terms of sex, age and social class differences. Secondly for the TRAP vowels, there was a significant effect of social groupings on vowel frontness; above all, the F-Y-UMC generally had more back TRAP vowels than the M-Y-UMC (as a sex comparison), than the F-O-UMC (as an age comparison) and than the F-Y-WC (as a social class comparison) and most of these patterns were found in each speech style. The F-Y-WC also had more back realisations than the M-Y-WC (as a sex comparison) in the RPS and than F-O-WC (as an age comparison). Lastly for the STRUT vowels, there was a significant effect of social groupings on the vowel openness in general and in the spontaneous speech style. In general, the F-Y-UMC had closer realisations than the F-O-UMC (as an age comparison), and the M-Y-UMC had closer realisations than the M-Y-WC (as a social class comparison). These patterns were equally true in the IS. In this speech style, there were a few more significant results identified in relation to these two groups, i.e. the F-Y-UMC and the M-Y-UMC; that is, the vowels for the F-Y-UMC were also closer than those for the F-Y-WC (as a social class comparison), and the vowels for the M-Y-UMC were closer than those for the M-O-UMC (as an age comparison).

These results revealed more for the 'TRAP/STRUT rotation'. The more back TRAP vowels for the F-Y-UMC and the closer STRUT vowels for the F-Y-UMC and the M-Y-UMC indicate that the rotation is especially true for the young UMC speakers, and also more remarkable especially for the female young UMC speakers. This is particularly so in less formal spontaneous speech style compared to more formal non-spontaneous speech styles where their vowels were not significantly closer than other groups.

Having recalled the general patterns of sex, age and social class from the previous sections (§6.5.3, §6.5.4 and §6.5.5), all the results found in this section were following those general patterns. Therefore, those general patterns that we found previously are more pronounced to these social groupings (i.e. especially the F-Y-UMC and the M-Y-UMC), or may even be attributed to the general patterns.

7 Results of Apparent-time Comparisons

7.1 Apparent-time age comparisons within London UMC and London WC

Although we have already investigated age-comparisons in general and in each condition of speech styles and phonetic environments above (§6.4.1.4, §6.4.2.4, §6.4.3.4, §6.4.4.4, §6.4.5.4, §6.4.6.4, §6.4.7.4, §6.4.8.4, §6.4.9.4, §6.5.4), what is still not entirely clear is the difference between the young and the old within each of London UMC and London WC, or the difference of each sex within each age group of each accent group. This chapter, therefore, will be dedicated to further apparent-time age comparisons firstly by the two accent groups (i.e. London UMC and London WC) and then by their respective sex groups.

Statistical tests were conducted on mean values of individual speakers in three different speech styles. The following multiple 1-way ANOVA tests were conducted for each of SF1 and SF21 of each vowel:

TEST Set-3: multiple 1-way ANOVAs with age factor
Test-3-1 (T31): 1-way ANOVA within London WC (Y-WC vs. O-WC)
Test-3-2 (T32): 1-way ANOVA within female London WC (Y-F-WC vs. O-F-WC)
Test-3-3 (T33): 1-way ANOVA within male London WC (Y-M-WC vs. O-M-WC)
Test-3-4 (T34): 1-way ANOVA within London UMC speakers (Y-UMC vs. O-UMC)
Test-3-5 (T35): 1-way ANOVA within female London UMC speakers (Y-F-UMC vs. O-F-UMC)
Test-3-6 (T36): 1-way ANOVA within male London UMC speakers (Y-M-UMC vs. O-M-UMC)

Since there were two dependent variables (SF1 and SF21) for three vowels, these tests were repeated six times in total. In each case, the point of interest is whether there is an association between variables. All the graphs in this chapter represent vowel plots of mean values for each vowel in each age and social (and sex) group; dotted and bold ellipses surrounding vowel means represent their Standard Distributions (SDs) for young speakers and old speakers respectively. An arrow indicates a significant result in terms of openness (by a vertical arrow), frontness (by a horizontal arrow), and combination of both (by a diagonal arrow) in the same way as explained earlier (§6.4.3.1). All the raw mean data and the statistical details are provided in Appendix 11.

7.2 Changes in London WC (T31) and London UMC (T34)

Apparent-time changes of DRESS, TRAP and STRUT vowels are compared between London WC (T31) and London UMC (T34). Figure 105 is the plot for change in London WC (Y-WC vs. O-WC), while Figure 106 is the plot for change in London UMC (Y-UMC vs. O-UMC):

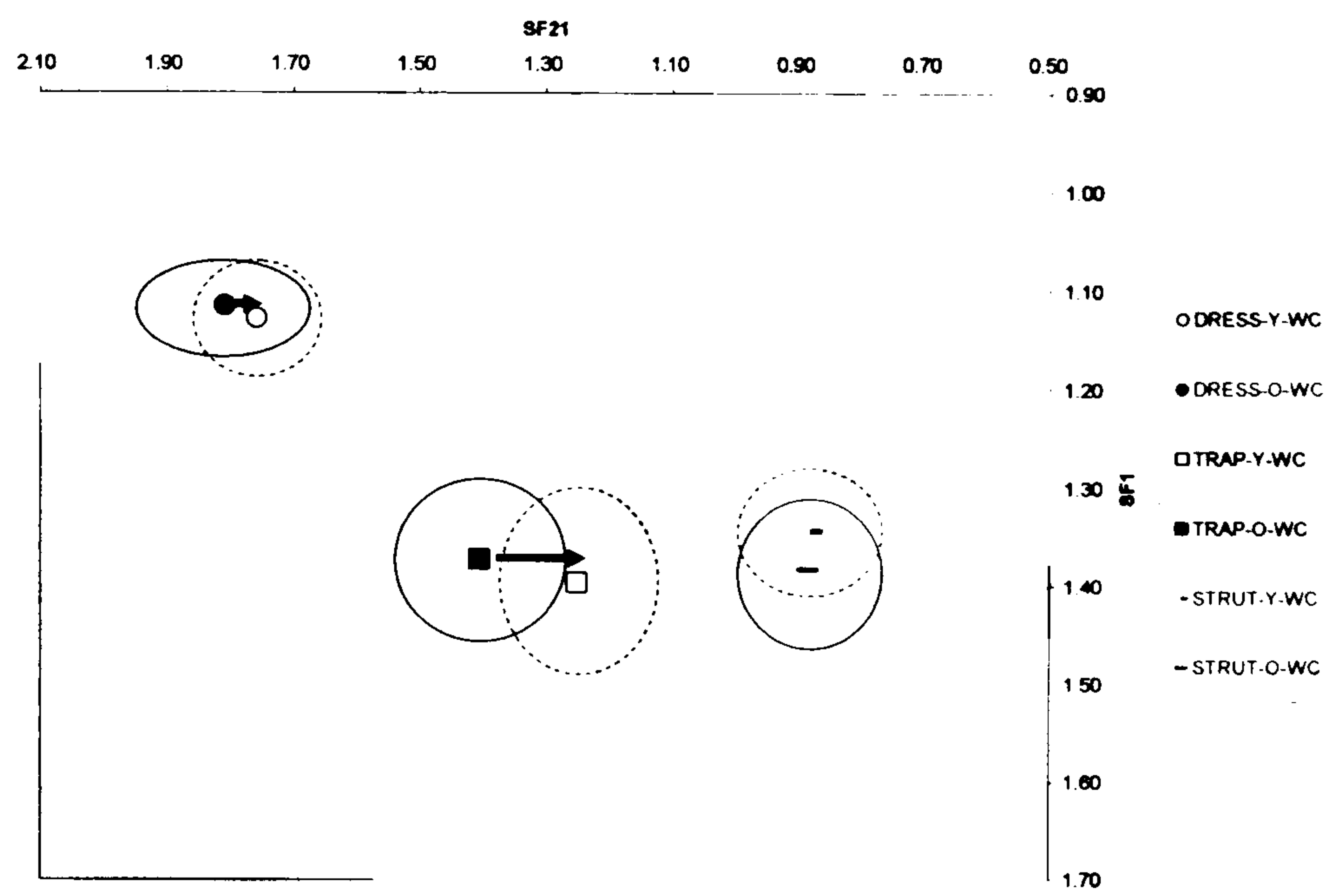


Figure 105 S-scaled F1/F2-F1 plot for the young and the old within London WC

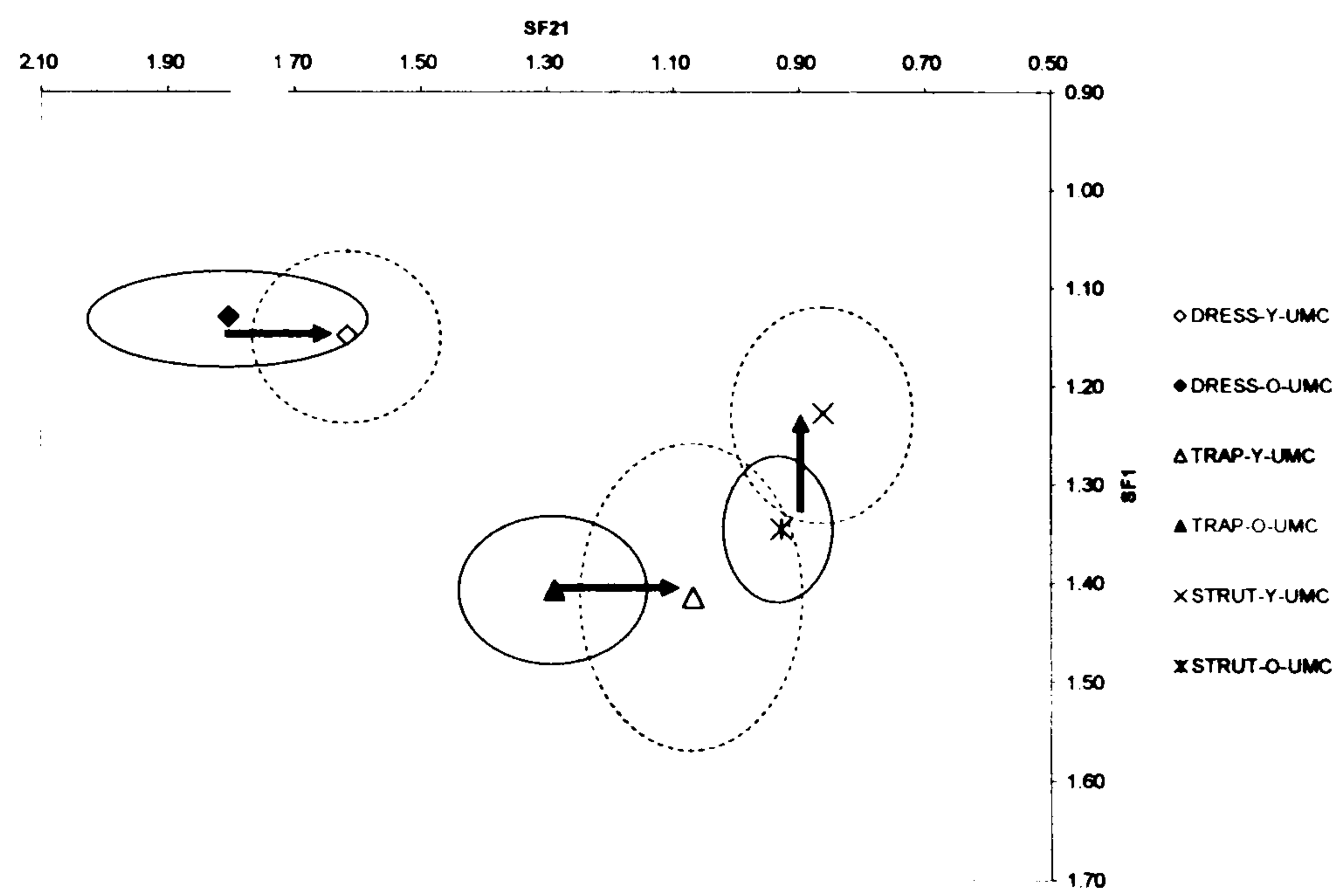


Figure 106 S-scaled F1/F2-F1 plot for the young and the old within London UMC

Significantly lower SF21 values for DRESS in the speech of younger speakers of both groups indicate that this vowel is backing in both London WC ($F(1, 46)=2.074$, $p<0.05$) and London UMC ($F(1, 46)= 11.718$, $p<0.01$). What the figures above show is firstly that the vowels for the old speakers in both groups are almost identical although the one of the London UMC shows a greater spread in the dimension of vowel frontness. Secondly, unlike the old speakers, the vowels for the young speakers are much more back for the London UMC than for the London WC, indicating backing is more advanced among the London UMC speakers. There is no indication of vertical movement for this vowel in either group.

Similar backing is also found for the TRAP vowels in both groups: $F(1, 46)=17.021$, $p<0.001$ for the London WC, $F(1, 46)=22.344$, $p<0.001$ for the London UMC. Again, the young London UMC speakers show much more advanced TRAP vowels than the old London UMC speakers whose TRAP is similar to the one for the young London WC speakers. The old London WC speakers show the most peripheral, frontest realisations. Like DRESS, there is no indication of vertical movement for this vowel in either group.

Turning to STRUT vowels, London UMC speakers, on the one hand, show a significantly lower SF1 value among the young compared to the old ($F(1, 46)=18.824$, $p<0.001$), indicating that this vowel is moving up within London UMC. Looking at the relevant parts in Figure 106, the vowel for the young looks not only closer, but also slightly more back; however, this difference proves to be statistically non-significant ($F(1, 46)=3.641$, $p=0.063$). London WC speakers, on the other hand, do not show any statistically significant movement across two generations, with the STRUT vowels for both young and old speakers located in a lower and back position, behind the TRAP vowel.

In summary, the backing of DRESS and TRAP that we had previously found as the general pattern (Figure 98) is true for both London WC and London UMC, and the degree of backing for these two vowels is greater for the London UMC than for the London WC. The general rising of STRUT that had previously been found (Figure 98) is in fact only true for the London UMC.

The results here disregard sex difference in both groups. In the following sections, therefore, we will further examine the difference between sexes within London WC and London UMC.

7.3 Changes in female London WC (T32) and male London WC (T33)

Figure 107 is the plot for change in female London WC (Y-F-WC vs. O-F-WC), while Figure 108 is the plot for change in male London WC (Y-M-WC vs. O-M-WC):

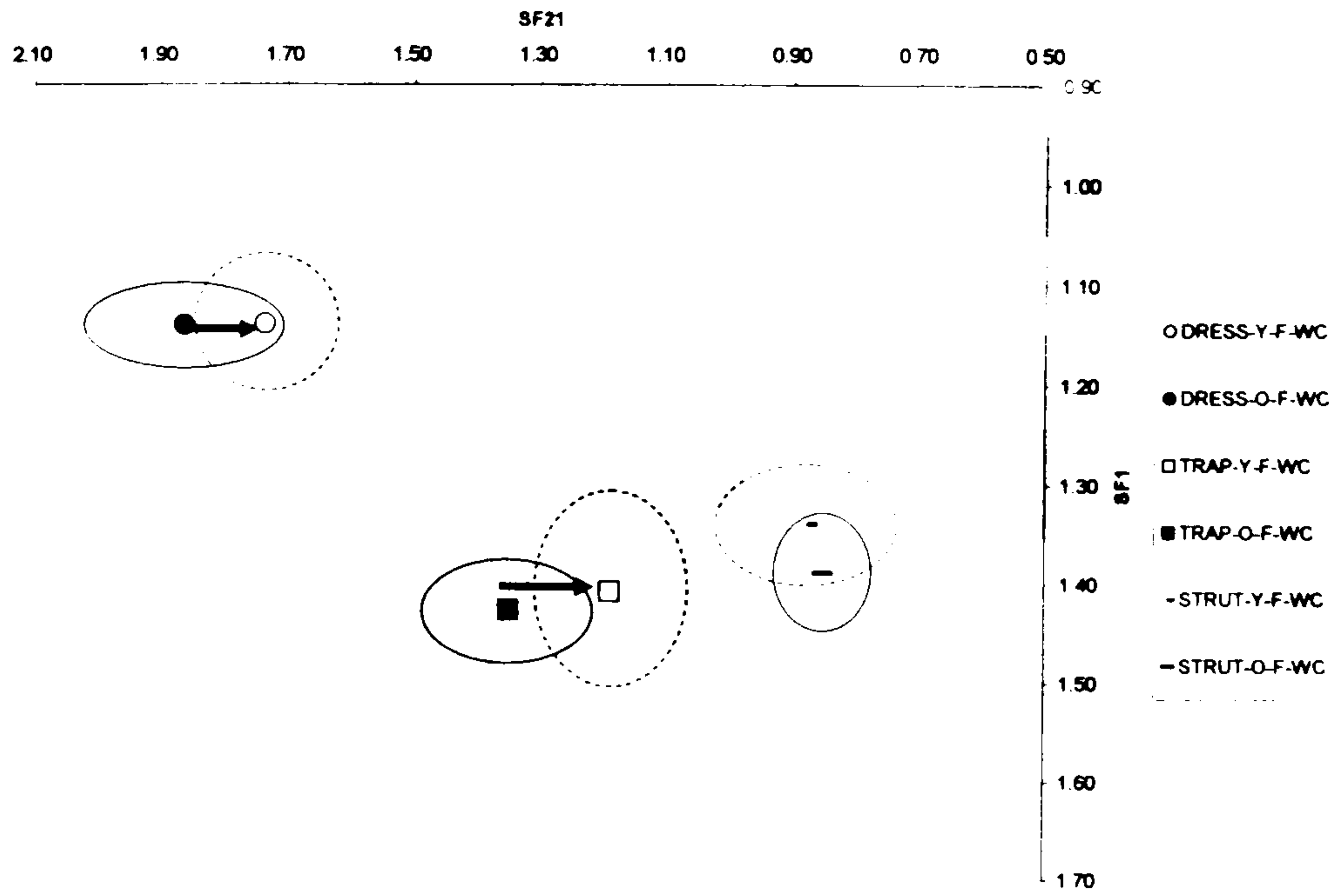


Figure 107 S-scaled F1/F2-F1 plot for the young and the old within female London WC (F-WC)

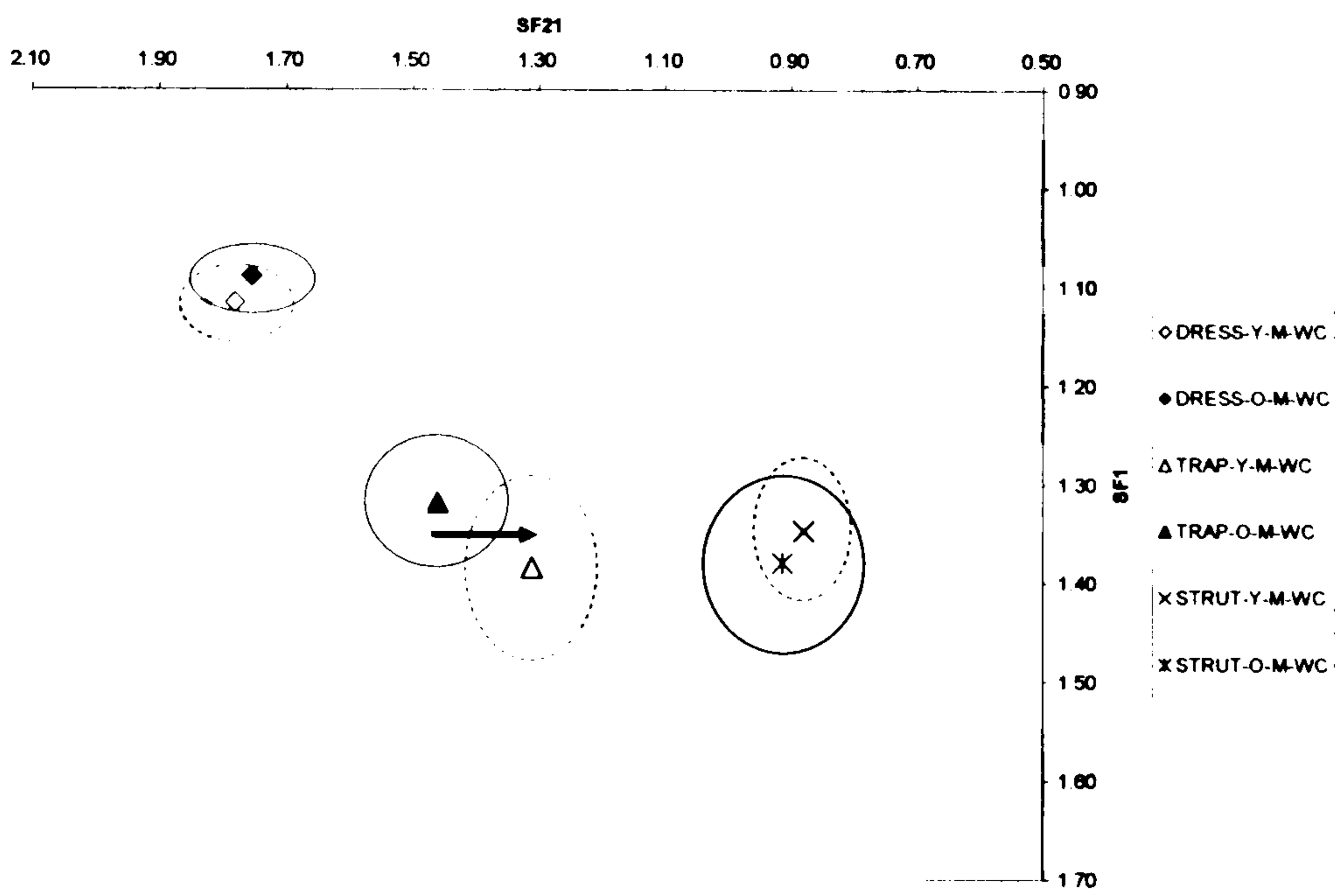


Figure 108 S-scaled F1/F2-F1 plot for the young and the old within male London WC (M-WC)

As is clear from the figures, the significant backing of DRESS is only observed among the female London WC ($F(1, 22)=5.247$, $p<0.05$). Male London WC speakers do not show such a backing, however, their realisation and distribution is rather centralised, being located in the position closer to the centralised realisation of the Y-F-WC.

Backing of TRAP is very significant for both female and male groups: $F(1, 22)=9.403$, $p<0.01$ for F-WC, $F(1, 22)=11.398$, $p<0.01$ for M-WC. Comparing distribution of this vowel between female and male speakers, those of the females are more back than those of the males. Moreover, the old female speakers apparently have lower realisations than the old male speakers. The TRAP of the Y-M-WC is also slightly more lowered than the O-M-WC, although it is found to be slightly above significance level, $F(1, 22)=3.890$, $p=0.061$.

No significant movement across generations for STRUT found in the previous section is again observed for all London WC speakers, although the mean values for the young speakers look slightly higher than those for the old speakers. This confirms the stableness of this vowel for London WC speakers.

7.4 Changes in female London UMC (T35) and male London UMC (T36)

Figure 109 is the plot for change in female London UMC (Y-F-UMC vs. O-F-UMC), while Figure 110 is the plot for change in male London UMC (Y-M-UMC vs. O-M-UMC):

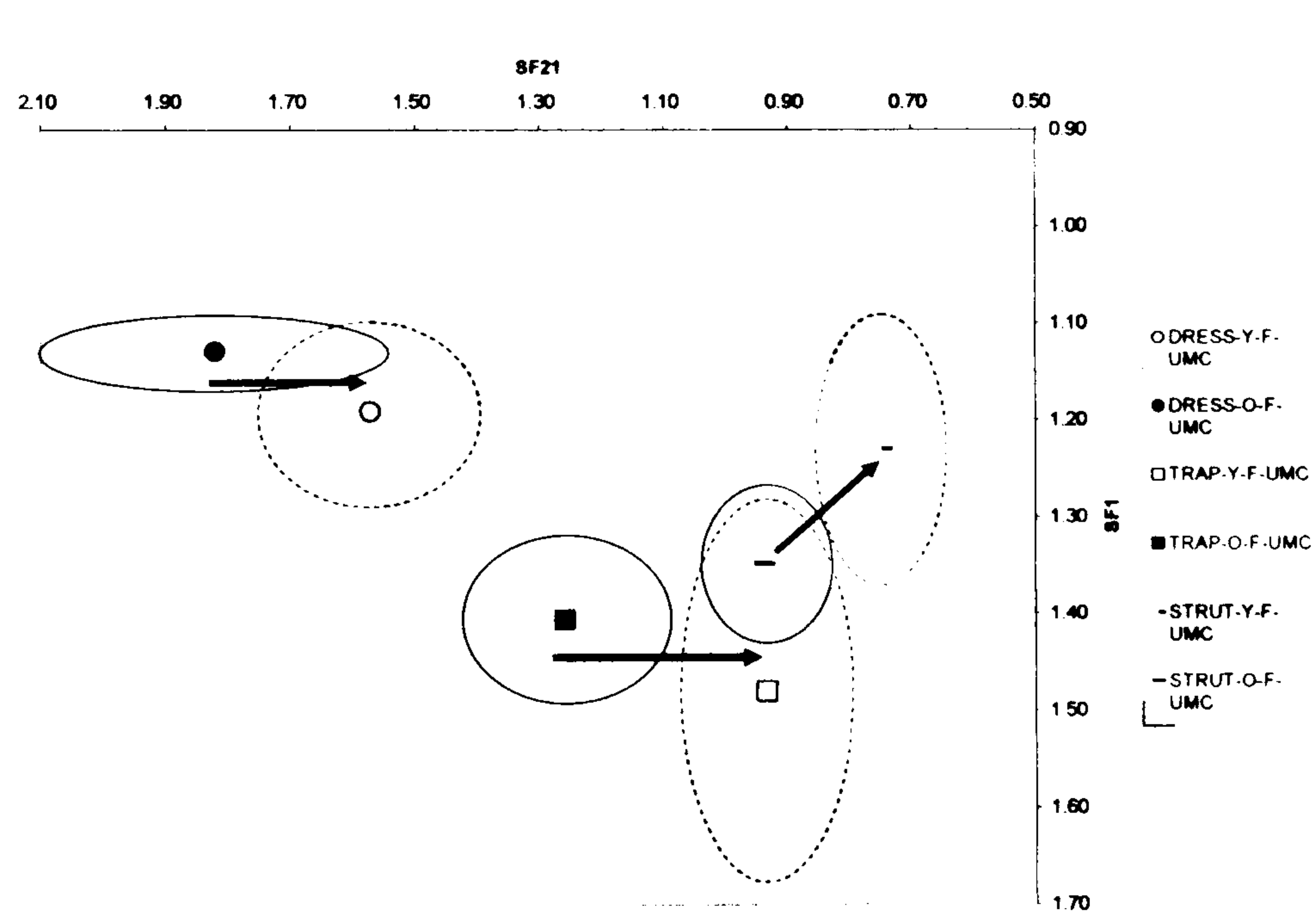


Figure 109 S-scaled F1/F2-F1 plot for the young and the old within female London UMC (F-UMC)

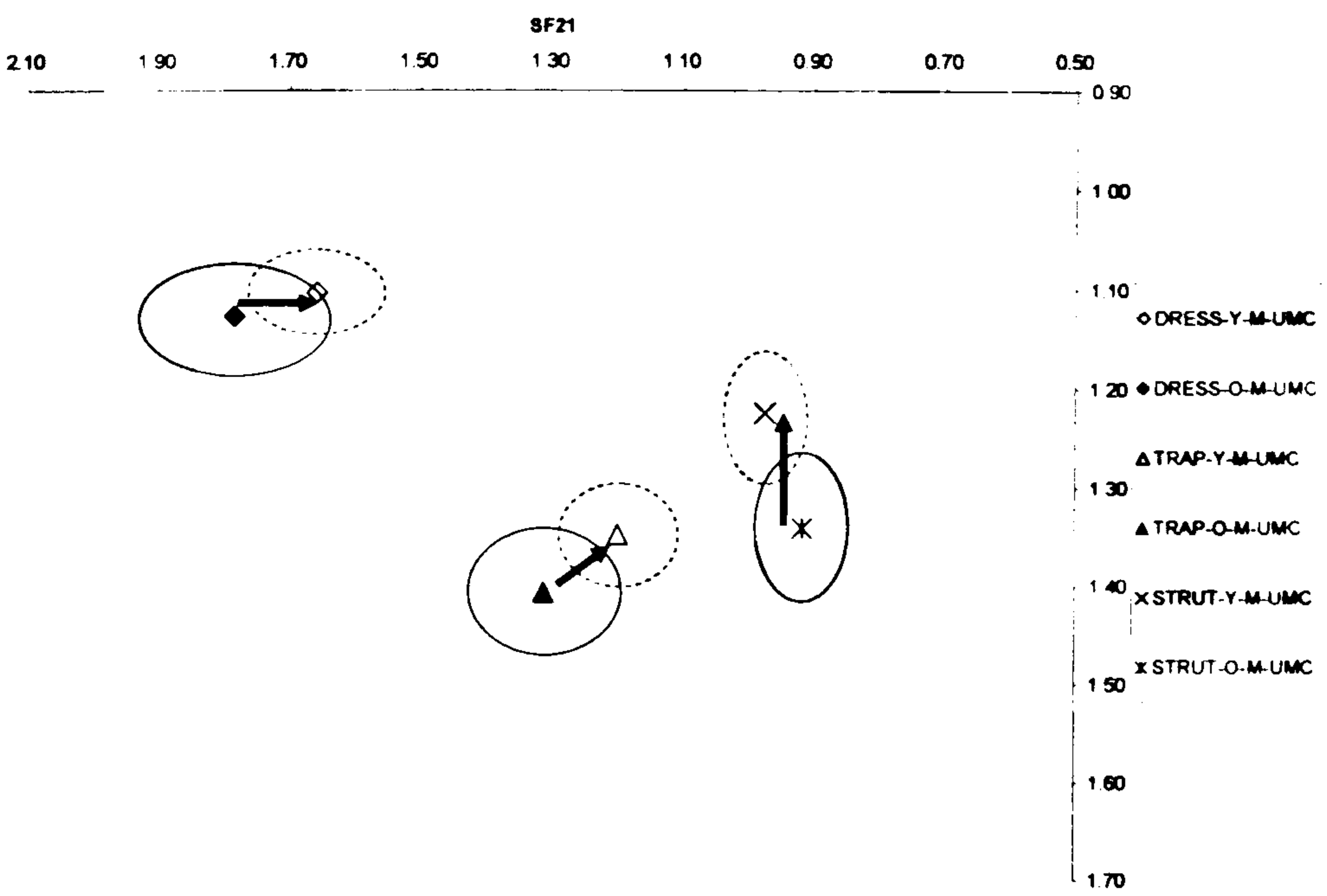


Figure 110 S-scaled F1/F2-F1 plot for the young and the old within male London UMC (M-UMC)

The figures clearly show significant backing of DRESS for both female and male London UMC speakers: F(1, 22)=6.609, p<0.05 for the F-UMC, F(1, 22)=5.766, p<0.05 for the M-UMC. Comparing changes between the females and the males, the degree of backing is apparently more advanced for the female group, whose DRESS is also slightly lowered which, however, does not reach significance level, F(1, 22)=4.224, p=0.052.

Similarly, the backing of TRAP is also significant for both female and male London UMC speakers: F(1, 22)=27.420, p<0.001 for the F-UMC, F(1, 22)=7.175, p<0.05 for the M-UMC. Again, the degree of backing is apparently more advanced for the female group to the extent that the distribution of the TRAP vowel for the Y-F-UMC approaches and overlaps with the distribution of the STRUT vowel for the O-F-UMC. The TRAP of the Y-F-UMC is also slightly lowered, although it proves to be non-significant, F(1, 22)=1.423, p=0.246. Contrary to the female group, the TRAP of the M-UMC is significantly moving upwards (i.e. lower SF1 for the Y-M-UMC than the O-M-UMC), F(1, 22)=5.720, p<0.05. Thus, the direction of the shift for the TRAP vowel is found to be slightly different for the female and male London UMC speakers: backing (and possibly lowering) for the female, backing and rising for the males.

As with the general tendency for the London UMC, the rising of STRUT is equally significant for both female and male speakers: F(1, 22)=6.258, p<0.05 for the F-UMC, F(1, 22)=16.473, p<0.001 for the M-UMC. The STRUT of the F-UMC is also very highly significantly moving backwards (i.e. lower SF21 for the Y-F-UMC than the O-F-UMC), F(1, 22)= 19.211, p<0.001.

The STRUT of the Y-M-UMC looks slightly more front (i.e. centralised)[59], although it turns out to be slightly above significance level, $F(1, 22)=4.268$, $p=0.051$. Thus, the direction of the shift for the STRUT vowels is found to be slightly different for the female and male London UMC speakers: backing and rising for the female, rising (and possibly centring) for the males.

7.5 Summary and discussions

In this section all the vowel changes observed above are overviewed and discussed in a comprehensive manner. The discussion will also extend to their possible explanations and implications with regard to internal and external factors.

The vowel changes in all groups are summarised in Table 92 and diagrammed in Figure 111:

Table 92 Summary of vowel changes from apparent-time investigations

	DRESS	TRAP	STRUT
London English	Backing	Backing	Raising
London WC	Backing	Backing	-
Female only	Backing	Backing	-
Male only	-	Backing (& lowering)	-
London UMC	Backing	Backing	Raising
Female only	Backing (& lowering)	Backing (& lowering)	Raising & Backing
Male only	Backing	Backing & Raising	Raising (& fronting)

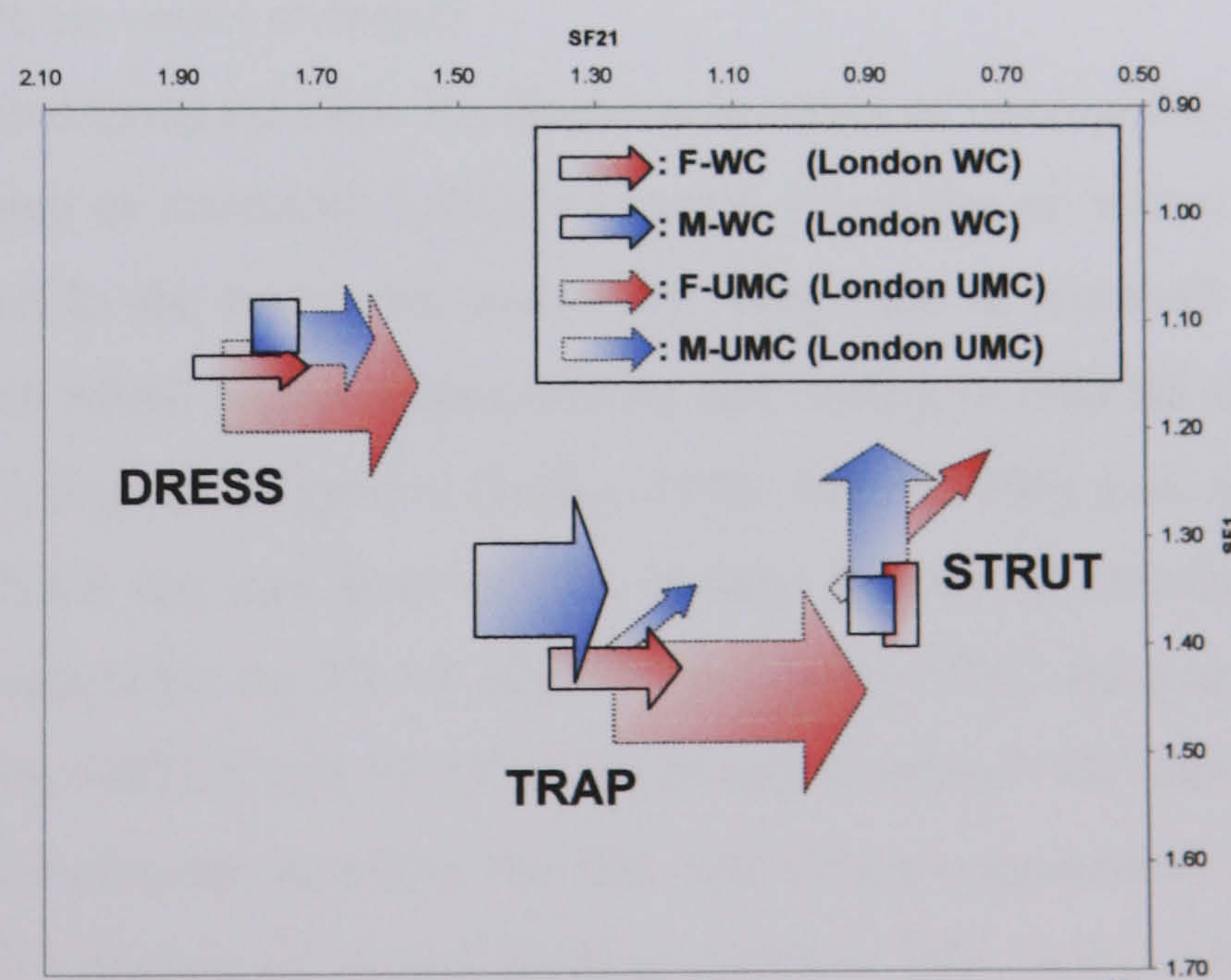


Figure 111 DRESS, TRAP and STRUT changes[60]

[59] This is consistent with Fabricius's (2007) real-time study of the short vowels of (mainly male) RP speakers.

[60] In the figure, arrows in solid lines and arrows in dotted lines indicate statistically-significant difference between old and young speakers for the London WC and for the London UMC respectively: therefore,

DRESS is backing except for the male London WC speakers whose DRESS vowel seems to be settled in the slightly centralised area with a small variability in both SF1 and SF21 dimensions. Particularly remarkable is the backing of this vowel for the female London UMC speakers who also show signs of lowering of this vowel.

Similarly, TRAP is backing both in London English as a whole and in all the subgroups, and again, the degree and progress of backing is the greatest for the female London UMC speakers with a greater variation in height. In both London WC and London UMC, the backing process is more advanced for the females compared to the males. Moreover, male London WC speakers show signs of TRAP lowering from closer and fronter position, while male London UMC speakers show TRAP raising (and backing) from more open and back position.

There is a noticeable difference in the changes of STRUT between London WC and London UMC. Unlike the literatures which suggest its lowering and fronting (Trudgill 2004) or its backing and raising (Torgersen *et al.* 2006), no evidence for shift in any direction is found for this vowel among the London WC speakers. For the London UMC speakers, however, there is a clear evidence of its raising. Moreover, it is also found that there is a difference in an SF21 dimension between the females and the males of the London UMC speakers: more back STRUT for the females, and possibly fronted (i.e. centred) STRUT for the males, the latter of which is in line with Fabricius's (2007) findings of backed, raised and centralised STRUT.

Now, what do these findings from the current apparent-time study imply with regard to internal and/or external factors for vowel changes?

Let us start with considering possible implications in terms of internal factors. First of all, how do these findings match or mismatch Labov's General Principles of Vowel Shifting? One clear fact is that, as argued in the recent literatures (cf. Torgersen & Kerswill 2004: 45), Labov's Pattern 4 chain shift in which he speculates tensing and raising of DRESS and TRAP in London English and in British English in general (Labov 1994: 208-11, 285) goes against the data here: both DRESS and TRAP are less fronting (i.e. laxing) instead of fronting (i.e. tensing) and evidence no raising (except for the TRAP of the male London UMC speakers) but show a sign of lowering at least for the DRESS and TRAP of the female London UMC and for the TRAP of the male London WC. Nonetheless, recalling the fact that Labov's suggestion is actually following his integrated General Principle of Vowel Shifting which is '[i]n chain shifts, peripheral vowels become less open and nonperipheral vowels become more open' (Labov 1994: 262), it is realised

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rectangles mean no significant difference observed between the old and the young speakers. Rough locations of the mean vowels are expressed by colour gradation within those arrows, from the lightest blue/red for the old males/females to the darkest blue/red for the young males/females: the exact locations can be referred to in the figures in §7.3 and §7.4.

that the present data may in fact fit well with the Principle, though in an opposite way from Labov's proposition. That is to say, although DRESS and TRAP in London are regarded as moving from 'nonperipheral' to 'peripheral' by Labov, the current data seem to suggest that they are moving from 'peripheral' (more front) to 'nonperipheral' (less front) across two generations. This should lead us, therefore, not to Labov's view of an upward movement of London short *tense* vowels (Labov 1994: 285), but to an opposite inference of a downward movement of London short *lax* vowels. If this is the case, the data presented here may be considered to be currently in the middle of this process, crossing into the nonperipheral track before lowering. In the case of STRUT vowels, raised and further backed realisations for the female London UMC speakers also fit well with this Principle; the vowel, which is originally a lax vowel, is moving from 'nonperipheral' (more central) to 'peripheral' (more back) across two generations, and raising along the peripheral track as described in the Principle. Following Labov's phonological space of peripheral and nonperipheral tracks (Labov 1994: 177), these possible changes for the female London UMC can be diagrammed as follows:

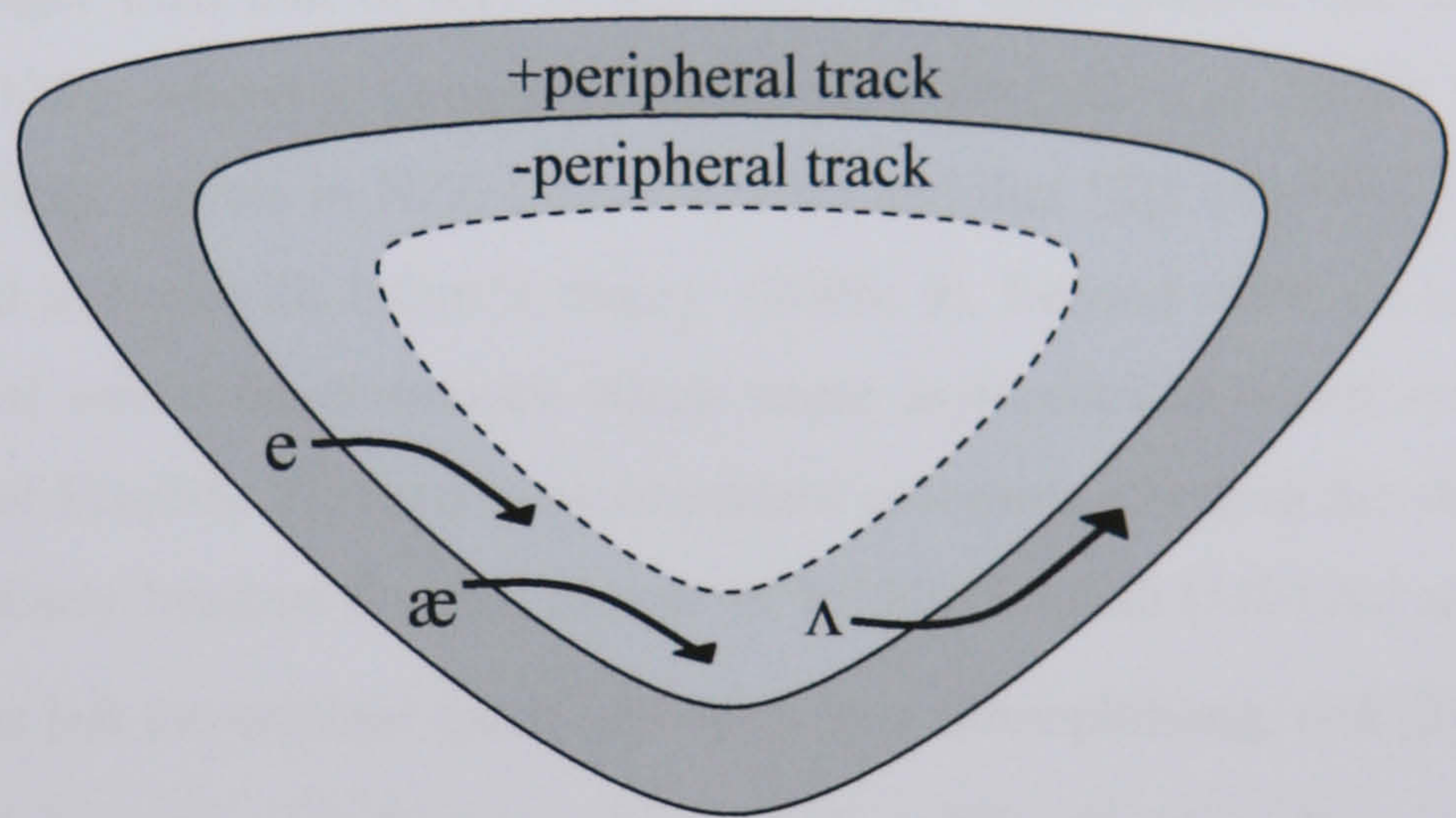


Figure 112 Possible Vowel Shift for the female London UMC according to Labov's integrated General Principle of Vowel Shifting (Labov 1994: 262)

In the case of the TRAP for the male London UMC speakers, however, this model does not perfectly fit since the vowel seems to be moving upward across generations despite its shift from more peripheral to nonperipheral area where they should in fact be lowered according to Labov's Principle. This mismatch, consequently, leads us to cast doubt on the validity of Labov's General Principles of Vowel Shifting. Labov, however, in fact admits that there are ultimately 'no directions of vowel shifting that are forbidden to speakers of human language', but adds that 'some directions', which are presumably those introduced as his General Principles of Vowel Shifting, are 'taken far more often than others' (1994: 116). In this view, it seems that the vowel change observed for the male London UMC speakers here needs to be treated as an exception in the framework of Labov's (1994) theory of directional vowel change. This centralisation of the TRAP for the male London UMC speakers will be discussed later in this section again.

Langstrof (2006) extensively discusses the issue on Labov's notions such as peripherality and tracks in relation to the raised DRESS and TRAP vowels in the upward push-chain short vowel shifts in New Zealand English (NZE). His data from 30 NZE speakers born between the 1890s and 1930s reveal raising of the DRESS and TRAP vowels across generations (Langstrof 2006: 71-2). Given that DRESS and TRAP, together with KIT, STRUT, LOT and FOOT, are phonotactically lax/short (hence nonperipheral) vowel for they cannot appear in free stressed syllables, the raising of these two vowels is unexpected for the Labov's theoretical framework as in the case of TRAP for the male London UMC. Langstrof shows a number of evidence that these two vowels pattern differently from the other lax/short vowels to assume that their status is rather 'indeterminate' (2006: 244) with respect to the notions such as track and peripherality. First evidence comes from his durational analysis. The duration of the DRESS and TRAP is found to be significantly longer than that of KIT which undergoes centralisation and lowering in NZE (Langstrof 2006: 120), whereby Langstrof argues that DRESS and TRAP have undergone reinterpretation as long vowels in NZE (2006: 9, 291) and that '[i]f this view is accepted, their behaviour is indeed in line with Labov's theory' (2006: 9). Second evidence is derived from a number of historical vowel developments which cause asymmetrical vowel system in most of Standard varieties of English. The two most important processes affecting the short front vowels of English are (1) Early Modern English merger of Middle English (ME) /eː/ and /ɛː/ on a high vowel /iː/ which has left the original space without a long monophthong, and (2) the lowering of ME /ʊ/ to /a/ which has caused a further asymmetry by adding another short vowel to the front series (Langstrof 2006: 8, 235-7). These historical processes bring about a rather untypical situation for DRESS and TRAP; that is, whereas the other lax/short vowels all have counterparts in the set of tense vowels, the DRESS and TRAP vowels do not have (Langstrof 2006: 242). In this context, Langstrof demonstrates another piece of evidence based on phonological aspect. Recognising [+/- peripheral] as a feature, TRAP and DRESS are demonstrated to be the only vowels in the overall system which do not have a counterpart sharing all other features, i.e. [+/- low], [+/- back] and [+/- high], except this one (cf. 2006: 242-3). Deriving from Labov's principle VII (Labov 1994: 285, cf. §3.1 above) that 'peripherality is not an absolute position of some element in a vowel system, but is meaningful only if a given vowel can be paired with another vowel of opposite peripherality' (Langstrof 2006: 232), Langstrof argues that the concepts of track and peripherality are valid only in the regions of the vowel space where a pair of vowels, which we can assign to two different tracks, i.e. peripheral or nonperipheral tracks, exists (2006: 244). In this view, neither DRESS nor TRAP succeeds in being paired with another vowel of opposite peripherality for historical and phonological reasons. Then it is concluded that 'this part of the vowel space is unstructured in terms of tracks and peripherality, and that the status of the vowels in that region is *indeterminate* with respect to these categories' (Langstrof 2006: 244, with his original emphasis). This leads him to argue that the notions such as track should be relaxed or ultimately abandoned in order to explain the historical developments of complex vowel systems (2006: 9, 244). Subsequently he proposes a model in which chain shifts can be understood by the increase of distance (which in turn decreases overlap or potential confusion) between vowel distribution (Langstrof 2006: 244, 273). An important point in this model is that the notion of 'distance' he means is a function of more than two phonetic dimensions for which he includes not only formant frequencies (F1/F2) but also vowel duration and diphthongisation (containing two dimensions, i.e. both spectral changes in F1 and F2) which he claims contribute to the location of a given vowel in vowel space (2006: 264).

Although discussions on applicability of suggested Langstrof's (2006) model which involves a multidimensional vowel space is far beyond the current research, a further investigation which takes into account other phonetic dimensions may reveal a rather clearer picture for the internal mechanism of the observed movement for the three short vowels in London, in which duration, for example, may possibly play an important role. As implied by Langstrof's empirical investigations, the key question for the Labov's Principle seems to be: with what evidence do we judge whether or not a vowel is peripheral? As far as this question remains unanswered, the Principle may as well be considered as a generalised fact rather than a theory.

Now let us consider the possible explanations for the observed vowel changes over the acoustic SF1/SF21 vowel space (cf. Figure 111) from a structural point of view. As a whole, on the one hand, the London UMC speakers generally show an anticlockwise chain shift which involves all the three short vowels examined here. The London WC speakers, on the other hand, do not show evidence for such a chain shift which involves all the three vowels; instead, the shifts are only observed in their front vowels. Therefore, the vowel changes commonly observed for both groups are those for their front vowels. This should remind us of the southeastern drag chain shift which, according to Trudgill (2004: 42-3, cf. §4.5 above), involves three front vowels; i.e. lowering of TRAP (1st stage), lowering of DRESS (2nd stage) and lowering of KIT (3rd stage). Although the situation of KIT is not known from the current data, and the shifts observed here for DRESS and TRAP is 'backing' rather than 'lowering', the speakers in the current study seem to be experiencing a similar drag-chain shift which is initiated by the backing of TRAP followed by the backing of DRESS. In this respect, it should be remembered that the similar backing, but not lowering, of TRAP and DRESS is observed among the Anglo speakers from Havering in the London study of Torgersen *et al.* (2006: 259, cf. 4.5). If this is tentatively understood as a modified version of Trudgill's drag-chain shift (which will be called 'modified drag-chain shift' hereafter), it appears that the speakers in London are now experiencing up to at least the second stage of this modified drag-chain shift, which is in fact in accordance with Trudgill's (2004: 43) proposition for modern Cockney. There seems to exist, however, a great deal of difference in the degree of this modified drag-chain between London WC and London UMC; that is, the backing of TRAP and DRESS is much greater for the London UMC compared to the London WC. This point may lead us to surmise a possible explanation for the difference in their movement of STRUT. Let us now recall the long-term ongoing independent lowering and fronting process which is proposed by Trudgill (2004: 133, cf. §4.5 above) who notes that '[I]n the English of London and other parts of the southeast [...] the fronting has progressed further, giving 'an open front vowel very close to *C* [a]'(Gimson 1962: 103)'(Trudgill 2004: 133). However, the current data do not show any evidence for the suggested front realisations for this vowel; instead, the vowels are now located at further back area for the WC speakers, and are backed and raised for the UMC speakers. The resultant vowels are thus more likely to be consequent realisations of the reversed – backing – process which is suggested by Torgersen & Kerswill (2004: 46) to have started in the middle of the twentieth century in London and which is presumably caused by the backing of the TRAP, an initial vowel shift in the modified drag-chain shift. This view leads us to surmise the following historical scenario for these three vowels. There have been two separate vowel shifts in and around London area: a (modified) drag-chain shift process for TRAP and DRESS (and possibly KIT too), and an independent lowering and fronting process of STRUT. The two processes conflicted each other where the backing of TRAP and the fronting of STRUT met, possibly creating variable mergers between TRAP and STRUT for some speakers as reported in Beaken (1971: 150) and Wells (1982: 292)(cf. §4.5). In order to equilibrate the local distance between adjacent vowels (cf. Langstrof 2006: 273), a compromise had to be made; then eventually the fronting process got reversed and changed to a new backing process of the STRUT sometime in the middle of twentieth century as suggested by Torgersen & Kerswill (2004: 46). The reason for the fronting process, not the modified drag-chain shift process, to be reversed may be considered that it was an independent process so that it would not have had to get any additional vowel shift involved by the change of the process itself, whereas the reversed TRAP movement (i.e. fronting) as a part of the modified drag-chain shift would have been more difficult structurally since it would have implied another conflict with DRESS, and subsequently possibly with KIT in the whole process. Thus, the speculated scenario can be briefly explained as: the front short vowel modified drag-chain shift process pushed back the independent fronting process. Interestingly, if this scenario was opposite, i.e. the fronting process forced the modified drag-chain shift process to be reversed, then Labov's proposition for the upward short front vowel shifts in London might have been happening right now. How can this scenario possibly explain the difference in the two different situations of STRUT between the London WC and UMC speakers? The key for this question may be, as mentioned earlier, the degree of the modified drag-chain shift, particularly that of the TRAP. As can be seen from the Figure 111, the backing process of the TRAP looks more progressed for the London UMC than for the London WC. This greater backing of the TRAP may well be the possible structural cause for the upward movement of the STRUT for the London UMC.

Let us now move on to consider possible implications in relation to social factors. Despite the claim reviewed earlier (§2.3.3) that there seems to exist a social pressure towards social levelling in the area centred on London, the current data do not show evidence for social convergence between the London UMC speakers and the London WC speakers; instead, they rather indicate a tendency for social divergence in which the difference between the UMC and WC speakers has apparently become greater for the young males/females than for the old males/females. To be specific, as can be seen in the Figure 111, the difference between young F-WC and young F-UMC looks greater than the one between old F-WC and old F-UMC for all the three vowels; this is statistically supported from the previous chapter particularly for the frontness of TRAP (i.e. its significant social class difference for the F-Y group vs. its non-significant social class difference for the F-O group, cf. §6.4.5.6, §6.4.6.6, §6.5.6) and openness of STRUT (i.e. its significant social class difference for the F-Y group vs. its non-significant social class difference for the F-O group, cf. §6.4.7.6, §6.4.9.6, §6.5.6). Similarly, but to a lesser extent than in the case of females, the difference between young M-WC and young M-UMC looks greater than the difference between old M-WC and old M-UMC for DRESS and STRUT; this is statistically supported from the previous chapter particularly for the openness of STRUT (i.e. its significant social class difference for the M-Y group vs. its non-significant social class difference for the M-O group, cf. §6.4.7.6, §6.4.9.6, §6.5.6). Considering the fact that the overall vowel change for the WC speakers is rather reserved with no significant change in STRUT for both the males and the females and DRESS for the males, this social divergence seems to be promoted by the UMC, particularly female speakers. What is indicative from this finding is that, as far as the three short vowels are concerned, the difference between Londoners at both sides of social spectrum is becoming more salient; that is, there is no evidence for social levelling between them. The difference in realisations of these three short vowels reflects the difference in social class more remarkably for the young generations than for the old generations, so that it seems to play a role not to blur but to enhance their social differentiation. Although the speech of the people socially between London UMC and London WC, i.e. London Lower Middle Class (London LMC), needs to be also investigated, the finding from the current data does not support the claim that the mesolectal type of accent varieties ranging from RP-end to Cockney-end of the accent continuum obscures its speakers' social class. Instead, it suggests that there exists a notable association between accent and social class.

In addition, one might find an interesting tendency in the chronological vowel shifts between sexes for each of London WC and London UMC. Now let us focus on the exact locations of the mean values for the three short vowels of the female/male London WC and London UMC speakers in the Figure 111 (i.e. the point in the lightest colour for the old speakers and the point in the darkest colour for the young speakers). For the London UMC speakers, on the one hand, their vowel shifts seem to be diverging to different target locations between the females and the males, bringing about a greater sex difference for the young compared to the old; this is statistically supported from the previous chapter particularly for the frontness of TRAP (i.e. its significant sex difference for the Y-UMC group vs. its non-significant sex difference for the O-UMC group, cf. §6.4.5.6, §6.4.6.6, §6.5.6). For the London WC speakers, on the other hand, their male and female vowel shifts appear to be converging into a similar target location, so that the sex difference is less for the young than for the old. This observation, however, is not statistically supported by the results from the previous chapter; therefore, it should be borne in mind that it is a tentative observation.

The above-mentioned centralisation (i.e. backing and raising) of the TRAP vowels for the male London UMC may possibly be explained in relation to different social attitudes: i.e. solidarity and formality/fashion. The first possible reason may be an increasing 'solidarity' of the male London UMC speakers to their social class counterpart, i.e. the male London WC speakers. It is noticed in Figure 111 that the observed vowel shift of TRAP for the male London UMC is not only smaller in degree than for the female London UMC, but also heading towards a similar vowel region where the shift of TRAP for the male London WC is also heading to; these are statistically supported in the results from the previous chapter (i.e. significant sex difference in its frontness between F-Y-UMC and M-Y-UMC, cf. §6.4.5.6, §6.4.6.6, §6.5.6, and significant social class difference in its frontness between M-O-WC and M-O-UMC vs. non-significant social class difference in its openness/frontness between M-Y-WC and M-Y-UMC, cf. §6.4.4.6, §6.4.5.6,

§6.4.6.6, §6.5.6). In this view, the young male London UMC are possibly considered to express their solidarity by making their TRAP sound closer to their social class counterpart (i.e. M-Y-WC) rather than to their sex counterpart (i.e. F-Y-UMC). However, the same type of solidarity, if there is any, does not seem to hold for their realisations of the STRUT in which their realisations are significantly different from their social class counterpart but more similar to their sex counterpart (i.e. significant social class difference in its openness between M-Y-WC and M-Y-UMC vs. non-significant sex difference in its openness/frontness between F-Y-UMC and M-Y-UMC, cf. §6.4.7.6, §6.4.8.6, §6.4.9.6, §6.5.6)

Another possible social reason for the centralised TRAP of the male London UMC is derived from an acoustic tendency found in the study of Deterding (1997) in which the eleven monophthongs in connected speech were found to be significantly less peripheral than those uttered in citation forms among male RP speakers. That is, taking apparent (but not significant) centring of STRUT in young male London UMC into consideration, peripheral and nonperipheral realisations of DRESS, TRAP and STRUT vowels for the old and young male London UMC speakers seem to correspond to peripheral and nonperipheral realisations of those for the more and less formal speech styles among male RP speakers in the study of Deterding. If so, the male London UMC may arguably be suggested to be shifting from a more formal type of speech to a less formal type of speech across two generations. This leads us to surmise that peripherality on a two dimensional (i.e. F1/F2) vowel space may play a role as a social marker for both formality and fashion among male London UMC speakers; namely, more peripheral short vowels may be associated with more formal and old-fashioned characteristics, while less peripheral short vowels with less formal and innovative characteristics. These observations, however, are merely speculations; therefore, it needs to be properly tested to be confirmed.

Moreover, having given the fact that the patterns of vowel shifts found in our two accent groups, particularly in London UMC, generally coincide with the findings from other recent studies (cf. Torgersen *et al.* 2006, Fabricius 2007), the social and accent classification solely depending on occupation seems to turn out to be reasonably accurate. This indicates not only that occupation proves to be an important indicator to determine speakers' social class, but also that accent variations are greatly depending on social characteristics.

The detailed difference between speakers' subgroups (by social class together with sex and age) would have in fact been obscured if the speakers were lumped together as a single group of London English speakers on the ground that they were located in the middle of the social spectrum, say, under the name of EE. Therefore, as far as these three short vowels are concerned, it is more sensible to consider observed variations in the middle of the continuum between RP and Cockney not as a single variety but as a series of accent variations.

With regard to the issue for the regional diffusion of the London features, there have been several studies discussed that the changes related to these three vowels are considered to be diffused from London. Trudgill, for example, discusses that the lowering and fronting of STRUT observed in East Anglia is a consequence of regional diffusion from London (Trudgill 1986: 50-2). As demonstrated above, however, the current data show that the vowel is not lowering and fronting any more, but it is in fact reversed: backing for London English in general and raising for London UMC. Assuming that the East Anglian STRUT continues to be influenced by the London-type STRUT, it is likely in the near future that their STRUT vowel is to be moved back and possibly raised too.

As for the influence on RP, it is noticed that the vowel shifts observed for the (female) young London UMC speakers are very much in line with the Fabricius's (2007) recently reported anticlockwise vowel changes for the young RP speakers which involves not only the change in TRAP (i.e. backing and lowering) but also the change in STRUT (i.e. backing, raising and centring). Recalling the fact that it has been said that London has been the main linguistic resource for RP as discussed in chapter 2, the (female) young London UMC speakers may arguably be its innovator. If this is confirmed to be true, the changes observed for these vowels in RP do not seem to be the case that is predicted by Wells (1982: 106, 118, 301, see discussions in Chapter 2) but rather they seem to be promoted by the (female) London UMC speakers who appear to be, as far as these three vowels are concerned, innovators in the current data.

In summary, the present section not only attempts to consider possible explanations for the observed vowel changes but also discusses a number of implications with regard to internal and external factors. The observed changes of DRESS, TRAP and STRUT for the London English are more or less in line with the anticlockwise chain shifts reported by Torgersen & Kerswill (2004), Hawkins & Midgley (2005), Torgersen *et al* (2006) and Fabricius (2007). Of all the social subgroups observed here, on the one hand, the most innovative group seems to be the female young London UMC, followed by the male young London UMC both of whom show a well-progressed anticlockwise chain shift involving all three short vowels with their TRAP raised higher up from their backed STRUT. The London WC, on the other hand, represents a rather reserved vowel shift which only involves backing of TRAP and DRESS with stable STRUT on the similar level as TRAP. The observed shifts could partially be explained by the Labov's General Principle of Vowel Shifting. From the structural point of view, it is speculated that the resultant apparent-time vowel shifts are consequent realisations of the combination of the two existing vowel shift processes, i.e. the modified drag-chain shift involving short front vowels and the independent lowering and fronting process for STRUT, the latter of which is now completely reversed. It is also discussed that the data in general do not show evidence for social convergence but indicate a tendency for social divergence which seems to be promoted by the (female) young London UMC speakers. In particular, the realisations between TRAP and STRUT are found to be an important social class marker. In relation to the last point, the next section will specifically focus on the configuration of these two vowels.

8 Results of Configurational Analysis of TRAP and STRUT

8.1 Results for angle and distance calculations

Following Fabricius (2007), the average angle (in degrees) and Euclidean distance were calculated from our *S*-normalised values of F1 and F2-F1. Table 93 presents calculated angles and Euclidean distance for each speaker both in individual speech styles (i.e. IS, RPS and WLS) and on average throughout all the three speech styles, while Table 94 provides those for each speaker in individual phonetic environments (i.e. before voiceless and voiced stops, nasals and voiceless and voiced fricatives)[61]:

Table 93 Angle measurements in degrees and Euclidean distance, calculated on *S*-normalised data by speech styles (Ang. indicates the angle of the line from TRAP to STRUT relative to the horizontal line. / Dist. indicates the distance between two points, TRAP and STRUT.)

ID	Age	Birth Year	Sex-Age-Class	IS		RPS		WLS		ALL	
				Ang.	Dist.	Ang.	Dist.	Ang.	Dist.	Ang.	Dist.
F01	18	1985	F-Y-WC	9	0.342	16	0.403	2	0.365	9	0.368
F02	22	1981	F-Y-WC	19	0.316	1	0.243	3	0.252	9	0.267
F03	25	1979	F-Y-WC	35	0.284	-1	0.282	-20	0.290	4	0.263
F04	30	1974	F-Y-WC	21	0.413	35	0.306	17	0.466	23	0.392
F05	20	1983	F-Y-UMC	72	0.331	73	0.391	44	0.479	61	0.388
F06	21	1982	F-Y-UMC	71	0.286	74	0.382	57	0.212	69	0.291
F07	21	1983	F-Y-UMC	19	0.485	50	0.333	35	0.452	33	0.414
F08	25	1978	F-Y-UMC	60	0.194	82	0.215	29	0.209	57	0.191
F09	54	1952	F-O-WC	0	0.436	-13	0.398	-6	0.520	-6	0.450
F10	65	1939	F-O-WC	17	0.288	11	0.489	14	0.424	13	0.400
F11	68	1936	F-O-WC	0	0.652	5	0.640	-2	0.779	1	0.689
F12	73	1931	F-O-WC	15	0.465	14	0.501	4	0.474	11	0.478
F13	50	1954	F-O-UMC	10	0.272	27	0.310	12	0.316	16	0.297
F14	51	1952	F-O-UMC	11	0.171	19	0.164	10	0.202	13	0.179
F15	61	1942	F-O-UMC	2	0.461	25	0.405	6	0.468	10	0.439
F16	70	1934	F-O-UMC	2	0.474	9	0.399	1	0.320	4	0.397
M01	22	1982	M-Y-WC	10	0.504	9	0.425	3	0.494	7	0.474
M02	24	1983	M-Y-WC	16	0.334	1	0.437	7	0.379	7	0.382
M03	25	1979	M-Y-WC	10	0.430	4	0.456	0	0.370	5	0.418
M04	29	1974	M-Y-WC	4	0.530	-1	0.481	-7	0.383	-1	0.463
M05	17	1987	M-Y-UMC	27	0.342	22	0.320	13	0.339	21	0.332
M06	20	1984	M-Y-UMC	27	0.314	58	0.220	28	0.190	36	0.234
M07	22	1982	M-Y-UMC	54	0.208	66	0.224	27	0.203	50	0.203
M08	23	1980	M-Y-UMC	31	0.171	20	0.310	8	0.355	17	0.275
M09	51	1951	M-O-WC	-3	0.581	-10	0.597	-11	0.747	-8	0.640
M10	54	1949	M-O-WC	-5	0.566	-6	0.573	-4	0.508	-5	0.549
M11	59	1944	M-O-WC	-7	0.414	-9	0.490	-12	0.358	-9	0.420
M12	61	1942	M-O-WC	-10	0.582	-4	0.574	0	0.629	-4	0.594
M13	59	1944	M-O-UMC	23	0.353	15	0.359	11	0.331	16	0.346
M14	59	1944	M-O-UMC	5	0.447	3	0.504	2	0.491	3	0.481
M15	65	1938	M-O-UMC	14	0.294	3	0.339	-10	0.401	1	0.340
M16	66	1938	M-O-UMC	12	0.531	28	0.481	9	0.369	17	0.456

[61] For the values shown in italic, see texts in §4.6.1 and later in this section.

Table 94 Angle measurements in degrees and Euclidean distance, calculated on S-normalised data by phonetic environments (Ang. indicates the angle of the line from TRAP to STRUT relative to the horizontal line. / Dist. indicates the distance between two points, TRAP and STRUT.)

ID	Age	Birth Year	Sex-Age-Class	_LS		_VS		_N		_LF		_VF	
				Ang.	Dist.	Ang.	Dist.	Ang.	Dist.	Ang.	Dist.	Ang.	Dist.
F01	18	1985	F-Y-WC	23	0.362	-5	0.274	-7	0.413	24	0.292	-14	0.559
F02	22	1981	F-Y-WC	14	0.170	13	0.297	14	0.235	-9	0.293	-9	0.289
F03	25	1979	F-Y-WC	-34	0.463	11	0.163	-37	0.549	-24	0.367	77	0.194
F04	30	1974	F-Y-WC	20	0.423	2	0.426	15	0.492	11	0.578	35	0.456
F05	20	1983	F-Y-UMC	74	0.473	54	0.501	31	0.568	39	0.508	22	0.469
F06	21	1982	F-Y-UMC	18	0.297	31	0.316	66	0.182	77	0.062	*100*	0.417
F07	21	1983	F-Y-UMC	39	0.444	*99*	0.284	13	0.720	32	0.578	36	0.448
F08	25	1978	F-Y-UMC	26	0.239	25	0.223	-9	0.358	86	0.265	35	0.153
F09	54	1952	F-O-WC	-11	0.662	3	0.459	-13	0.738	0	0.399	-3	0.361
F10	65	1939	F-O-WC	31	0.468	18	0.358	-2	0.370	16	0.324	6	0.647
F11	68	1936	F-O-WC	2	0.604	5	0.716	-3	0.832	-4	0.907	-8	0.848
F12	73	1931	F-O-WC	1	0.363	-4	0.493	1	0.556	26	0.491	1	0.478
F13	50	1954	F-O-UMC	19	0.252	9	0.418	-1	0.433	22	0.467	*19*	*0.029*
F14	51	1952	F-O-UMC	0	0.199	7	0.151	19	0.214	9	0.206	12	0.247
F15	61	1942	F-O-UMC	2	0.407	14	0.588	-1	0.702	7	0.365	14	0.292
F16	70	1934	F-O-UMC	7	0.235	-8	0.449	3	0.437	12	0.174	-1	0.318
M01	22	1982	M-Y-WC	-2	0.515	5	0.479	3	0.645	2	0.330	5	0.507
M02	24	1983	M-Y-WC	11	0.288	16	0.486	5	0.439	-2	0.156	0	0.538
M03	25	1979	M-Y-WC	15	0.334	-5	0.317	1	0.531	2	0.342	-14	0.348
M04	29	1974	M-Y-WC	-2	0.252	-2	0.416	-4	0.406	-18	0.428	-4	0.423
M05	17	1987	M-Y-UMC	24	0.369	13	0.312	9	0.392	4	0.432	18	0.205
M06	20	1984	M-Y-UMC	4	0.194	53	0.265	-35	0.143	20	0.313	69	0.206
M07	22	1982	M-Y-UMC	33	0.219	29	0.187	17	0.334	56	0.138	11	0.169
M08	23	1980	M-Y-UMC	17	0.392	2	0.384	-1	0.459	22	0.302	2	0.263
M09	51	1951	M-O-WC	-13	0.814	-11	0.821	-20	1.030	-3	0.599	-2	0.495
M10	54	1949	M-O-WC	-7	0.460	-3	0.365	-9	0.686	7	0.587	-5	0.456
M11	59	1944	M-O-WC	-16	0.285	-4	0.266	-20	0.606	-7	0.321	-4	0.326
M12	61	1942	M-O-WC	2	0.568	-1	0.554	-5	1.034	1	0.624	11	0.376
M13	59	1944	M-O-UMC	1	0.339	0	0.447	0	0.416	12	0.335	67	0.243
M14	59	1944	M-O-UMC	1	0.391	0	0.298	-6	0.791	5	0.582	16	0.415
M15	65	1938	M-O-UMC	-14	0.433	-8	0.501	-11	0.530	-14	0.245	7	0.256
M16	66	1938	M-O-UMC	6	0.530	6	0.412	25	0.252	4	0.261	11	0.399

Unlike Fabricius (2007), *S*-normalised F2-F1 values were used for the x axis in this study. Therefore, calculated angle values cannot directly be compared with those from Fabricius' (shown in §4.6.2) which were obtained with *S*-normalised F2 values. When the angles are calculated with SF2 for the current data (see Appendix 12), however, they are shown to be correlated with those obtained with SF21 (shown in the tables above). This can be seen in Appendix 12 where, plotting the angles obtained by the two different ways on the x and y axes, the correlation coefficients squared (R^2) always present values higher than 98% indicating that they are very highly correlated. In other words, one set of angles accounts for the variability of at least 98% of the other set of angles (cf. Field 2005: 128-9).

Turning back to our data in the tables above, the Euclidean distance for speaker F13 before voiced fricatives is the only case which should possibly be disregarded as suggested by Fabricius in that the distance was 'so relatively small as to make comparison of the TRAP and STRUT average positions effectively meaningless' (2007: 302). However, since the value does not seem to deviate from the other values before voiced fricatives found in the same social grouping (F-O-UMC) and those before other consonants obtained from the same speaker, it was included in the analysis. All the other Euclidean distances seemed to be relatively long enough so that they were all taken into account. The obtained angle measurements in Table 93 and Table 94 are diagrammed in Figure 113 and Figure 114, where each symbol indicates an average angle measurement per individual speaker in each speech style and in average (Figure 113) and in each of the five phonetic environments (Figure 114)[62]:

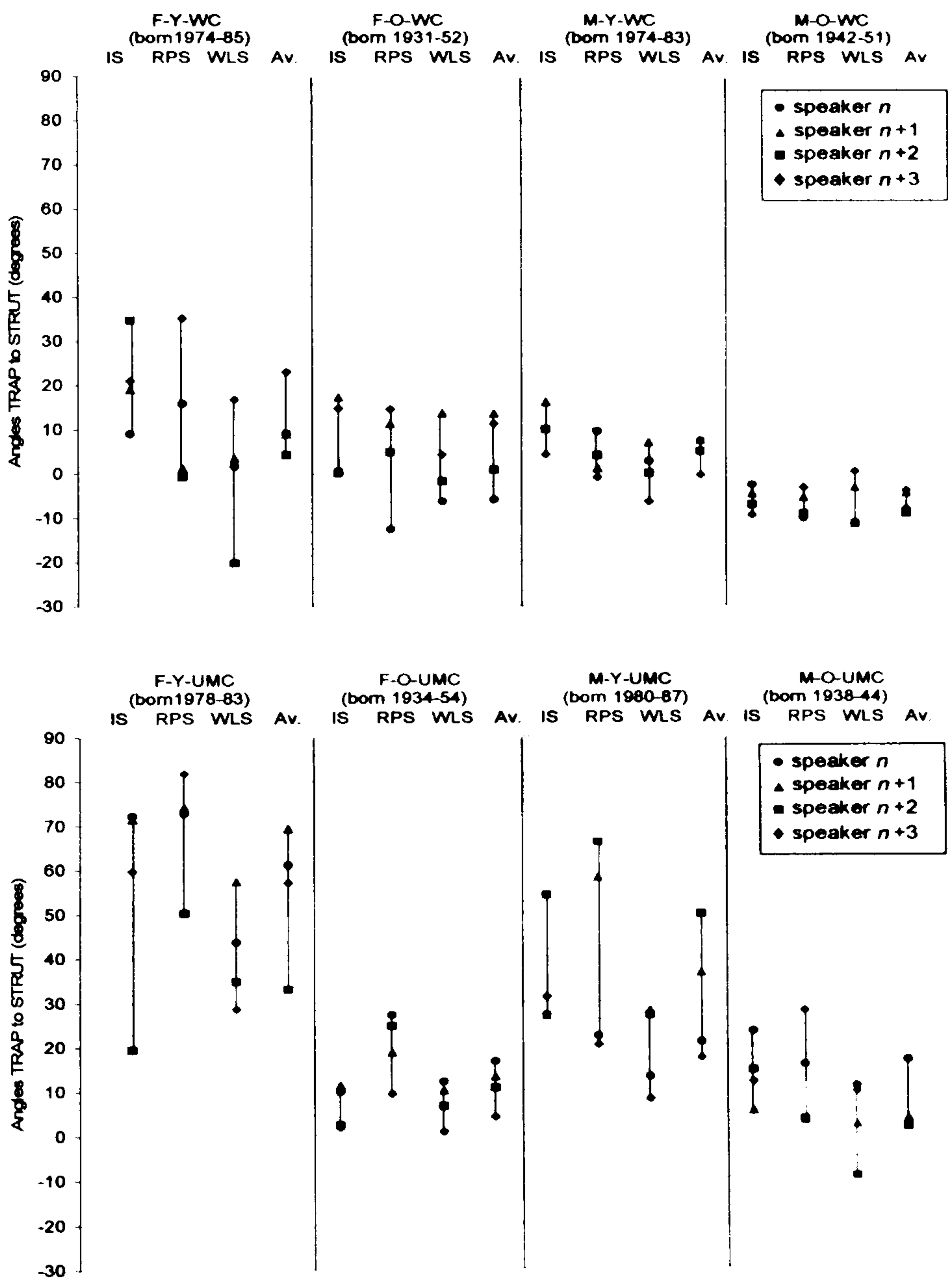
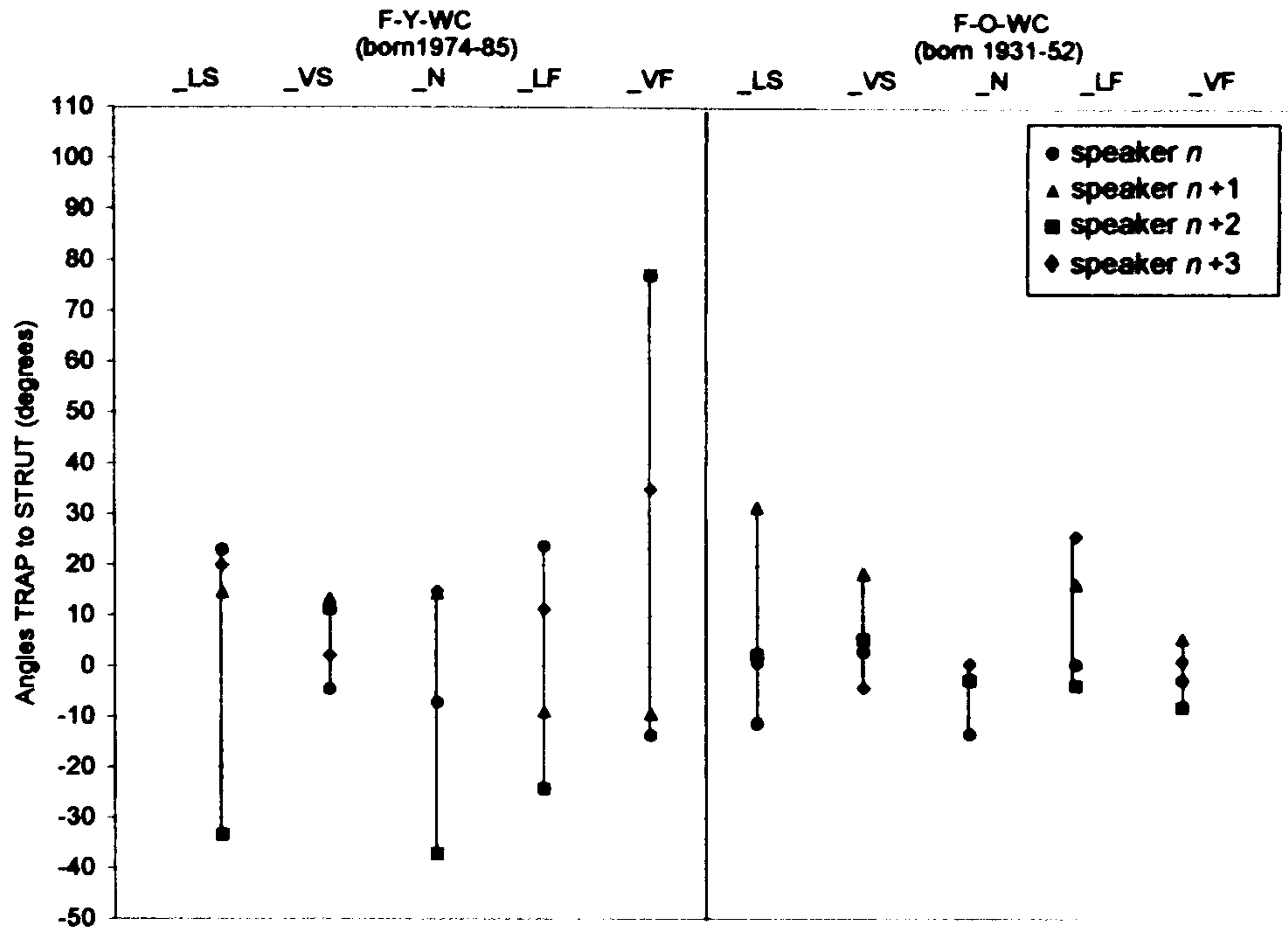
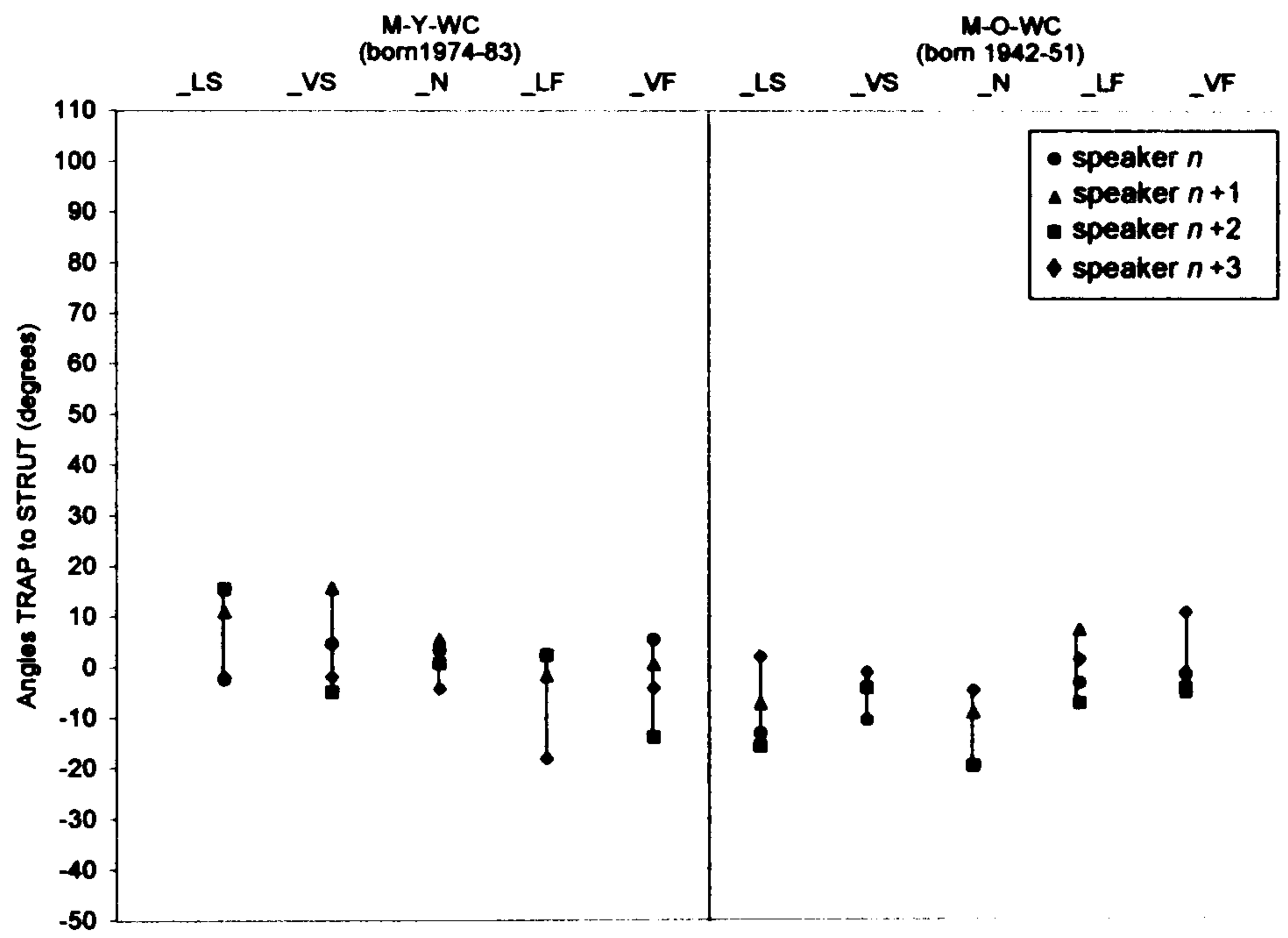


Figure 113 Distribution of angle measurements in degrees by speech styles from Table 93

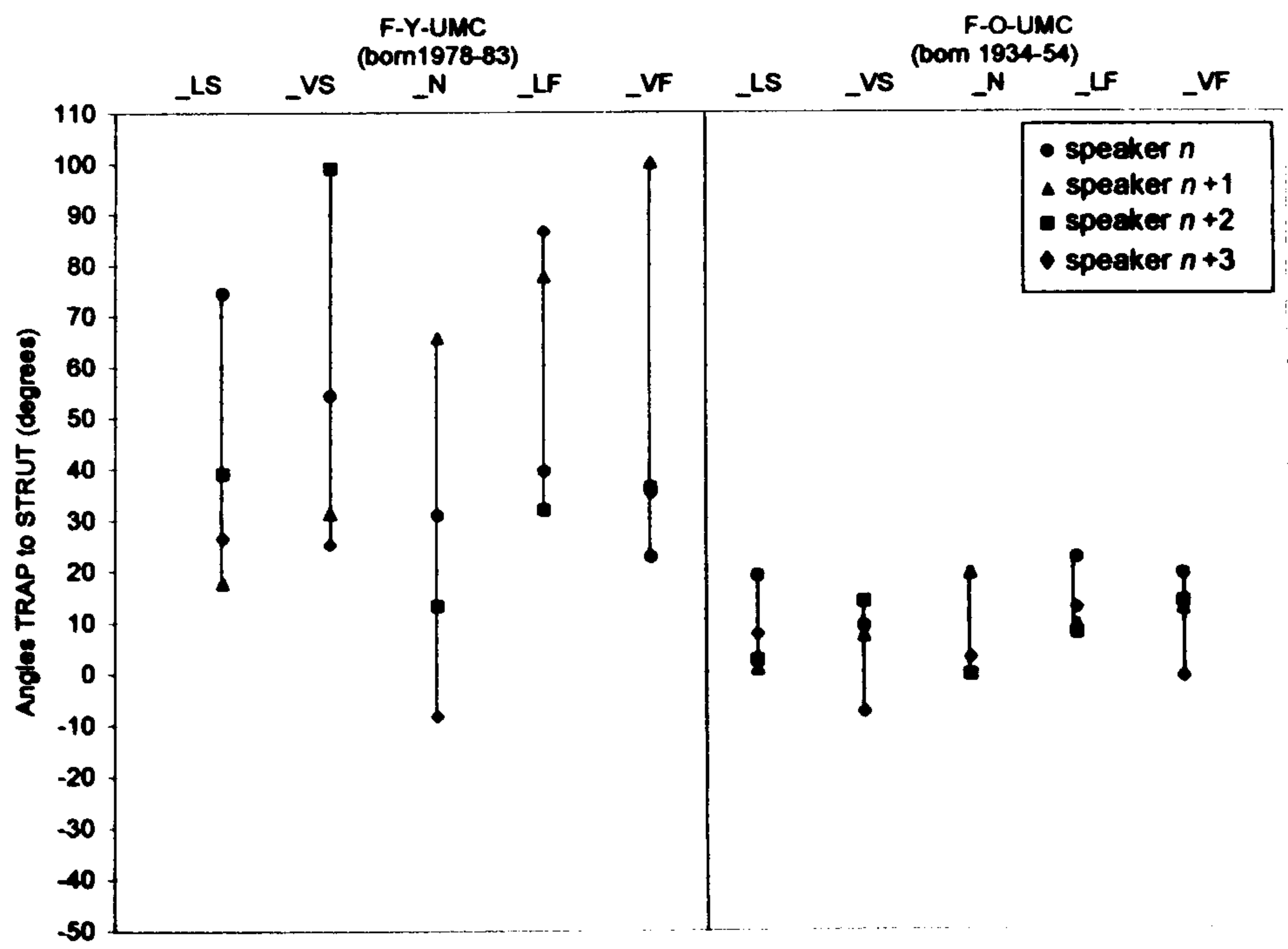
[62] In these figures, *n* is F01 for F-Y-WC, F05 for F-Y-UMC, F09 for F-O-WC, F13 for F-O-UMC, M01 for M-Y-WC, M05 for M-Y-UMC, M09 for M-O-WC, and M13 for M-O-UMC respectively.



F-Y-WC
(born1974-85)
F-O-WC
(born 1931-52)
_LS
_VS
_N
_LF
_VF
Angles TRAP to STRUT (degrees)
speaker n
speaker n+1
speaker n+2
speaker n+3



M-Y-WC
(born1974-83)
M-O-WC
(born 1942-51)
_LS
_VS
_N
_LF
_VF
Angles TRAP to STRUT (degrees)
speaker n
speaker n+1
speaker n+2
speaker n+3



F-Y-UMC
(born1978-83)
F-O-UMC
(born 1934-54)
_LS
_VS
_N
_LF
_VF
Angles TRAP to STRUT (degrees)
speaker n
speaker n+1
speaker n+2
speaker n+3

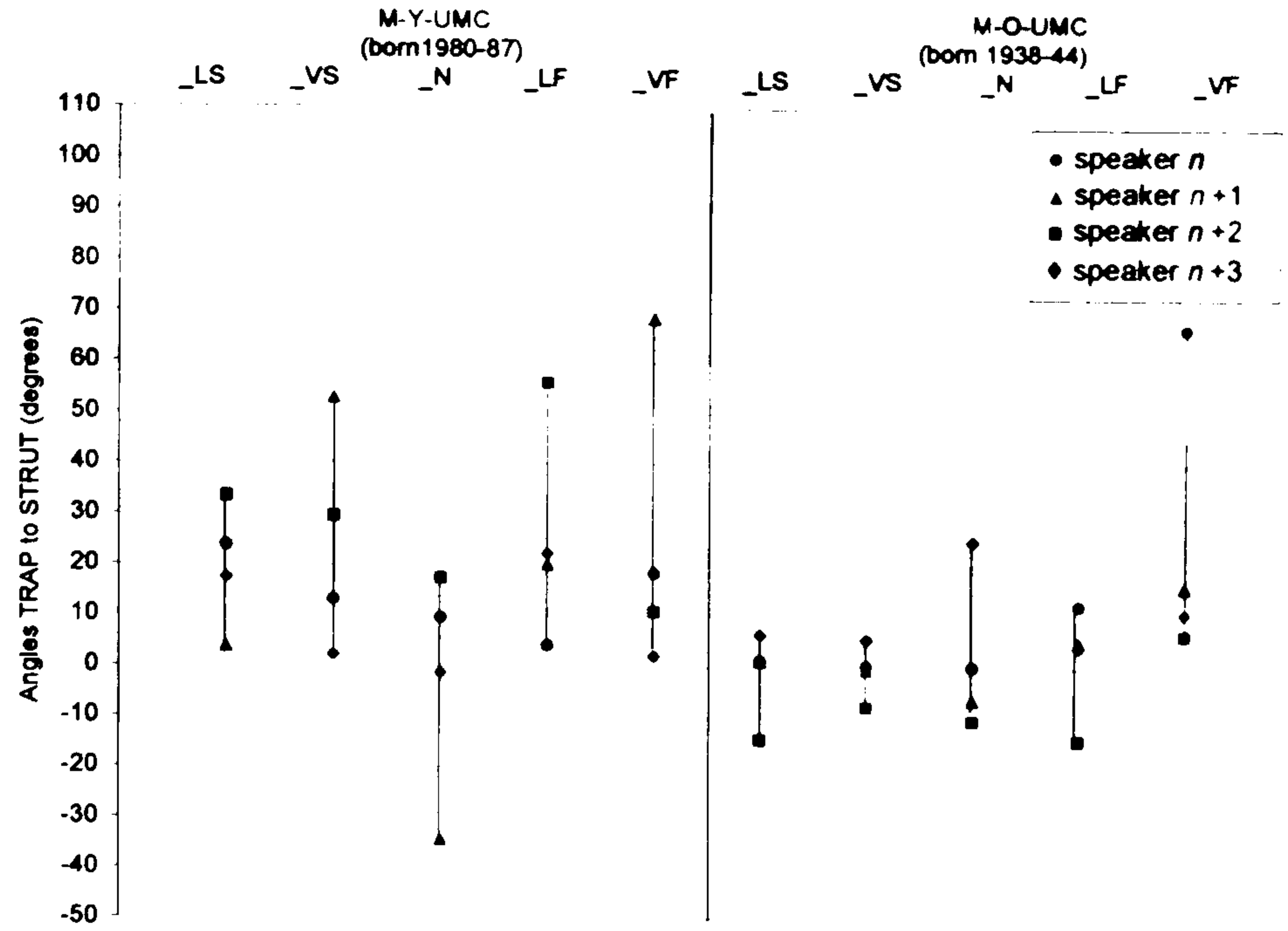


Figure 114 Distribution of angle measurements in degrees by phonetic environments from Table 94

Similar to the main statistical tests in §6.1, the following ANOVA tests were conducted for the values of the angles in Table 93 and Table 94:

Test-1-1'(T11'): 2-way ANOVA with speech style x sex (to overall data)
Test-1-2'(T12'): 2-way ANOVA with speech style x age (to overall data)
Test-1-3'(T13'): 2-way ANOVA with speech style x social class (to overall data)
Test-1-4'(T14'): 2-way ANOVA with speech style x social grouping (by sex x age x social class) (to overall data)
Test-2-1'(T21'): 2-way ANOVA with phonetic environment x sex (to WLS data only)
Test-2-2'(T22'): 2-way ANOVA with phonetic environment x age (to WLS data only)
Test-2-3'(T23'): 2-way ANOVA with phonetic environment x class (to WLS data only)

The results of the main effects and interaction effects for all the ANOVA tests are provided in Table 95, while all the estimated marginal means (see §6.1) are given in Table 96:

Table 95 ANOVA results for angles: main effects and interaction effects

Test No.	Factor(s)	Type III Sum of Squares	df	Mean Square	F	Sig.	
1-1'	sstyle	2295.438	2, 60	1147.719	12.103	0.000	$p<0.001$
	sex	957.031	1, 30	957.031	2.445	0.128	ns
	sex x sstyle	134.313	2, 60	67.156	0.708	0.497	ns
1-2'	sstyle	2295.438	2, 60	1147.719	13.253	0.000	$p<0.001$
	age	3563.087	1, 30	7472.531	24.542	0.000	$p<0.001$
	age x sstyle	627.896	2, 60	313.948	3.625	0.033	$p<0.05$
1-3'	sstyle	2295.438	2, 60	1147.719	14.324	0.000	$p<0.001$

	social class	4394.531	1, 30	1394.531	15.878	0.000	***p*<0.001**
	social class x sstyle	1016.438	2, 60	508.209	6.343	0.003	***p*<0.01**
1-4'	**sstyle**	2295.438	2, 48	1147.719	15.322	0.000	***p*<0.001**
	groupings	10634.27	7, 24	1519.182	17.673	0.000	***p*<0.001**
	groupings x sstyle	2228.396	14, 48	159.171	2.125	0.027	**p<0.05**
2-1'	**PhonEn.**	3980.038	2.79, 83.66	1427.232	3.021	0.038	**p<0.05**
	sex	4644.025	1, 30	4644.025	3.792	0.061	ns
	PhonEn x sex	197.913	2.79, 83.66	70.971	0.15	0.919	ns
2-2'	**PhonEn.**	3980.038	2.77, 82.94	1439.58	3.055	0.037	**p<0.05**
	age	8526.4	1, 30	8526.4	7.785	0.009	***p*<0.01**
	PhonEn x age	638.788	2.77, 82.94	231.05	0.49	0.675	ns
2-3'	**PhonEn.**	3980.038	2.79, 83.75	1425.748	3.066	0.036	**p<0.05**
	social class	13104.4	1, 30	13104.4	13.901	0.0008	***p*<0.001**
	PhonEn x social class	779.038	2.79, 83.75	279.071	0.6	0.605	ns

Table 96 Estimated Marginal Means for angles (in degree) from the Table 93 and the Table 94

		Speech Styles				Phonetic Environments					
		Ave-rage	IS	RPS	WLS	Ave-rage	_LS	_VS	_N	_LF	_VF
Speech Style		15	18	20	8						
Phonetic Environment						10	9	11	1	13	16
Sex	F	21	23	27	13	16	14	17	6	20	20
	M	10	13	12	4	5	4	6	-3	6	12
Age	Y	26	30	32	15	17	18	21	5	20	23
	O	5	5	7	2	3	1	1	-3	6	9
Class	WC	4	8	3	-1	1	2	2	-5	1	5
	UMC	27	28	36	18	19	16	20	7	25	27
Grouping	F-Y-WC	11	21	13	1						
	F-Y-UMC	56	56	70	41						
	F-O-WC	5	8	4	3						
	F-O-UMC	11	6	20	7						
	M-Y-WC	5	10	3	1						
	M-Y-UMC	32	35	42	19						
	M-O-WC	-7	-6	-7	-7						
	M-O-UMC	10	14	12	3						

8.1.1 Angles by speech styles

As can be seen in Table 95, the difference between means across speech style was found to be very highly significant, F(2, 60) = 12.10~15.32, p<0.001. Further planned contrasts and *post hoc* pairwise comparisons by LSD revealed that, although there was no significant difference between spontaneous and non-spontaneous speech styles (F(1, 30) = 3.03~3.22, p>0.05), the mean angle in WLS is significantly smaller than the one in RPS at the level of p<0.001, and than the one in IS at the level of *p*<0.01 (see Table 96). The mean value of the angle from TRAP to STRUT was +8 degrees in the WLS, that is, eight degrees above the horizontal moving from left to right, which may be considered as a 'shallow positive angle'. This was significantly smaller than the means in the IS (+18 degrees) and the RPS (+20 degrees) as schematically illustrated below:

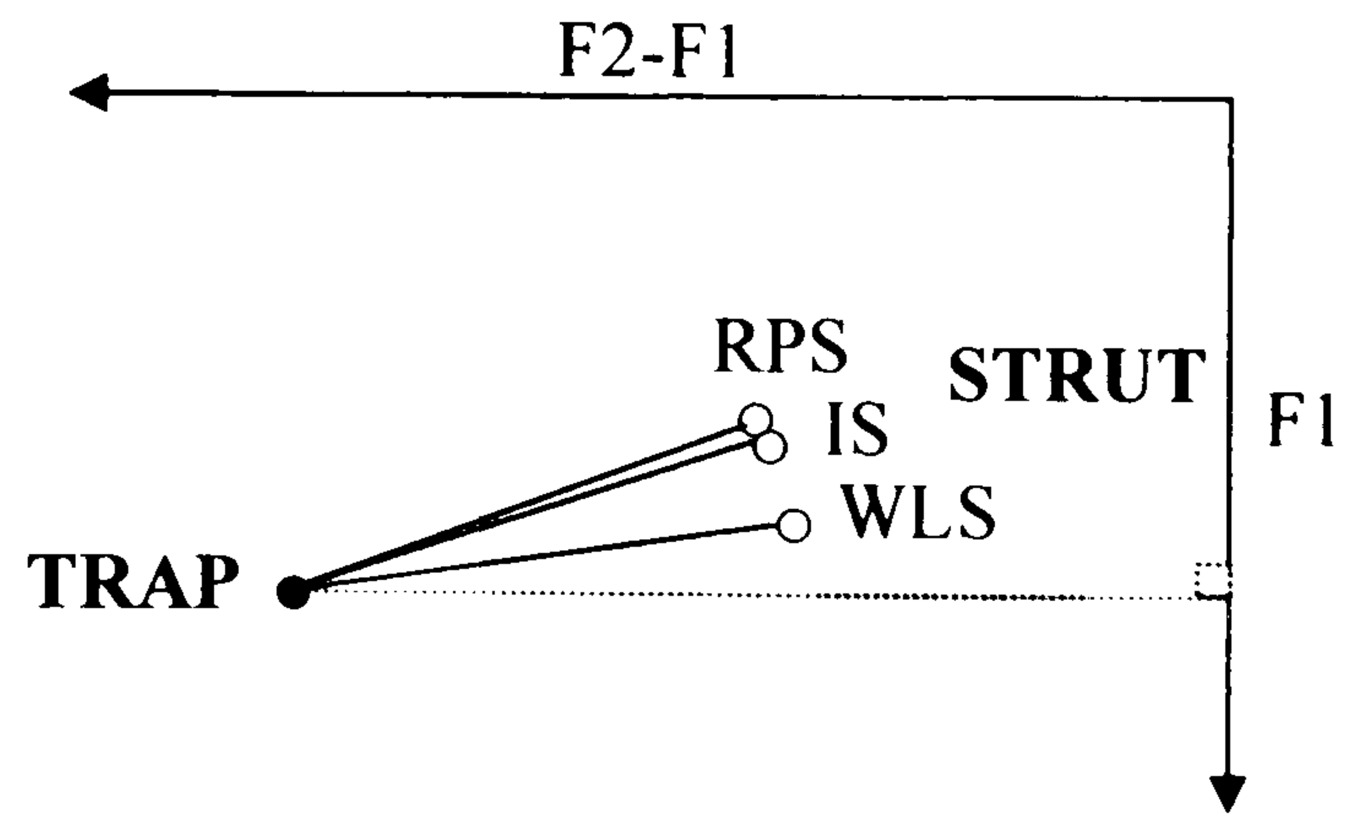


Figure 115 Schematic angle difference in three speech styles

Although one would expect RPS realisations to be between IS and WLS realisations, it was not the case here. Although the angles between +8 and +20 may all be considered as 'shallow positive angles' in Fabricius's (2007) term, they are statistically proved to be significantly different. This can be seen from Table 93 and Figure 113 for most of the subjects. Thus, the angle is smaller in more formal non-spontaneous speech style in general. Looking at the results for the interactions in Table 95, significant interactions were found between age and speech style, $F(2, 60)=3.625$, $p<0.05$, between social class and speech style, $F(2, 60)=6.343$, $p<0.01$, and between social groupings and speech style, $F(14, 48)=2.125$, $p<0.05$. That is, the way in which the angle values were affected by speech style did differ for young and old speakers, for WC and UMC speakers, and for speakers divided by social groupings. These interactions are broken down by the simple effects tests and subsequent *post hoc* pairwise comparisons using the LSD, which revealed the following results and patterns shown in Table 97:

Table 97 Angle TRAP to STRUT: Simple effects of speech style in T11', T12', T13', and T14'(ns: non-significant, *p<0.05, **p<0.01, ***p<0.001)

Patterns for simple effect of speech style at:		Pairwise comparisons by LSD		
		IS vs. RPS	IS vs. WLS	RPS vs. WLS
Sex	**Female** ***	ns	>**	>***
	Male *	ns	>*	>*
Age	**Young** ***	ns	>***	>***
	Old^{ns}	–	–	–
Class	WC^{ns}	–	–	–
	UMC ***	<*	>**	>***

Groupings	**F-Y-WC****	ns	>**	>*
	F-Y-UMC***	<*	>*	>***
	F-O-WC^{ns}	–	–	–
	F-O-UMC*	ns	ns	>*
	M-Y-WC^{ns}	–	–	–
	M-Y-UMC***	ns	>*	>***
	M-O-WC^{ns}	–	–	–
	M-O-UMC^{ns}	–	–	–

Similar to the general pattern, the mean angles for the females, the males, the young, the F-Y-WC and the M-Y-UMC were smaller in the most formal non-spontaneous speech style compared to less formal spontaneous and non-spontaneous speech styles as in M07 (from F-Y-UMC) shown in Figure 116, in which corresponding TRAP and STRUT vowels in IS, RPS and WLS are connected by a bold line, a coarser dotted line, and a finer dotted line respectively. For the UMC and the F-Y-UMC, in addition to the general pattern, their mean angle in IS was smaller than those in RPS; that is, their angle values were significantly increasing in the order of WLS, IS and RPS as in speaker F08 (F-Y-UMC) shown in Figure 117. For the F-O-UMC, their mean angles were smaller in WLS compared to RPS only as in F15 (F-O-UMC) shown in Figure 118.

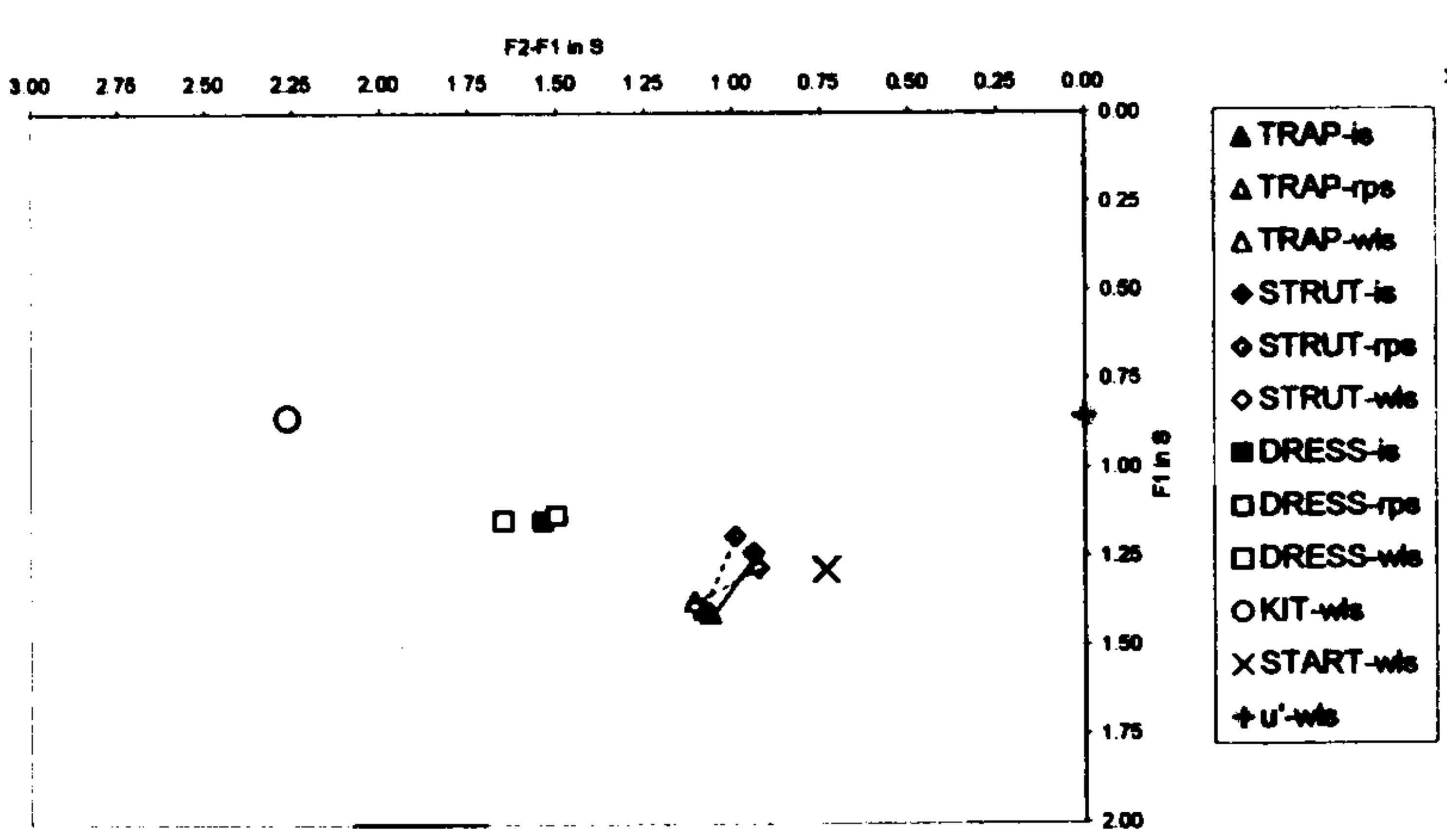


Figure 116 Selected vowel system for M07 (M-Y-UMC) in three speech styles

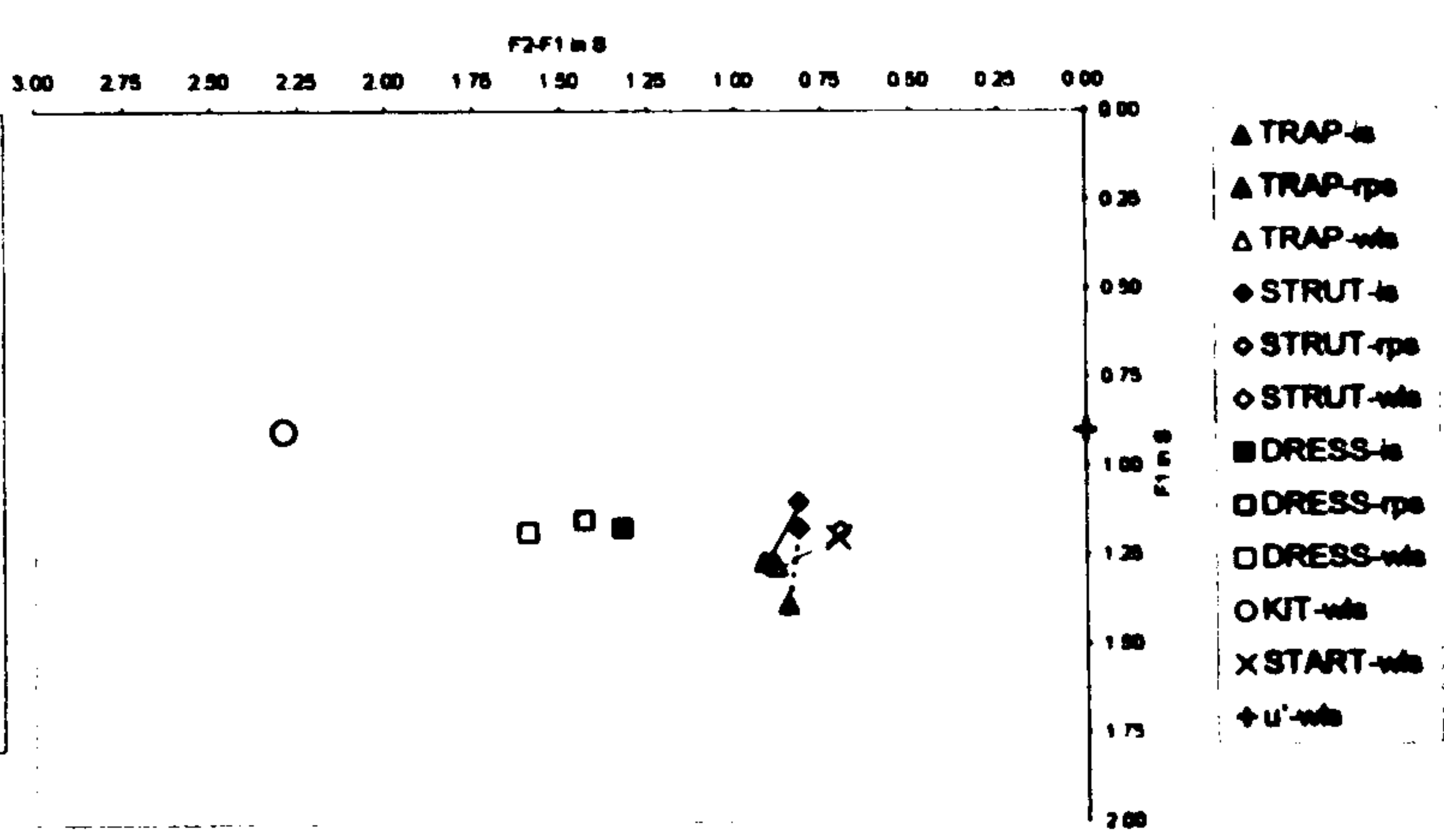


Figure 117 Selected vowel system for F08 (F-Y-UMC) in three speech styles

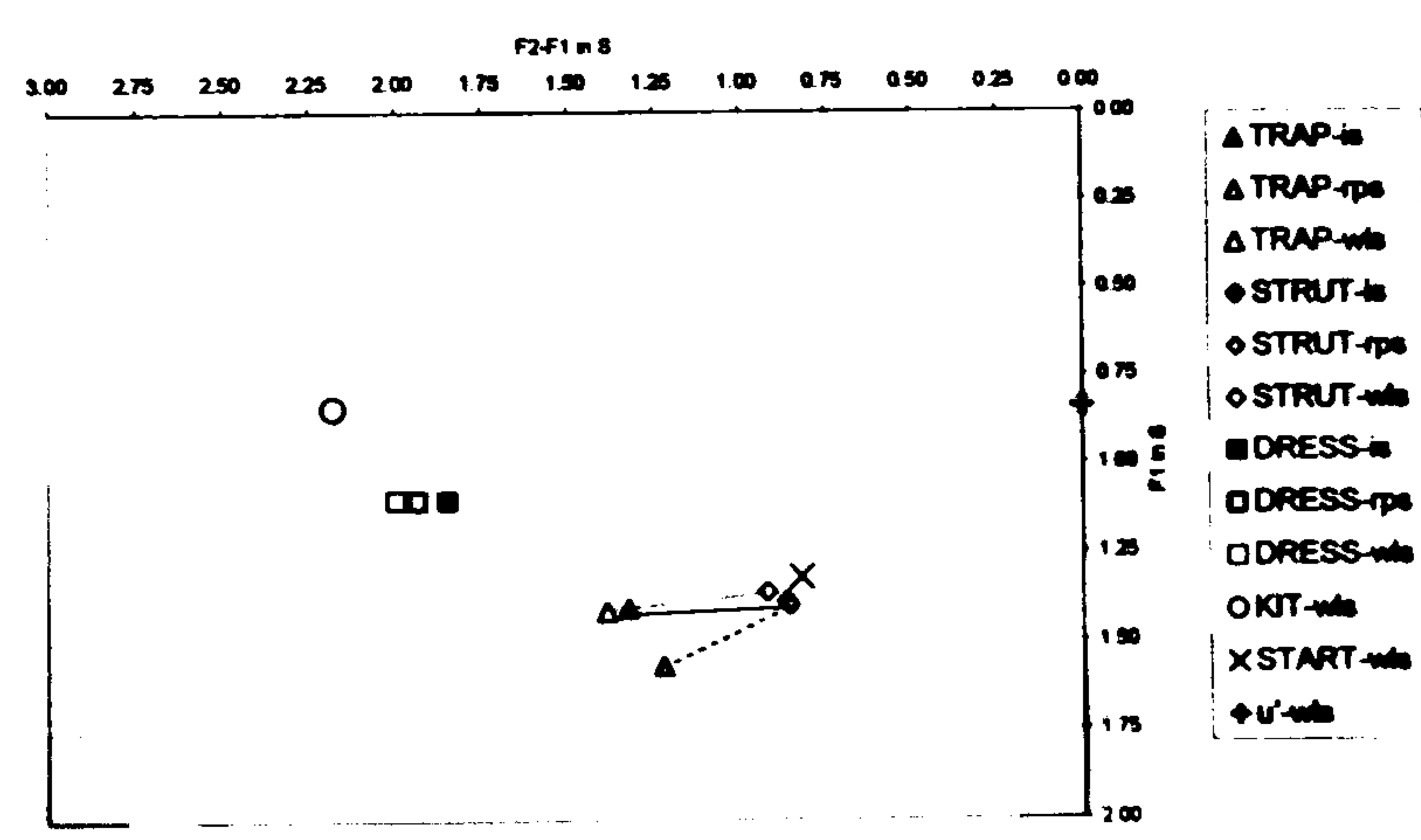


Figure 118 Selected vowel system for F15 (F-O-UMC) in three speech styles

8.1.2 Angles by phonetic environments

Table 95 shows that the difference between means across phonetic environments was found to be significant at the level of $p<0.05$ in all the tests (i.e. T21', T22' and T23'). Subsequent *post hoc* pairwise comparisons revealed that the mean angle before nasals (+1 degree) was smaller than those before obstruents (i.e. voiceless stops (+9 degrees, $p<0.05$), voiced stops (+11 degrees, $p<0.05$), voiceless fricatives (+13 degrees, $p<0.01$) and voiced fricatives (+16 degrees, $p<0.05$)). Looking at the results for the interactions in Table 95, there was no significant interaction between phonetic environments and any of the other factors. These non-significant interactions were further examined by the simple effects tests and subsequent *post hoc* pairwise comparisons. As a result, significant simple effects of phonetic environments were only found for the young. Their mean angles were significantly smaller before nasals (+5 degrees) compared to voiceless stops (+18 degrees, $p<0.01$), voiced stops (+21 degrees, $p<0.05$), voiceless fricatives (+20 degrees, $p<0.05$) and voiced fricatives (+23 degrees, $p<0.05$). Looking at Table 94, this pattern seems to be more noticeable for the UMC speakers among the young. Figure 119 to Figure 122 demonstrate actual angles by phonetic environments for F07 (F-Y-UMC), F08 (F-Y-UMC), M06 (M-Y-UMC) and M08 (M-Y-UMC) respectively. Corresponding TRAP and STRUT vowels before stops, fricatives and nasals are connected by a coarser dotted line, a finer dotted line and a bold line respectively.

As we will see below, both female and male speakers among Y-UMC generally have greater angles, i.e. small or steeper positive angles. Before nasals, however, the angles become relatively smaller compared to the other environments as in F07 (Figure 119), or remarkably smaller to such an extent that they reach small or steeper negative angles as in the cases of F08 (Figure 120), M06 (Figure 121) and M08 (Figure 122).

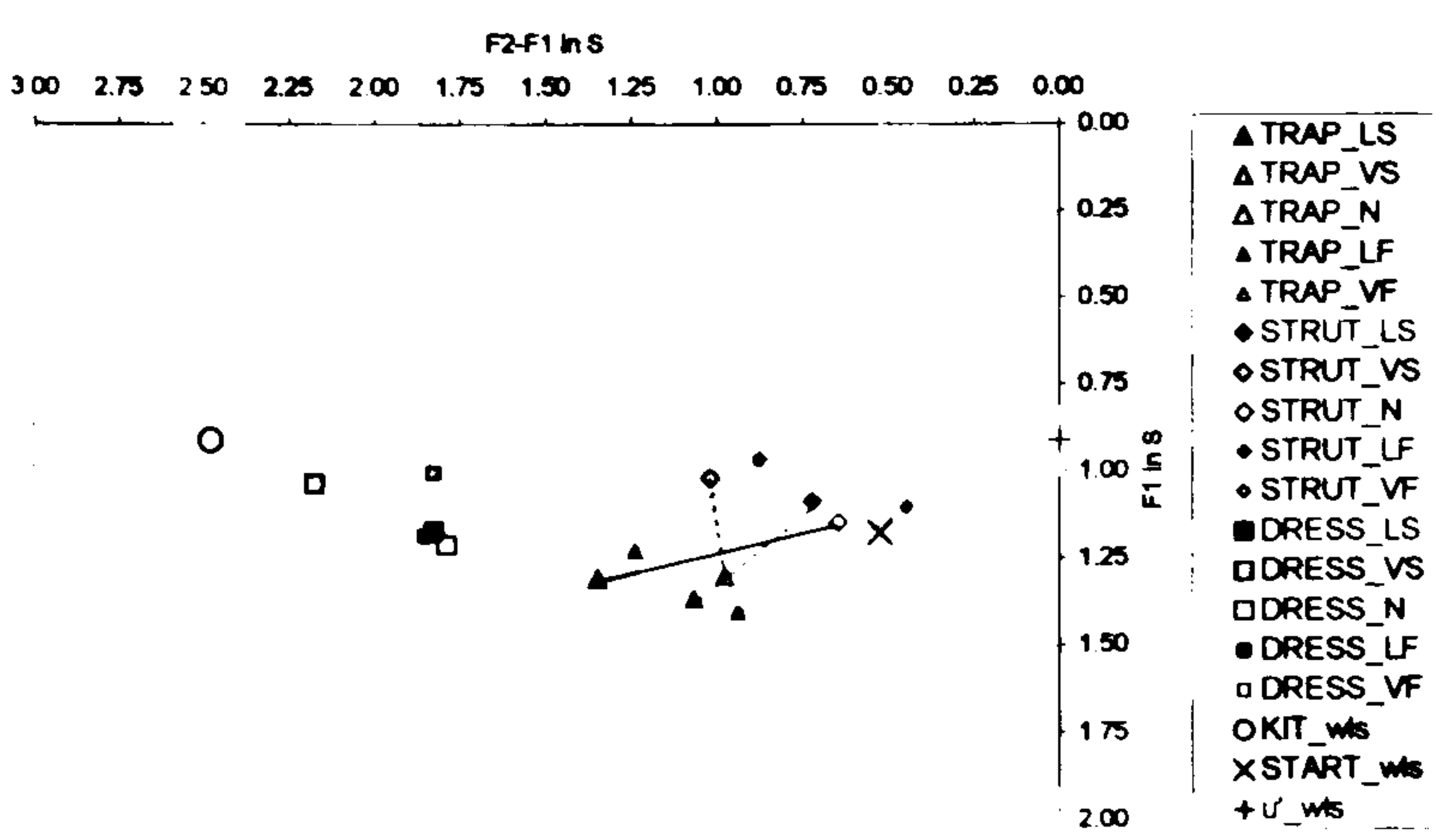


Figure 119 Selected vowel system for F07 (F-Y-UMC) in five phonetic environments

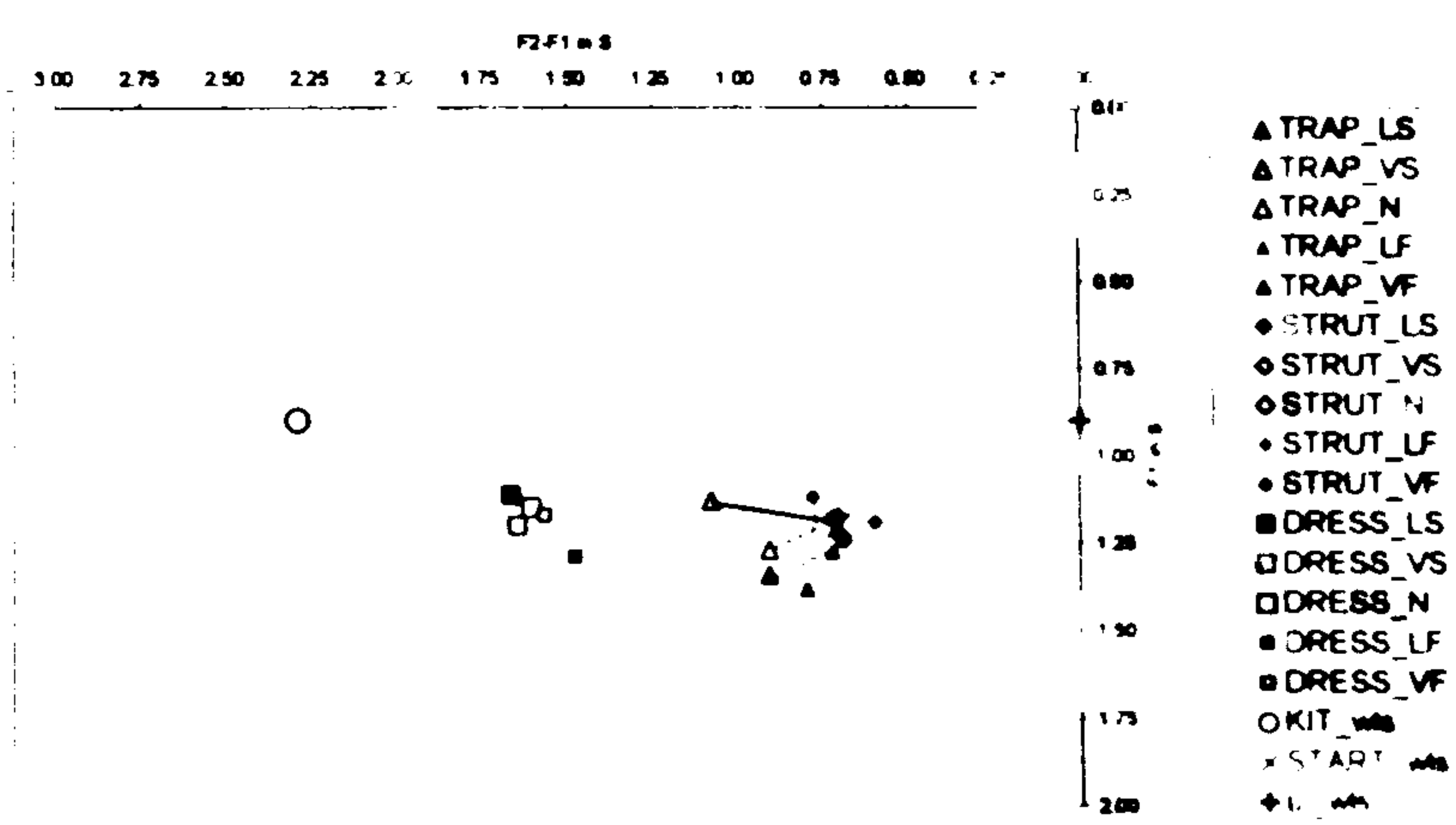


Figure 120 Selected vowel system for F08 (F-Y-UMC) in five phonetic environments

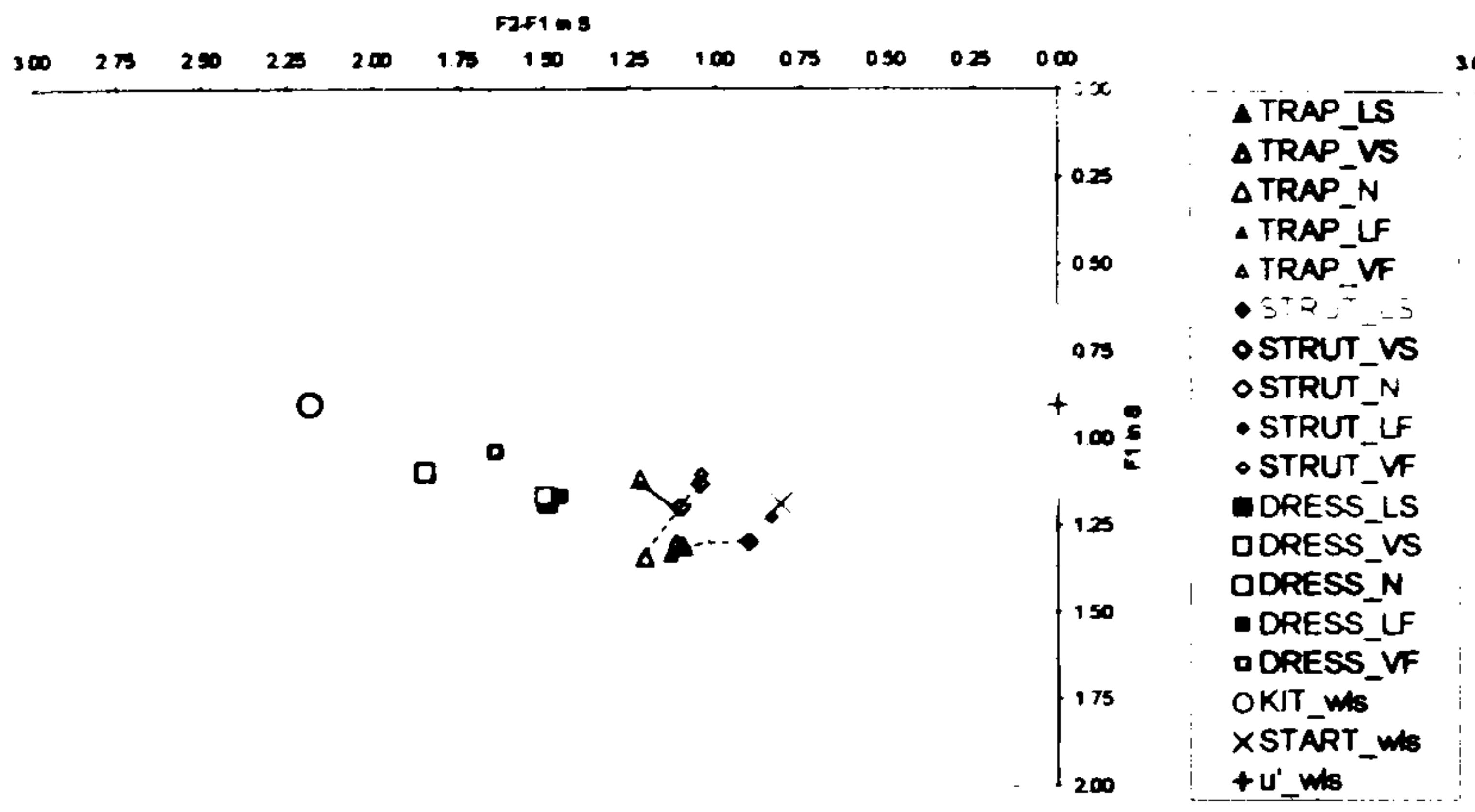


Figure 121 Selected vowel system for M06 (M-Y-UMC) in five phonetic environments

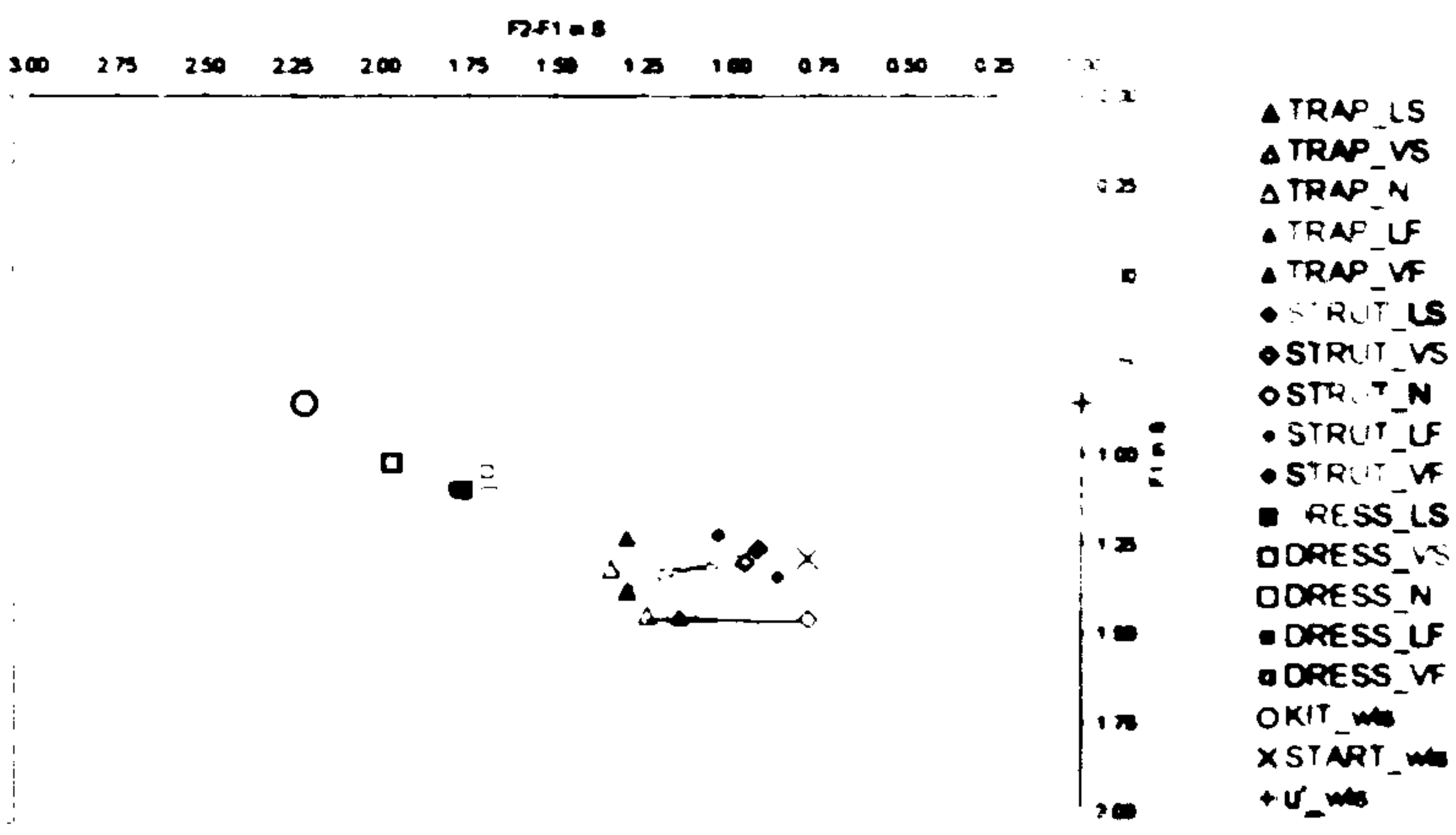


Figure 122 Selected vowel system for M08 (M-Y-UMC) in five phonetic environments

8.1.3 Angles by sex

Looking at Table 95, the main effect of sex was shown to be non-significant in T11', F(1, 30)=2.445, *p*=0.128, and in T21', F(1, 30)=3.792, *p*=0.061, indicating that there was not a significant effect of sex on the angle values both for the entire data and for WLS data in particular. There were no significant interaction effects obtained for sex in relation to either speech styles or phonetic environments. Further simple effects tests of sex were also not significant for any conditions of speech style and phonetic environment (*p*>0.5). However, there was a significant difference between the F-Y-UMC and the M-Y-UMC. The details will be shown in the results for the effects of social groupings below.

8.1.4 Angles by age

The main effect of age was shown to be very highly significant in T12', F(1, 30)=3.625, p<0.001, and in T22', F(1, 30)=7.785, p<0.001, indicating that the mean angle values were significantly greater for the young than for the old both in the entire data and in WLS data in particular. Further simple effects tests revealed that this was also true in IS: F(1, 30)=17.043, p<0.001, RPS: F(1, 30)=8.609, p<0.01 and WLS: F(1, 30)=6.5, p<0.05, and before stops (i.e. voiceless stops: F(1, 30)=6.847, p<0.05, and voiced stops: F(1, 30)=7.605, p0.01). There was also a significant interaction effect between age and speech styles, F(2, 60)= 3.625, p<0.05, since the young had a significant simple effect of speech styles but the old had no such effect as we have seen in Table 97. The significant age effect was only true between the F-Y-UMC and the F-O-UMC and between the M-Y-UMC and the M-O-UMC, but not between the F-Y-WC and the F-O-WC and between the M-Y-WC and the M-O-WC. The details will be provided in the results for the effects of social groupings.

8.1.5 Angles by social class

Similarly, the main effect of social class was found to be very highly significant in T13', F(1, 30)=15.878, p<0.001, and in T23', F(1, 30)=13.901, p<0.001, indicating that the mean angle values were significantly greater for the UMC compared to the WC in both entire data and WLS data in particular. Further simple effects tests revealed that this was also true in IS: F(1, 30)=8.328, p<0.01, RPS: F(1, 30)=19.619, p<0.001 and WLS: F(1, 30)=13.627, p<0.001, and before obstruents (i.e. voiceless stops: F(1, 30)=4.392, p<0.05, voiced stops: F(1, 30)=5.966, p<0.05, voiceless fricatives: F(1, 30)=9.147, p<0.01, and voiced fricatives: F(1, 30)=6.453, p<0.05). There was also a significant interaction effect between social class and speech styles, F(2, 60)=6.343, *p*<0.01, since the UMC had a significant simple effect of speech styles but the WC had no such effect as was seen in Table 97. The significant social class difference was especially true between the F-Y-WC and the F-Y-UMC, between the M-Y-WC and the M-Y-UMC, and between the M-O-WC and the M-O-UMC, but not between the F-O-WC and the F-O-UMC. The details will be presented in the results for the effects of social groupings below.

8.1.6 Angles by social groupings: sex x age x social class

Table 95 shows that the main effect of social groupings is very highly significant, F(7, 24)=17.673, *p*<0.001, indicating the mean angles were significantly different between the groupings. Subsequent *post hoc* pairwise comparisons revealed how different they were. Table 98 provides the results of the pairwise comparisons by inequality signs with asterisks for significance level:

Table 98 Angle measurements: Post hoc pairwise comparisons by LSD for social groupings by sex x age x social class in T14' (selected results for sex, age, and social class comparisons are in the dark grey cells, the medium grey cells, and the light grey cells respectively)

	F-Y-WC	F-Y-UMC	F-O-WC	F-O-UMC	M-Y-WC	M-Y-UMC	M-O-WC	M-O-UMC
F-Y-WC	x	<***	**ns**	ns	**ns**	<**	>*	ns
F-Y-UMC		x	>***	**>*** **	>***	**>** **	>***	>***
F-O-WC			x	**ns**	ns	<***	**ns**	ns
F-O-UMC				x	ns	<**	>*	**ns**
M-Y-WC					x	**<*** **	**ns**	ns
M-Y-UMC						x	>***	**>** **
M-O-WC							x	<*
M-O-UMC								x

There are several tendencies to be found from the results. Firstly, the mean angle for the F-Y-UMC (+56 degrees) was greater than those for any other groups (-7 to +32 degrees) (see Table 96 for detailed mean values). Secondly, the mean for the M-Y-UMC (+32 degrees) was greater than those for all the others except the F-Y-UMC (-7 to +11 degrees). Thirdly, the mean for the M-O-WC (-7 degrees) was smaller than those for any other groups except the F-O-WC and the M-Y-WC (i.e. +5 degrees). These three results are also clear from the distribution of mean angle values for individual speakers in Table 93 and Figure 113. That is, on the one hand, the average values for the F-Y-UMC (ranging between +33 and +69 degrees, i.e. steeper positive angles) are greater than those for the M-Y-UMC (ranging between +17 and +50 degrees, i.e. shallow positive angle and steeper positive angles), both of which are greater than those for the other groups (ranging between -9 and +23 degrees, i.e. shallow negative angles and shallow positive angles). The average values for the M-O-WC (ranging between -9 and -4 degrees, i.e. shallow negative angles), on the other hand, are smaller than those for any other groups except the F-O-WC and the M-Y-WC whose scores similarly range between -6 and +13 degrees and between -1 and +7 degrees respectively. Fourthly, focusing on the sex comparisons (in dark grey cells), the mean angle was greater for the females compared to the males within the Y-UMC (+56 vs. +32 degrees). This was particular for these groups, since, as we have seen above, the effect of sex was not significant in general or in any condition of speech styles and phonetic environments. Fifthly, focusing on the age comparisons (in medium grey cells), it was greater for the young compared to the old within the F-UMC (+56 vs. +11 degrees) and the M-UMC (+32 vs. +10 degrees). This age difference is consistent with the results from the main effect and simple effects of age seen above. Lastly, focusing on social class comparisons (in light grey cells), it was greater for the UMC compared to the WC within the F-Y (+56 vs. +11 degrees), the M-Y (+32 vs. +5 degrees) and the M-O (+10 vs. -7 degrees). This social class difference is, again, consistent with the results from the main effects and simple effects of social class.

Let us now look at the results for the interactions between social groupings and speech styles in Table 95. It is found that the interaction is significant, $F(14, 48)=2.125$, $p<0.05$. This interaction was further examined by simple effects tests and *post hoc* pairwise comparisons by LSD. As a result, the simple effects of social groupings were found to be very highly significant in all speech styles, i.e. IS: $F(7, 24)=10.803$, $p<0.001$, RPS: $F(7, 24)=13.914$, $p<0.001$, and WLS: $F(7, 24)=9.933$, $p<0.001$. The results of the pairwise comparisons in each speech style are presented in Table 99 jointly where different results for IS, RPS and WLS are separated by a slash (/) if there are any:

Table 99 Angle measurements: Post hoc pairwise comparisons by LSD for the simple effect of social groupings in IS / RPS / WLS (selected results for sex, age, and social class comparisons are in the dark grey cells, the medium grey cells, and the light grey cells respectively)

	F-Y-WC	F-Y-UMC	F-O-WC	F-O-UMC	M-Y-WC	M-Y-UMC	M-O-WC	M-O-UMC
F-Y-WC	x	<***	ns	ns	ns	ns/<**/<*	>**/>*/ns	ns
F-Y-UMC		x	>***	>***	>***	>*/**/**	>***	>***
F-O-WC			x	ns	ns	<**/***/*	ns	ns
F-O-UMC				x	ns	<**/<*/ns	ns/>**/ns	ns
M-Y-WC					x	<**/***/*	ns	ns
M-Y-UMC						x	>***	>*/**/*
M-O-WC							x	<*/<*/ns
M-O-UMC								x

While the pattern found in RPS was the same as the general pattern in Table 98, those found in IS and WLS were slightly different from the general pattern. Firstly, the mean angle for the M-Y-UMC was not significantly greater than that for the F-Y-WC in the IS (+35 vs. +21 degrees), and that for the F-O-UMC in the WLS (+19 vs. +7 degrees). Secondly, the mean angle for the M-O-WC was not significantly smaller than that for the F-O-UMC in the IS (-6 vs. +6 degrees) and WLS (-7 vs. +7 degrees), and that for the F-Y-WC in the WLS (-7 vs. +1 degrees). Lastly, the mean angle for the M-O-UMC was not greater than that for the M-O-WC (no social class difference in the M-O) in the WLS (+3 vs. -7 degrees). With regard to the last point, looking at the relevant parts in Table 93 and Figure 113, the angle values for the M-O-UMC in the WLS are not only shallow positive angles (up to +11 degrees) but also shallow negative angles (down to -10 degrees), which are typical for the M-O-WC speakers regardless of their speech styles. Therefore, in more formal non-spontaneous speech style, there was no significant difference in angles between the M-O-UMC and the M-O-WC. Focusing on the other sex, age and social class comparisons, the results were the same as in Table 98. In detail, for the sex comparisons, the angles were significantly greater for the females compared to the males within the Y-UMC in all speech styles as between F08 (F-Y-UMC) in Figure 117 and M07 (M-Y-UMC) in Figure 116 or M05 (M-Y-UMC) in Figure 123. In the case of age comparisons, the angle was greater for the young compared to the old within the F-UMC and the M-UMC in all speech styles as can be compared between F08 (F-Y-UMC) in Figure 117 and F15 (F-O-UMC) in Figure 118, and between M07 (M-Y-UMC) in Figure 116 and M16 (M-O-UMC) in Figure 126 respectively. As to the social class comparisons, the angle was greater for the UMC compared to the WC within the F-Y, the M-Y and the M-O, as, for example, can be compared between F08 (F-Y-UMC) in Figure 117 and F04 (F-Y-WC) in Figure 124, between M07 (M-Y-UMC) in Figure 116 and M04 (M-Y-WC) in Figure 125, and between M16 (M-O-UMC) in Figure 126 and M09 (M-O-WC) in Figure 127.

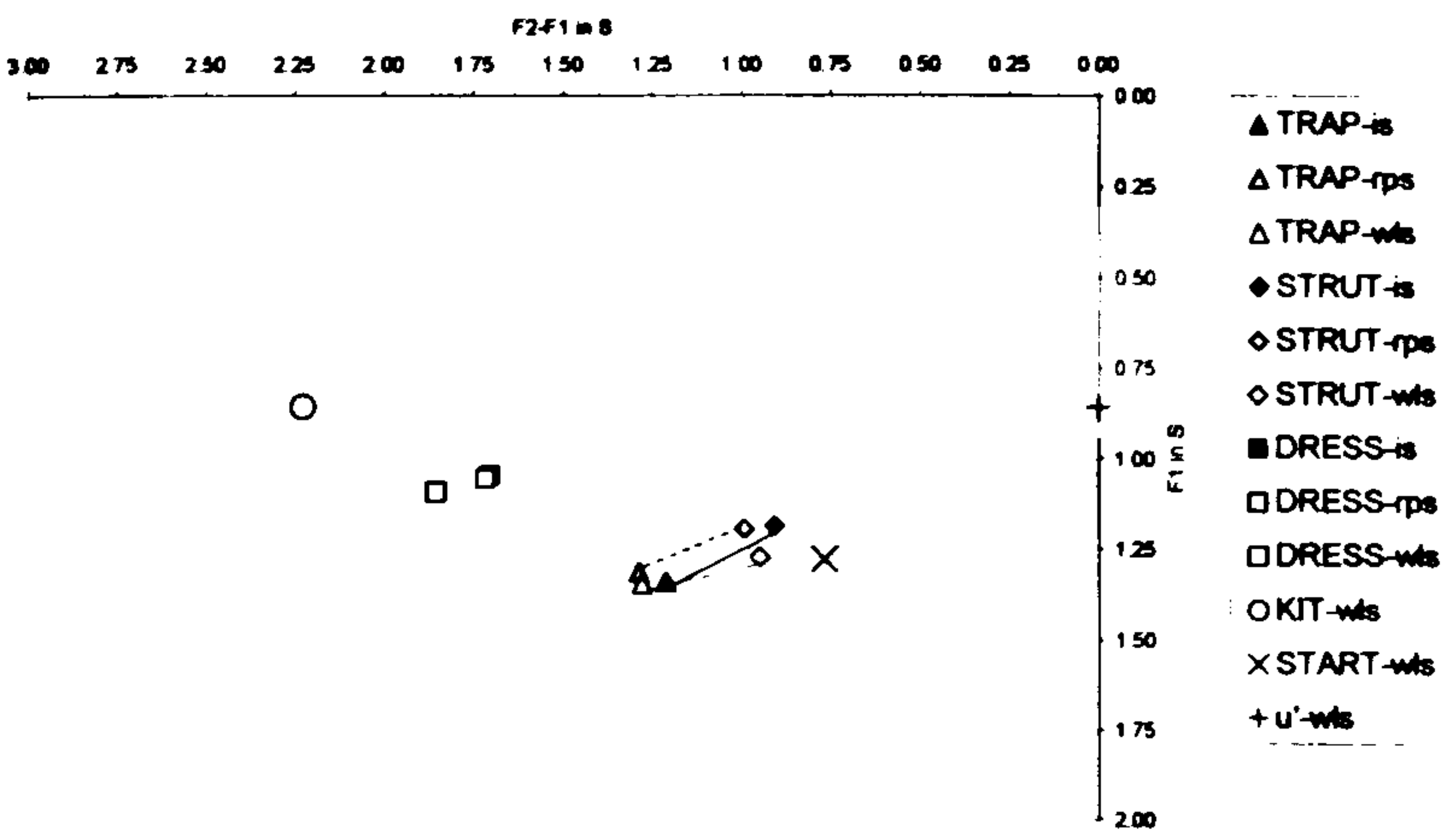


Figure 123 Selected vowel system for M05 (M-Y-UMC) in three speech styles

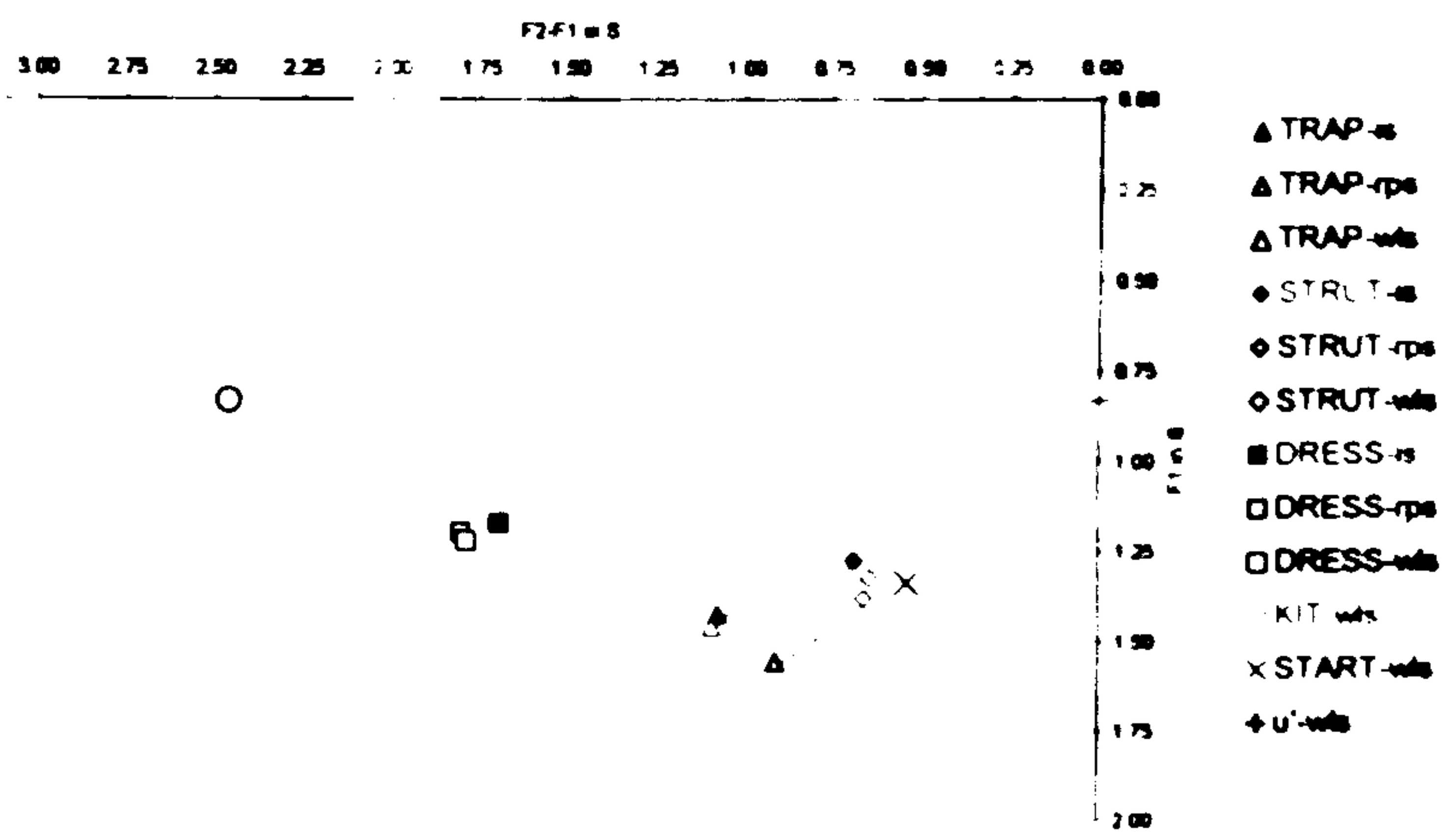


Figure 124 Selected vowel system for F04 (F-Y-WC) in three speech styles

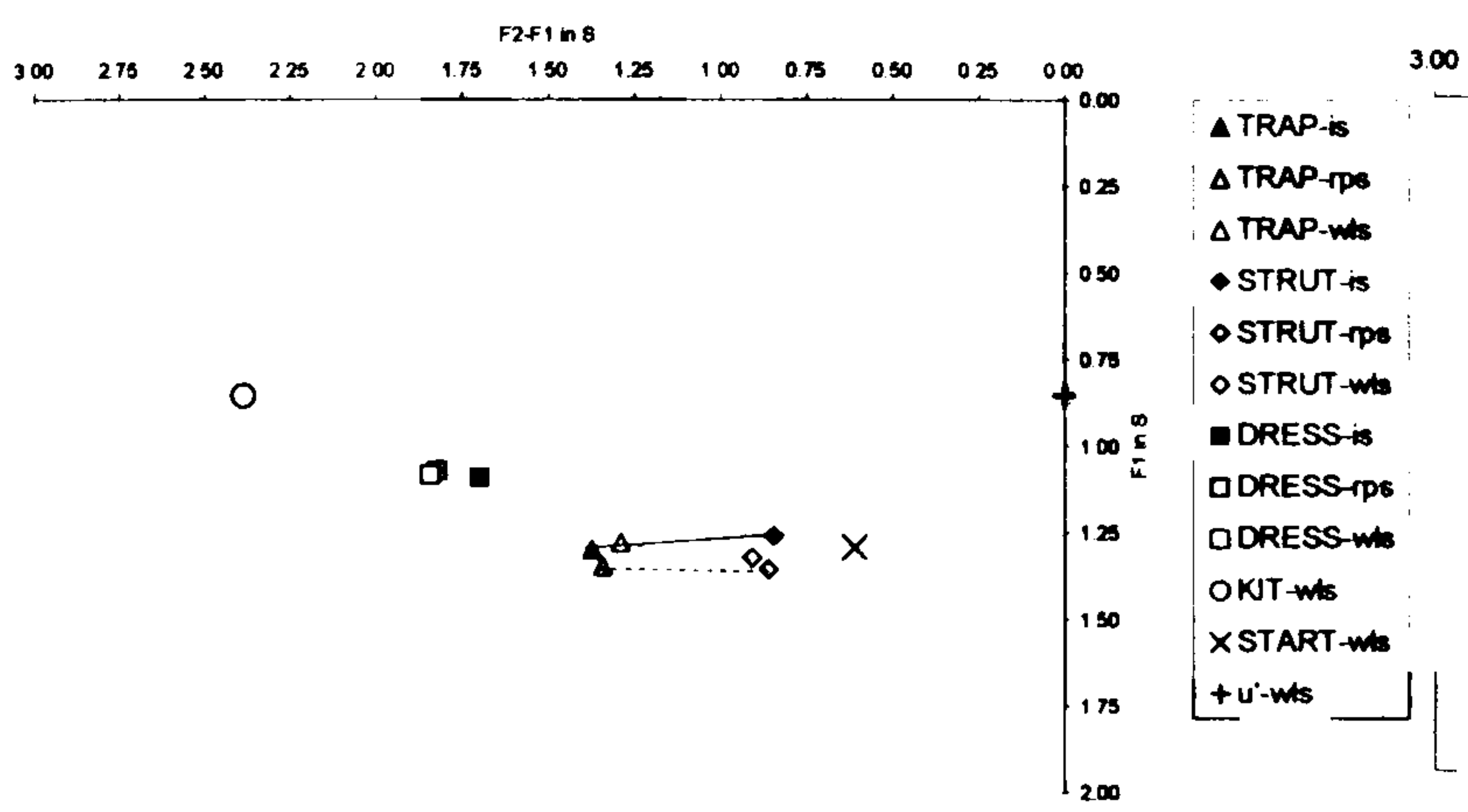


Figure 125 Selected vowel system for M04 (M-Y-WC) in three speech styles

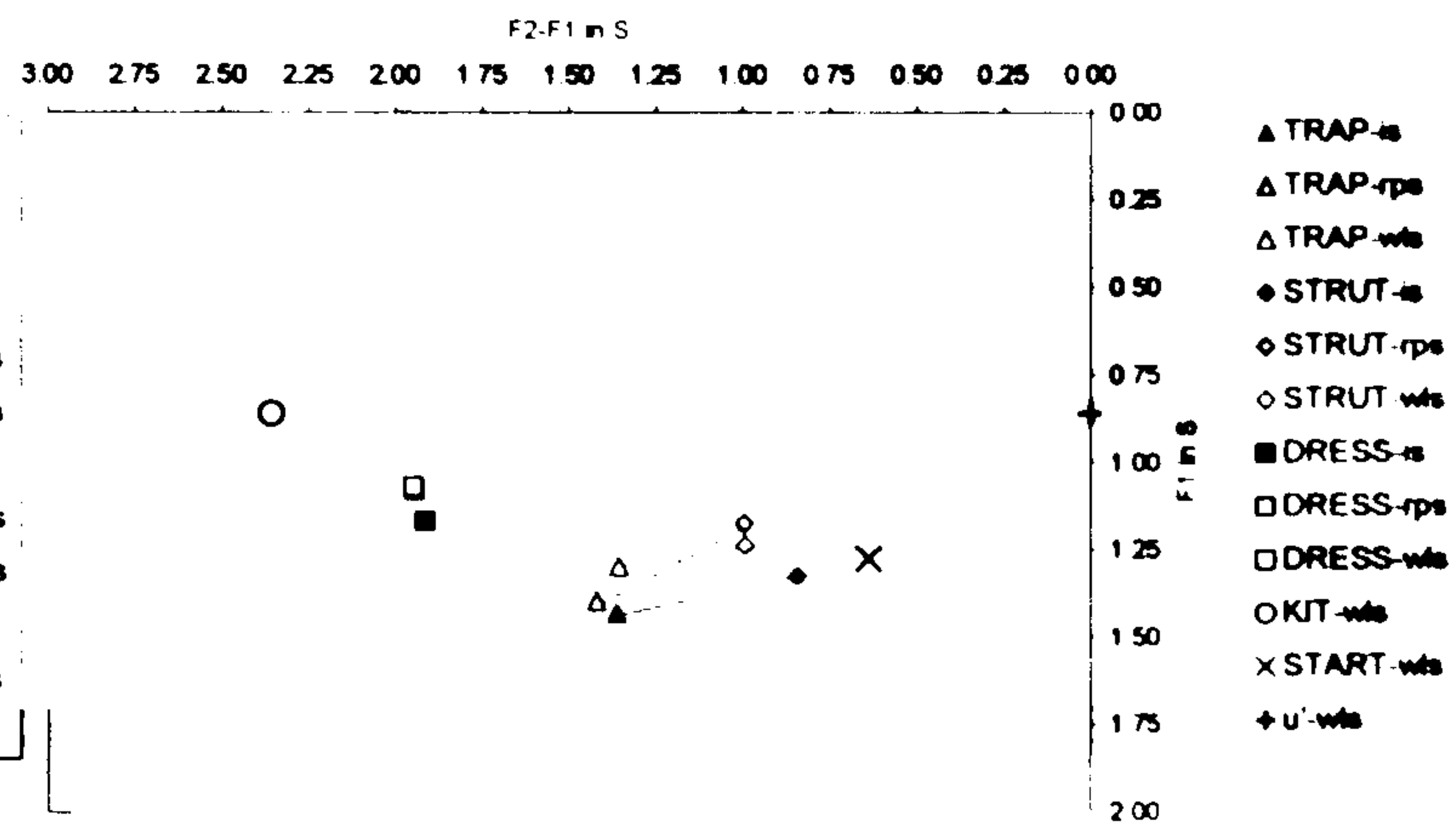


Figure 126 Selected vowel system for M16 (M-O-UMC) in three speech styles

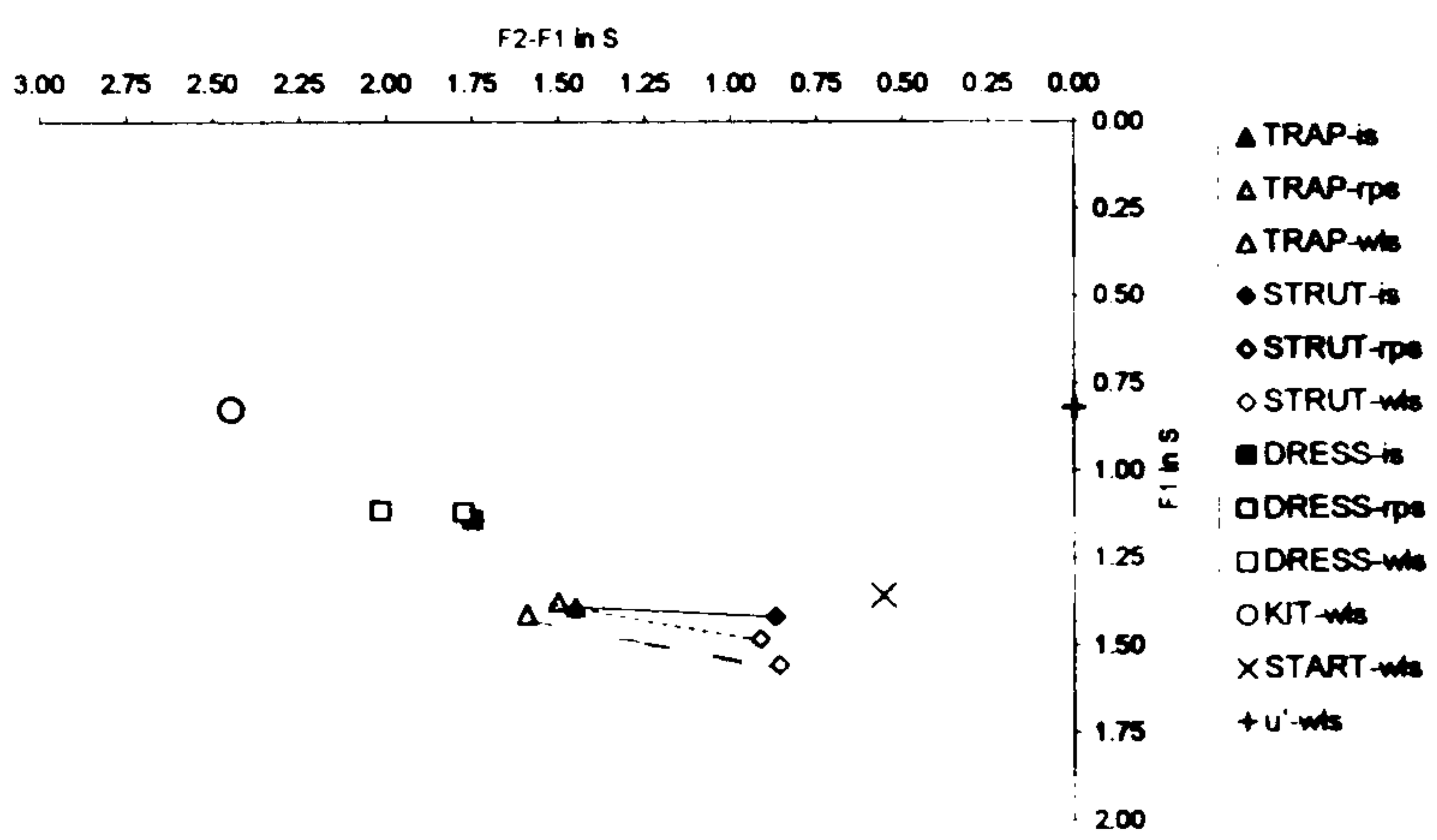


Figure 127 Selected vowel system for M09 (M-O-WC) in three speech styles

8.2 Summary and discussions

As a whole, the data clearly indicate that there exist both diachronic realignment and synchronic social/phonological differences of the relative positions of TRAP and STRUT vowels and supports the currently ongoing process of TRAP/STRUT rotation among RP speakers described in Fabricius (2007: 310). The diachronic change in the angles was found from our apparent-time comparison between young and old speakers, while synchronic differences were found in the form of social and phonological differences.

8.2.1 Speech styles

First of all, with regard to the speech style difference, the statistical analyses showed that the mean angles were influenced by formality of speech. Although the difference between spontaneous and non-spontaneous speech was not significant, the angles in more formal non-spontaneous speech were constantly smaller than in less formal speech styles, particularly than in less formal non-spontaneous speech in general and in most of the subcategories of the factors (see Table 97). This configurational difference between TRAP and STRUT vowels across speech styles seems to be generally achieved by closer TRAP vowels and more open STRUT vowels in the WLS as can be seen in the Figure 89. Of particular interest were the interactions between speech styles and one of the other factors, i.e. sex, age, social class, or social groupings, and the subsequent simple effects tests of speech styles for each condition of these factors. The results from the significant simple effect of speech styles for different conditions will be summarised below, and the patterns observed in different conditions will be discussed in relation to each of the other factors, i.e. sex, age, social classes and social groupings.

8.2.2 Phonetic environments

The mean angles were also significantly different depending on the type of following segment. They were generally smaller before nasals compared to obstruents. Looking back at Figure 92 for the relative position of TRAP and STRUT vowels, this difference in angles between before-nasals and before-obstruents were achieved by fronter TRAP vowels and more open STRUT vowels before nasals which forms a rather horizontal configuration between the two vowels, resulting in the smaller angles. Further simple effects tests revealed, however, that this difference due to the following segments was only observed for the young speakers. The significant pattern for the young was exactly the same as the general pattern. These results may suggest that the TRAP/STRUT rotation tends to be phonologically restrained before nasals compared to obstruents (among the young).

8.2.3 Age difference

As for the diachronic realignment, the current apparent-time investigation revealed a statistically very highly significant difference between young and old speakers in their angles in general, with the angles of the young greater than those of the old. The pairwise comparisons between social groupings (cf. Table 98 and Table 99) revealed that this age difference was only true when we compared the young and old groups of the same sex in the UMC – i.e. our London UMC speakers – as can be seen in Table 93 and Figure 113; the angles for the old UMC speakers range from 'shallow negative angles' (-10 degrees at smallest) to 'shallow positive angles' (below 30 degrees), whereas those for the young UMC speakers range from 'shallow positive angles' (+8 degrees at smallest) to 'steeper positive angles' (up to 82 degrees). These results correspond to the configurational patterns found in the real-time investigation of these two vowels for RP speakers by Fabricius (2007) as we have seen above (§4.6.2). That is, our older London UMC speakers born between 1934-54, on the one hand, seem to match Fabricius's older RP speakers born between 1926-45 in that they both showed the 'shallow negative/positive angles' to have the mid-twentieth century configuration 'with TRAP and STRUT both peripheral and on a similar level' (Fabricius 2007: 310, cited in §4.6.2, and see Figure 118 and Figure 126 above). Our younger London UMC speakers born between 1978-87, on the other hand, correspond to Fabricius's younger RP speakers born between 1976-80 in that they were the only group who showed 'steeper positive angles' to have the later twentieth century configuration 'with TRAP lowest and STRUT non-peripheral' (Fabricius 2007: 310, and see Figure 116 and Figure 117 above). The fact that this generational difference was not found within our WC – i.e. London WC – speakers suggests that this is an ongoing change happening particularly in RP. Moreover, our detailed statistical tests also revealed more profiles with some synchronic social/phonological characteristics for this trend. Firstly, this tendency was true in each of three speech styles, which is considered as additional convincing evidence for this diachronic change. Secondly, this generational difference was statistically significant only when the vowels were before stops (see the Figure 114). In other words, the angles for the young were significantly greater than those for the old when the vowels were followed by stops, which may indicate there is a phonological constraint in terms of the type of the following segments operating for this configurational pattern. That is, this historical TRAP/STRUT rotation may be particularly progressed before stops. Recalling the results for the relative positions of the TRAP and STRUT vowels in Figure 98, significant generational shifts were observed not only for the TRAP (as backing from the old to the young) but also for the STRUT (as raising from the old to the young) before stops, whereas there was such a shift only for the TRAP (backing) before nasals and fricatives. That is, the

TRAP/STRUT rotation for the young may be enhanced before stops because of the raising of STRUT in addition to the backing of TRAP. Thirdly, the significant interaction between age and speech styles – in which the young speakers showed stylistic variation for their angles whereas the old did not – may possibly be suggesting that, for the young (especially London UMC) speakers, the alignment between TRAP and STRUT is stylistically determined. The results from the analysis of relative vowel positions across speech styles shown in Figure 89 show that the young speakers use lowered TRAP vowels, which form greater angles, in less formal speech style (RPS, but not IS); however, they use raised TRAP vowels with smaller angles in more formal non-spontaneous speech style to have the similar alignment of these two vowels of their older counterparts, possibly because of social constraint/pressure. Moreover, interestingly, exceptions for this age and speech style interaction were found for the F-Y-WC and the F-O-UMC, both of which had similar stylistic variations to the young London UMC speakers; that is, their angles were significantly smaller in more formal non-spontaneous speech style (cf. Table 97). Considering the fact that their male counterparts – M-Y-WC and M-O-UMC – did not have such a significant style difference, the common factor between these two groups – i.e. being women – may have something to do with this pattern. That is, the general sociolinguistic pattern for women whose tendency is towards a more 'standard' or 'innovative' or 'non-localisable' way of speaking may be attributed to the patterns for these particular groups. This is, however, an unsure speculation, since the sex difference was not only found to be non-significant in all conditions of speech styles and phonetic environments, but also shown to be non-significant from the sex comparisons between F-Y-WC and M-Y-WC and between F-O-UMC and M-O-UMC (cf. Table 98 and Table 99).

8.2.4 Social class difference

Regarding social class difference, the mean angles were in general very significantly greater for the UMC compared to the WC, indicating that the TRAP/STRUT rotation was, as mentioned above, especially happening among our London UMC speakers. The pairwise comparisons between social groupings (cf. Table 98 and Table 99) revealed that this social class difference was true when we compared the F-Y-UMC with the F-Y-WC, the M-Y-UMC with the M-Y-WC and the M-O-UMC with the M-O-WC as can be seen in Table 93 and Figure 113. The angles for the F-Y-WC and the M-Y-WC range from 'shallow negative angles' to 'shallow positive angles', while those for the F-Y-UMC and the M-Y-UMC range from 'shallow positive angles' to 'steeper positive angles'. The social class difference between these groups was constantly true in all three speech styles. This may suggest that the presence versus absence of the TRAP/STRUT rotation is considered to be the class marker between UMC and WC among the young speakers regardless of the formality. In the case of the M-O groups, the angles for the M-O-WC are constantly showing zero or 'shallow negative angles', whereas those for the M-O-UMC range from 'shallow negative angles' to 'shallow positive angles'. The social class difference between these two groups was true except in more formal non-spontaneous speech style. These results may lead us to speculate an interesting perspective on the M-O group. That is, although the M-O-UMC speakers did not show any evidence for the TRAP/STRUT rotation with the angles much smaller than the young speakers in the same social class group, they did show a significant difference from the WC speakers of the same sex and age group by having slightly greater angles than the M-O-WC in less formal speech styles. In the more formal non-spontaneous speech style, however, the M-O-UMC speakers tended to show mainly shallow negative angles which were not significantly different from those for the M-O-WC. Considering the general tendency of language behaviour in the most formal speech style, this 'shallow negative angles' might have been considered by the M-O-UMC as the more *correct* choice in that it was closer to the configuration used by the generation older than them who showed 'steeper negative angles' as in Fabricius's oldest speaker born in 1909 (Fabricius 2007: 304-5, see also Figure 4). The fact that such a social class difference was not observed between the F-O-WC and the F-O-UMC who showed 'shallow negative/positive angles' may be because regardless of social class the female old speakers tended to use more conservative (non-rotated TRAP/STRUT) variations. The detailed statistical tests also revealed more profiles for this social class difference. Firstly, this social class difference in angles was true in each of three speech styles, which is considered as further evidence for the perspective that the TRAP/STRUT rotation is a change among the RP speakers. Secondly, this social class difference was statistically significant in all the phonetic environments except before nasals. In this environment, as can be seen from Table 96, the mean angles for both of the WC and the UMC were fairly small with relatively small differences between them. Thirdly, the significant interaction between social class and speech styles – in which the UMC speakers showed stylistic variation for their angles whereas the WC did not – may possibly be suggesting that, for the UMC speakers, the alignment between TRAP and STRUT is stylistically determined. Looking back at Figure 89 at the results of the analysis of the relative positions of the TRAP and STRUT across three speech styles, the UMC speakers showed significantly closer TRAP vowels and more open STRUT vowels, to have smaller angles in the WLS compared to the RPS (and the IS), indicating that the relative positions of the two vowels as well as the angles may be associated with formality for the UMC but not for the WC.

8.2.5 Sex difference

Unlike the age and social class differences in angles, it was found that the mean angles between female and male speakers were not significantly different. This non-significant sex difference was also found in all the conditions of speech styles and phonetic environments. The detailed pairwise comparisons between social groupings (cf. Table 98 and Table 99) found, however, that the mean angles of the females were significantly greater than those of the males when we compared sex within the Y-UMC as can be seen in Table 93 and Figure 113. Moreover this sex difference within the Y-UMC was constantly true in all three speech styles. These results suggest that the degree of TRAP/STRUT rotation is constantly greater for the females than the males within the young UMC speakers. Furthermore, the detailed simple effects tests also revealed more profiles of this sex difference in relation to speech styles and phonetic environments. Firstly, the non-significant interaction between sex and speech styles revealed that both female and male speakers showed the same stylistic variations; their angles are smaller in the WLS compared to the IS and the RPS. As we saw above, this is the same as the general stylistic tendency of the angles. Therefore, the smaller angles – i.e. non-rotated or less-rotated TRAP and STRUT alignments – seem to be related to the greatest formality. Secondly, the non-significant interaction between sex and phonetic environments revealed that the angles for both female and male speakers were not influenced by any of the five following segments.

8.2.6 Social groupings

The effect of social groupings on the angles was found to be very highly significant. The angles were significantly higher for the F-Y-UMC (predominantly 'steeper positive angles') than all the other groups, followed by the M-Y-UMC ('shallow/steeper positive angles'), and lower for the M-O-WC (predominantly 'shallow negative angles) than all the others except for the F-O-WC and the M-Y-WC ('shallow negative/positive angles) in general and in RPS (cf. Table 98 and Table 99). This clearly showed that the TRAP/STRUT rotation was led by the young London UMC speakers, especially the female ones, and that this process was not operating for the London WC speakers, especially the M-O ones; however, the possible exception should be the female young London WC speakers whose angles fluctuate more widely than other London WC (i.e. WC) speakers, from 'shallow negative angles' to 'shallow positive angles' and slightly 'steeper positive angles', which could be considered a possible sign of incipient rotation. In the IS and WLS styles, the patterns of angles between groupings were only slightly different in terms of the significance of pairwise comparisons involving either M-Y-UMC or M-O-WC, however, the fact that the angles for the F-Y-UMC were the greatest was always true regardless of speech styles (cf.

Table 99). The significant interaction between social groupings and speech styles indicate that the stylistic variations did differ between these groupings. The significant simple effects of speech styles were observed for the F-Y-WC, the F-Y-UMC, the F-O-UMC and the M-Y-UMC. The angles were smaller in more formal non-spontaneous speech style than in less formal non-spontaneous speech style for all of these groups, and than in less formal spontaneous speech style for all except the F-O-UMC. In the case of the F-Y-UMC, the angles were smaller in less formal non-spontaneous speech compared to less formal spontaneous speech style: that is, the angles increased for this group in the order of WLS, IS and RPS. Supposing that the smaller angles are related to the greater formality, this order of stylistic variation seems a little odd. The result may lead one to cast doubt on the validity of the interview procedure itself. Considering the fact that some other results have shown rather consistent stylistic variations from IS through RPS to WLS (cf. §6.4.2.1), however, it seems unlikely that there was a problem in the procedure itself. Instead, what needs to be considered here seems to be the significance threshold. Looking back at the Table 97 for the statistical results, it is noticed that the angles in IS and RPS for the UMC group, particularly the F-Y-UMC, are significantly different at the level of $p<0.05$ (to be precise, $p=0.014$ for the UMC, $p=0.043$ for the F-Y-UMC); in other words, they would not have been significantly different if the significance threshold was stricter, say, $p<0.01$. In the case for the F-Y-UMC, the alpha value of probability was very close to 0.05; therefore, it may be conceivable that the difference between IS and RPS for the F-Y-UMC was in fact a less important subtle difference. By increasing the significance level, all the statistical results should become much sharper, so that more prominent results would be left. Although this appears to be a solution to avoid possibly less meaningful results, it will create another problem as having been mentioned earlier (§6.1); that is, any potentially important subtle differences would also be missed out under such a stricter significant threshold. One should, therefore, be careful when drawing a final interpretation solely based on the statistical values.

9 Conclusions

The present study has investigated the correlations between the acoustic characteristics of the three short vowels – DRESS, TRAP and STRUT – and social/phonological characteristics of London UMC and London WC speakers not only by the traditional descriptions for the vowel formant plots of the two vowels in the *S*-normalised F1/F2-F1 vowel space, but also by the angle and Euclidean distance analyses innovated by Fabricius (2007). With thorough statistical tests, the results have revealed a great deal of general and minute patterns of the relative positions of these vowels both diachronically and synchronically, generational changes of these vowels within each sex of two different accent groups, and the changes in the angles of the line from TRAP to STRUT vowels relative to the horizontal line due to different factors.

Although all the results presented in the previous three chapters have already provided detailed answers to the research questions set up in §5.1 above, this chapter presents final remarks for each of the questions as well as for possible implications with regard to internal and external factors.

Q1. Are the three short vowels (DRESS, TRAP and STRUT) in London English shifting?

Yes, they are shifting. In London English as a whole, DRESS and TRAP vowels are backing, while STRUT vowels are raising (§6.5.4). These findings more or less follow an anticlockwise chain shift which has repeatedly been reported in the recent studies in RP, southeastern English English, and London English, whereas they provide counter evidence both for Labov's (1994) proposition for the tensing and raising of London short front vowels and for Trudgill's (2004) lowering and fronting process of STRUT in London. Although both TRAP and DRESS are generally not lowering in the current data, there is evidence of clear lowering for DRESS and a sign of lowering for TRAP only before nasals, indicating the lowering process for the short front vowels may be accelerated before nasals across generations. The backing of TRAP is well-established, observed regardless of speech styles and phonetic environment, whereas the backing of DRESS and the raising of STRUT are less-established being susceptible to stylistic and phonological conditions (§6.5.4). The backing of TRAP and the raising of STRUT give rise to a significant configurational change between these two vowels, enhancing the TRAP/STRUT rotation (§6.5.4, §8.2.3)

Q2. If the vowels are shifting, in which directions are they shifting in London WC and London UMC respectively?

In London UMC, vowels are shifting in the same way as the general shift observed for London English; DRESS and TRAP are backing, whilst STRUT is raising (§7.2). Considering the female and male London UMC speakers separately, however, slightly different vowel shifts are revealed (§7.4). For the female London UMC, in addition to the greater backing of DRESS and TRAP and the greater raising of STRUT, their STRUT vowels are also backing. Taking account of the phonological space of peripheral and nonperipheral tracks (Labov 1994: 177), this is argued to fit very well with Labov's (1994: 262) integrated General Principle of Vowel Shifting (cf. §3.1). For the male London UMC, on the other hand, in addition to the backing of DRESS and TRAP and the raising of STRUT, their TRAP vowels are also raising, which cannot be explained under Labov's Principle and which consequently leads us to cast doubt on the validity of the Principle itself. With regard to this issue, it is discussed that a given vowel change may need to be considered in a multidimensional vowel space containing not only formant frequencies (F1/F2) but also vowel duration and diphthongisation as suggested by Langstrof (2006). With regard to the Labov's Principle, it is argued that the key for the principle may lie in finding a clearer definition for the concept of peripherality.

Moreover, the vowels for the male London UMC seem to be centralising as a whole. Having given the shrinking of vowel space from non-spontaneous to spontaneous speech style found among male RP speakers in the study of Deterding (1997), it is discussed that these three short vowels of male London UMC speakers may be shifting from more formal type of speech to a less formal type of speech across two generations, leading to the following assumption; more peripheral short vowels may be associated with more formal and old-fashioned characteristics, while less peripheral short vowels with less formal and innovative characteristics among the male London UMC (§7.5). The backing of TRAP and the raising of STRUT for both female and male London UMC speakers bring about the TRAP/STRUT rotation; the degree of rotation is greater for the females whose overall vowel shifts are greater. These results suggest that young London UMC speakers, particularly the females, may lead this rotation most (§8.1, §8.2). The changes observed for the London UMC are to some extent in line with the anticlockwise chain shift which has been reported by recent studies such as Torgersen & Kerswill (2004), Hawkins & Midgley (2005), Torgersen *et al.* (2006) and Fabricius (2007), although the two front vowels do not show significant lowering but show significant backing. The finding that the backing in TRAP is more progressed than the backing in DRESS may possibly indicate that the backing process might have been initiated by TRAP then subsequently followed by DRESS, as suggested by Trudgill (2004: 42-43) for the order of drag-chain shift for the short front vowels (§7.5).

In London WC, their vowel shifts are not as developed as in London UMC. Although their DRESS and TRAP vowels are barely backing, their STRUT vowels show no evidence of raising (§7.2). Looking at the vowel shifts for the female and male London WC speakers separately, it was also found that the backing of DRESS is only observed among the females but not among the males; that is, the male London WC speakers only show backing of TRAP (§7.3). Absence of STRUT raising seems to keep the configuration of TRAP and STRUT conservative, with the STRUT vowels being behind and on a similar level to the TRAP vowel so that TRAP/STRUT rotation is generally not observed among London WC speakers (§8.2.4). Moreover, slightly closer realisations of TRAP for the older male speakers exhibit even more conservative configuration, with the STRUT vowels being behind and slightly lower than the TRAP vowels, which resulted in negative angles between these two vowels (§8.1, §8.1.6, §8.2.6).

Q3. Is there any indication of social effects on the movements of these vowels? Is there any particular social group of people who seem to lead a particular change?

Sex effect

Female speakers generally show more open DRESS and more open and back TRAP than male speakers (§6.5.3). With regard to the angle study, although there is no general sex difference, comparison of sex within Y-UMC reveals a significant sex effect; F-Y-UMC speakers have significantly greater angles between TRAP and STRUT vowels than M-Y-UMC regardless of speech styles, indicating that that the degree of TRAP/STRUT rotation is constantly greater for the females than the males within the young London UMC speakers (§8.1.5, §8.2.5). This is in line with the findings of Labov (2001) that females appear to be the active agents of gender differentiation in many cases of linguistic changes.

Social class effect

There is no social class effect for DRESS. However, the higher the social class, the more back the TRAP vowels and the closer the STRUT vowels (§6.5.5). This subsequently results in the significant social class effect in the angle study; the higher the social class, the greater the angles. In fact, the TRAP/STRUT rotation is only observed in London UMC not in London WC, so that it is argued that its existence might be associated with UMC (London UMC), whereas its absence might be associated with WC (London WC) in London (§8.2.4).

Social groupings effect

The backing of TRAP is particularly significant for the female young London UMC speakers, while the raising of STRUT is significant for the young London UMC speakers, particularly in spontaneous speech style compared to non-spontaneous speech styles (§6.5.6).

Similarly, the TRAP/STRUT rotation is most advanced among the young London UMC speakers, especially the females, indicating that the rotation is led by the female young London UMC, followed by the male young London UMC. The rotation is apparently not observed for the London WC speakers, especially among the old males who predominantly show lower angles, i.e. shallow negative/positive angles; however, the possible exception is the female young London WC speakers whose fluctuated angles indicate a sign of incipient rotation (§8.2.5).

Thus, the current data repeatedly indicate that young London UMC speakers, particularly the females, lead the backing of TRAP and the raising of STRUT, and the TRAP/STRUT rotation; as far as the change in these three vowels in the current data is concerned, therefore, it is conceivable that they are the most innovative cohort.

Q4. Is there any consistent stylistic variation for the movements of these vowels?

Yes, in general, the vowels are more peripheral in more formal speech (§6.5.1). However, the degree of stylistic variation or patterns of stylistic variations are sometimes subject to the type of vowel or social condition (§6.5.1, §6.5.2).

With regard to the angle study, the angles in more formal non-spontaneous speech are constantly smaller than in less formal speech styles, particularly than in less formal non-spontaneous speech in general and in most of the subcategories of the factors (§8.1.1, §8.2.1). It is argued, therefore, that the smaller angles – i.e. non-rotated or less-rotated TRAP and STRUT alignments – seem to be related to the greatest formality (§8.2.4).

Q5. Is there any tendency for shifting with regard to the following segment?

In relation to the relative positions of vowels, the degree of vowel openness due to the following segments is in accordance with the order of general short vowel durations i.e. _VF ≥ _VS > _N > _LF ≥ _LS (Wiik 1965, cited in Cruttenden 2001: 96, see also §3.2, §6.5.2). The results also indicate a possible effect of F1 cutback (Kent & Read 1992: 120-1) before stops (cf. §3.2, §6.5.2). With regard to the vowel frontness due to the following segments, the current data partially support and partially disagree with Labov's findings that _N and _LF environments would condition the tensing of low vowels; the data indicate that, while _N environment gives rise to vowel peripherality (i.e. fronter for DRESS and TRAP and more back for STRUT). _LF environments consistently cause more back realisations for all the vowels (§6.5.2).

In connection with configurations between TRAP and STRUT, the angles between TRAP and STRUT are generally smaller before nasals compared to before obstruents (§8.1.2, §8.2.2,). It is argued that the TRAP/STRUT rotation may be phonologically restrained before nasals compared to obstruents (§8.2.2), but particularly progressed before stops (§8.2.3) because of the generational STRUT raising before stops, but not before nasals and fricatives (§6.5.4).

Q6. Is there a significant configurational change between TRAP and STRUT in London English? If so, is there any correlation with social, and phonological?

As answered to Q1 – Q5.

The results from the apparent-time investigations in Chapter 7 lead us to an extensive discussion for possible motivations for the observed vowel shifts as well as for a number of implications with regard to internal and external factors. The general changes of DRESS, TRAP and STRUT for the London English are more or less in line with the anticlockwise chain shifts found in a number of recent empirical studies investigating on any or all of these vowels in RP, southeast of England, or London (Torgersen & Kerswill 2004, Hawkins & Midgley 2005, Torgersen *et al.* 2006, Fabricius 2007). It is found that, as far as the vowel changes of these three short vowels in the current study are concerned, the most innovative group is the female young London UMC, followed by the male young London UMC. These two groups both show a well-advanced anticlockwise chain shift involving all these three short vowels with their TRAP raised higher up compared to their STRUT which consequently brings about the greater angles between these two vowels. Moreover, acknowledging the fact that the vowel shifts observed for the (female) young London UMC speakers are very much in line with the Fabricius's (2007) RP speakers and considering the historical development of RP (cf. §2.1.2), it is discussed that the (female) young London UMC speakers may arguably be the innovator for the current changes in these vowels. Meanwhile, the young London WC speakers represent a rather reserved vowel shift which only involves backing of TRAP and DRESS with stable STRUT on the similar level as TRAP; their angles thus turn out to be smaller than the young London UMC. With regard to the perspectives of internal factors, it is discussed that the observed vowel shifts are partially explainable by the Labov's General Principle of Vowel Shifting. In this connection, Langstrof's (2006) extensive discussions for Labov's notions such as peripherality and tracks as well as his evolutionary model for the vowel shifts which involves a multidimensional vowel space are briefly reviewed. It is also speculated from the structural point of view that the resultant vowel shifts may possibly be consequent realisations of the combination of the two vowel shift processes, the modified drag-chain shift (which involves backing of short front vowels) and the independent lowering and fronting process for STRUT, the latter of which got reversed in the middle of twentieth century as discussed by Torgersen & Kerswill (2004: 46). With regard to the social class difference across generations, despite the claim that there seems to exist a social pressure towards social levelling in the area centred on London (cf. §2.3.3), the current data generally do not show evidence for social convergence, but rather indicate a tendency for social divergence which appears to be promoted by the (female) young London UMC speakers; in other words, the difference in realisations of these three short vowels seems to reflect the difference in social class more remarkably for the young London English speakers than for the old London English speakers, so that their realisations of the vowels seem to play a role to enhance their social class differentiations among the young compared to the old. As regards possible sex difference in both London UMC and WC speakers across generations, divergence is observed between the male/female London UMC speakers, while convergence is possibly observed between the male/female London WC speakers. All and some others are fully discussed in §7.5.

As for the notion of accent varieties in London, if we consider London English as if it were a discrete mesolectal variety on a continuum between RP and Cockney as in the case of 'Estuary English', actual differences within a continuum would have been obscured. The current data show the backing of DRESS and TRAP and the raising of STRUT in London English as a whole (§6.5.4), however, the vowel shift of each social group (by social class, sex, age) is in fact slightly different from each other (cf. §7.2, §7.3, §7.4, §7.5). Therefore, as far as these three short vowels are concerned, it may be more sensible to consider the observed variations in the middle ground between RP and Cockney not as a single variety but as a series of accent variations on a multidimensional continuum between two extreme varieties, RP and Cockney. The current study adopted occupation as a single indicator of social class, and also of accent. Owing to the fact that the patterns of vowel shifts found in our two accent groups generally coincide with the findings from other recent studies (Torgersen & Kerswill 2004, Hawkins & Midgley 2005, Torgersen *et al.* 2006, Fabricius 2007), the social and accent classification solely depending on occupation seems to turn out to be reasonably accurate. This indicates not only that, as discussed above, occupations prove to be an important indicator to determine people's social class, but also that accent variations may greatly be depending on social characteristics (cf. §7.5).

One of the important methodological issues for any study dealing with acoustic vowel formant frequency values from physically different speakers should be vowel normalisation. The current study applies a method called *S-procedure* (Watt & Fabricius 2002). It is demonstrated that the procedure substantially improves in the match among the areas both in F1 and F2-F1 dimensions for the different vowel space triangles on the S-transformed scale than on linear Hz scale, on Bark scale, and on ERB scale (§5.2.6). The application of this method throughout the analyses, therefore, allows direct visual and statistical comparisons for multiple speakers regardless of their physical differences.

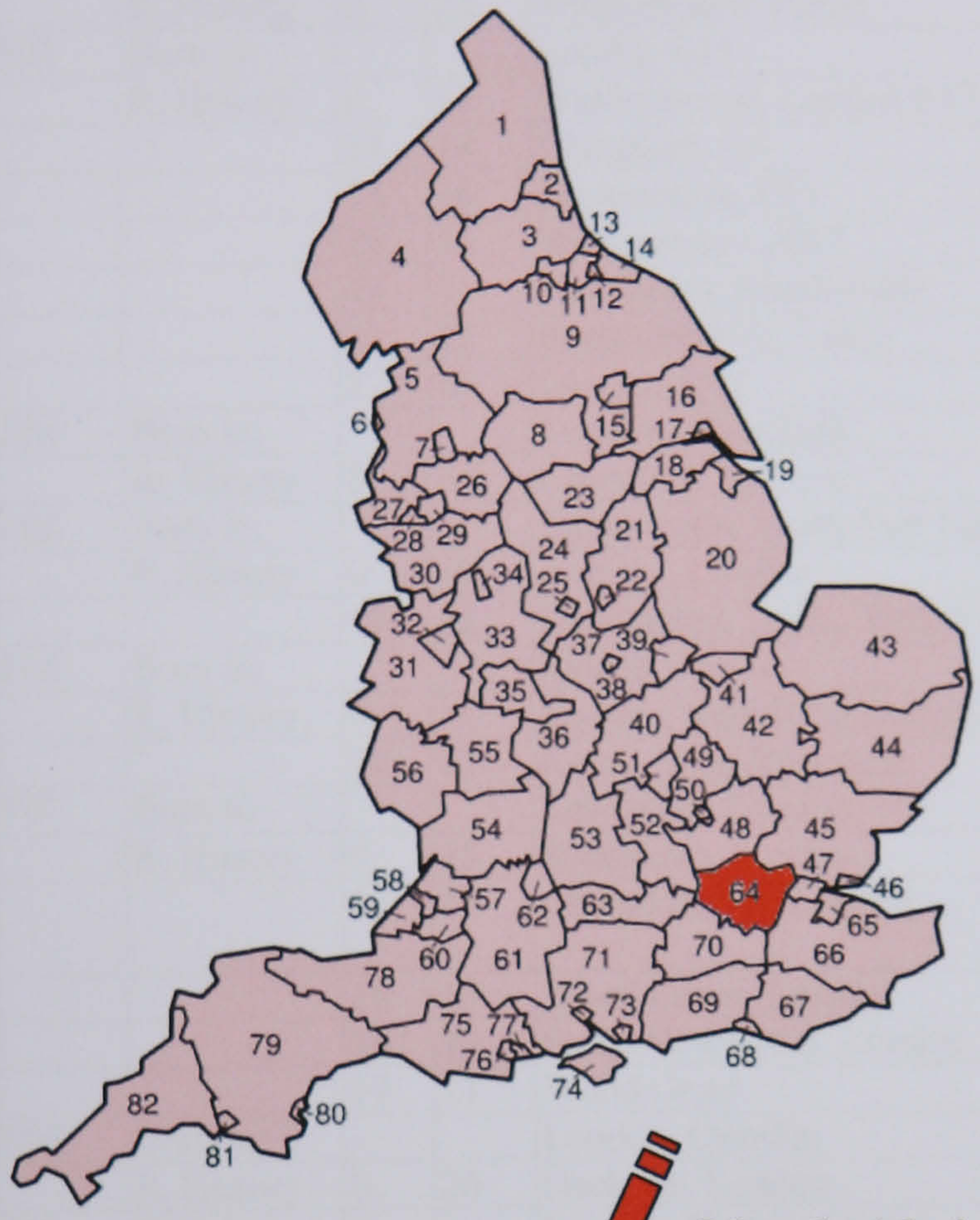
An important note should be made before the end of this thesis. Although the data in the present research repeatedly suggest that the possible innovator for the anticlockwise vowel shift involving all these three short vowels is the (female) London UMC, the statement as such needs to be understood with special caution. This is not only because there are still other short vowels to be investigated to fully understand a full picture of this chain shift, but also because, as having been added a note of caution early in the thesis (§2.5), the data are mainly from white Anglo speakers in this study. Therefore, the observed results as well as any subsequent discussions and statements have to be understood with the proviso that no particular ethnic effects are concerned. In this connection, the current results are found to be slightly different from the findings in the study of Torgersen *et al.* (2006, cf. §4.5). Observing their data of Londoners from both Anglo and non-Anglo background, they conclude that 'the progress of language change in inner London is influenced by contact with non-native varieties of English and a number of ethnicity-specific varieties ('ethnolect'), as well as social networks, social mobility and identity' (Torgersen *et al.* 2006: 262). Although discussion for any possible association of the speakers in the current study with non-native varieties of English is beyond the current research, it would be an interesting as well as necessary issue to be investigated systematically in the future.

The number of studies which acoustically investigate phonetic varieties of English in the UK is remarkably few, compared to other urban cities in the world. To the best of my knowledge, moreover, there have been so far no studies which investigated correlations between these three short vowels in London and their social and phonological characteristics in this detail. Although further investigations should still be carried out for the LMC speakers, for the auditory analysis and for other short vowels such as KIT, LOT and FOOT vowels with consideration of Londoners from various ethnic groups to capture an entire picture of short vowel systems in London, it is hoped that the measurements made and the results obtained for this study will provide a referential role for any future work related to London English.

Appendix 1 Details of speakers' place of birth and residential history (R. History)

N.B. Area codes: 1= Greater London, 2 = Adjacent counties, 3 = other counties in England, 4 = Foreign countries.

Sub area codes for counties in England are shown in Map-1, while those for London boroughs within Greater London in Map-2.



1. Northumberland
2. Tyne and Wear †
3. Durham
4. Cumbria
5. Lancashire
6. Blackpool ††
7. Blackburn with Darwen ††
8. West Yorkshire †
9. North Yorkshire
10. Darlington ††
11. Stockton-on-Tees ††
12. Middlesbrough ††
13. Hartlepool ††
14. Redcar and Cleveland ††
15. York ††
16. East Riding of Yorkshire ††
17. Hull ††
18. North Lincolnshire ††
19. North East Lincolnshire ††
20. Lincolnshire
21. Nottinghamshire
22. Nottingham ††
23. South Yorkshire †
24. Derbyshire
25. Derby ††
26. Greater Manchester †
27. Merseyside †
28. Halton ††
29. Warrington ††
30. Cheshire
31. Shropshire
32. Telford and Wrekin ††
33. Staffordshire
34. Stoke-on-Trent ††
35. West Midlands †
36. Warwickshire
37. Leicestershire
38. Leicester ††
39. Rutland ††
40. Northamptonshire
41. Peterborough ††
42. Cambridgeshire
43. Norfolk
44. Suffolk
45. Essex
46. Southend-on-Sea ††
47. Thurrock ††
48. Hertfordshire
49. Bedfordshire
50. Luton ††
51. Milton Keynes ††
52. Buckinghamshire
53. Oxfordshire
54. Gloucestershire
55. Worcestershire
56. Herefordshire ††
57. South Gloucestershire ††
58. Bristol ††
59. North Somerset ††
60. Bath and North East Somerset ††
61. Wiltshire
62. Swindon ††
63. Berkshire †††
64. Greater London *
65. Medway †
66. Kent
67. East Sussex
68. Brighton and Hove ††
69. West Sussex
70. Surrey
71. Hampshire
72. Southampton ††
73. Portsmouth ††
74. Isle of Wight ††
75. Dorset
76. Poole ††
77. Bournemouth ††
78. Somerset
79. Devon
80. Torbay ††
81. Plymouth ††
82. Cornwall

† metropolitan county
†† unitary authority
††† no county council
* 'administrative area' not a county

Map-1. Administrative Counties of England

(From http://en.wikipedia.org/wiki/Administrative_counties_of_England)

1. City of London (N.B. not a London Borough)
2. City of Westminster
3. Kensinton and Chelsea
4. Hammersmith and Fulham
5. Wandsworth
6. Lambeth
7. Southwark
8. Tower Hamlets
9. Hackney
10. Islington
11. Camden
12. Brent
13. Ealing
14. Hounslow
15. Richmond
16. Kingston
17. Merton
18. Sutton
19. Croydon
20. Bromley
21. Lewisham
22. Greenwich
23. Bexley
24. Havering
25. Barking and Dagenham
26. Redbridge
27. Newham
28. Waltham Forest
29. Haringey
30. Enfield
31. Barnet
32. Harrow
33. Hillingdon

Map-2. London Boroughs of Greater London

(From http://en.wikipedia.org/wiki/London_borough)

ID		Age-to-Age		Place Reported	Area Code	Sub Area Code	Place Generalised
F01	Born in:			Harlow, Essex	2	45	Essex
	R. History	0	5	Sheering, Epping Forest, Essex	2	45	Essex (Epping Forest, "Sheering")
		5	19	Ilford, Essex	1	26	Redbridge
F02	Born in:			Walthamstow, London	1	28	Waltham Forest
	R. History	0	23	Walthamstow Forest	1	28	Waltham Forest
F03	Born in:			London E11	1	28	Waltham Forest
	R. History	0	12	Walthamstow, London E17	1	28	Waltham Forest
		12	14	Chingford, E4	1	28	Waltham Forest
		14	16	Leytonstone, E11	1	28	Waltham Forest
		16	18	Walthamstow, E17	1	28	Waltham Forest
		18	21	Hull, North Humberside	3	17	Hull
		21	22	Buckhurst Hill, Essex	2	45	Essex
		22	25	London, E17	1	28	Waltham Forest
F04	Born in:			London, Chingford	1	28	Waltham Forest
	R. History	0	30	Chingford, London	1	28	Waltham Forest
F05	Born in:			Camberwell, South East London	1	7	Southwark
	R. History	0	19	Anerley, London	1	20	Bromley
		19	21	Headingley, Leeds, West Yorkshire	3	8	West Yorkshire
F06	Born in:			Sidcup, *Bexley*	1	23	Bexley
	R. History	0	20	London, Kent [Chislehurst]	1	20	Bromley
		20	22	Leeds, West Yorkshire	3	8	West Yorkshire
F07	Born in:			Lewisnam, London	1	21	Lewisham
	R. History	0	15	Sydenham, London	1	21	Lewisham
		15	18	Crystal Palace, London	1	6+7+19+20	Lambeth+Southwark+Croydon+Bromley
		18	19	Wood Green, London	1	29	Haringey
		19	19	Stoke Newington, London	1	9	Hackney
		19	21	Wood Green	1	29	Haringey
F08	Born in:			London, Camden	1	11	Camden
	R. History	0	26	Hackney, London	1	9	Hackney
F09	Born in:			London, Bethnal Green	1	8	Tower Hamlets
	R. History	0	2	Bethnal Green, London	1	8	Tower Hamlets
		2	19	Dagenham, Essex	1	25	Barking and Dagenham
		19	29	Barking, Essex	1	25	Barking and Dagenham
		29	52	Dagenham, Essex	1	25	Barking and Dagenham
F10	Born in:			Leytonstone, London	1	28	Waltham Forest
	R. History	0	8	Leytonstone, London	1	28	Waltham Forest
		8	12	Chingford, Essex	1	28	Waltham Forest
		12	65	Chingford, Essex	1	28	Waltham Forest
F11	Born in:			[Stepney] London (East)	1	8	Tower Hamlets
	R. History	0	20	Hackney, London, E8	1	9	Hackney
		20	68	Walthamstow, London, E17 3RA	1	28	Waltham Forest
F12	Born in:			London, Stepney	1	8	Tower Hamlets
	R. History	0	*9*	Hackney (till the war broke out)	1	9	Hackney
		9	*15*	East End (till bombed out)	1	9	Hackney
		15	21	Dagenham	1	25	Barking and Dagenham
		21	24	*Bow, E3*	1	8	Tower Hamlets
		24	29	*Stoke Newington, N16*	1	9	Hackney
		29	73	*Ilford*	1	26	Redbridge
F13	Born in:			Redbridge, Essex	1	26	Redbridge
	R. History	0	7	Redbridge, Essex	1	26	Redbridge
		7	26	Loughton, Essex	2	45	Essex
		26	27	U.S.A (Evanston, Illinois & Washington D.C.)	4		U.S.A.

		27	29	West Yorkshire (Leeds & NR Bradford)	3	8	West Yorkshire
		29	31	Norwich, Norfolk & Cambridge, Cambridgeshire	3	43+42	Norfolk+Cambridgeshire
		31	50	Buckhurst Hill, Essex	2	45	Essex
F14	Born in:			Walthamstow, London	1	28	Waltham Forest
	R. History	0	30	Walthamstow	1	28	Waltham Forest
		30	52	Chingford	1	28	Waltham Forest
F15	Born in:			Vange, Essex	2	45	Essex
	R. History	0	5	Vange, Essex	2	45	Essex
		5	12	Dagenham, Essex	1	25	Barking and Dagenham
		12	19	Seven Kings, Essex	1	26	Redbridge
		19	21	Barkingside, Essex	1	26	Redbridge
		21	23	Redbridge, Essex	1	26	Redbridge
		23	36	Hainault, Essex	1	26	Redbridge
		36	62	Wanstead, E11	1	26	Redbridge
F16	Born in:			London, Stepney	1	8	Tower Hamlets
	R. History	0	5	London (Stepney)	1	8	Tower Hamlets
		5	26	London (Clapton,StokeNewington)	1	9	Hackney
		26	28	Buckhurst Hill, Essex	2	45	Essex
		28	47	Redbridge, Essex	1	26	Redbridge
		47	69	South Woodford, London, E18	1	26	Redbridge
		69	70	Chigwell, Essex, IG7	2	45	
M01	Born in:			Walthamstow, London	1	28	Waltham Forest
	R. History	0	22	Walthamstow, London	1	28	Waltham Forest
M02	Born in:			Forest Gate	1	27	Newham
	R. History	0	1	Forest Gate	1	27	Newham
		1	2	West Ham	1	27	Newham
		2	3	Dagenham	1	25	Barking and Dagenham
		3	24	Dagenham	1	25	Barking and Dagenham
M03	Born in:			Leytonstone, London	1	27	Newham
	R. History	0	2	Leytonstone, London	1	27	Newham
		2	8	Walthamstow, London	1	28	Waltham Forest
		8	9	Waltham Abbey	2	45	Essex
		9	11	Walthamstow, London	1	28	Waltham Forest
		11	11	Australia (Sydney) 4 months	4		Australia
		12	25	Walthamstow, London	1	28	Waltham Forest
M04	Born in:			North London, Islington	1	10	Islington
	R. History	0	30	London, Wandsworth	1	5	Wandsworth
M05	Born in:			Leyton, London	1	28	Waltham Forest
	R. History	0	17	Leyton, London	1	28	Waltham Forest
M06	Born in:			*Croydon*, Surrey	*1*	*19*	*Croydon*
	R. History	0	21	Croydon, Surrey	1	19	Croydon
M07	Born in:			Carshalton, Sutton	1	18	Sutton
	R. History	0	5	Sutton (London), Surrey	1	18	Sutton
		5	19	As above	1	18	Sutton
		18	19	Leeds, Yorkshire	3	8	West Yorkshire
		19	20	Japan (Kobe)	4		Japan
		20	*22*	*Leeds, Yorkshire*	*3*	*8*	*West Yorkshire*
M08	Born in:			London	*1*	*11*	*Camden*
	R. History	0	20	Islington, London	1	10	Islington
		20	21	Leeds	3	8	West Yorkshire
		21	22	Moscow, Russia	4		Russia
		22	24	Leeds	3	8	West Yorkshire
M09	Born in:			Wanstead, London	1	26	Redbridge
	R. History	0	17	Chigwell Row, Essex	2	45	Essex
		17	29	Chigwell, Essex	2	45	Essex
		29	39	Sheering, Essex	2	45	Essex (Epping Forest, "Sheering")

		39	53	Barkingside, Ilford, Essex	1	26	Redbridge
M10	Born in:			Walthamstow	1	28	Waltham Forest
	R. History	0	28	Walthamstow, Chingford, Walthamstow, Leyton, Chingford, Walthamstow	1	28	Waltham Forest
		28	*32*	Walthamstow	*1*	*28*	*Waltham Forest*
				Norfolk	3	43	Norfolk
		32	*38*	*Walthamstow*	*1*	*28*	*Waltham Forest*
		38	39	Waltham Abbey	2	45	Essex
		39	*41*	*Walthamstow*	*1*	*28*	*Waltham Forest*
		41	41	Australia	4		Australia
		42	54	Walthamstow	1	28	Waltham Forest
				Dagenham	1	25	Barking and Dagenham
				Waltham Abbey	2	45	Essex
M11	Born in:			Plaistow / Stratford, London	1	27	Newham
	R. History	0	22	Plaistow, London	1	27	Newham
		22	26	Canning Town, London	1	27	Newham
		26	56	Eastham, London	1	27	Newham
		56	60	Witham, Essex	2	45	Essex
M12	Born in:			Bow, East London	1	8	Tower Hamlets
	R. History	0	5	Bow, East London	1	8	Tower Hamlets
		5	7	Catford	1	21	Lewisham
		7	10	Ilford	1	26	Redbridge
		10	28	Ilford	1	26	Redbridge
		28	62	Ilford	1	26	Redbridge
M13	Born in:			Hammersmith, London	1	4	Hammersmith
	R. History	0	12	London, Hammersmith	1	4	Hammersmith
		12	21	East Acton	1	13	Ealing
		21	27	Luton (Bedfordshire)	3	49	Bedfordshire
		27	29	London Acton	1	13	Ealing
		29	60	Ilford, Essex	1	26	Redbridge
M14	Born in:			London	*1*	*26*	*Redbridge*
	R. History	0	60	London (Ilford)	1	26	Redbridge
M15	Born in:			Chingford, London	1	28	Waltham Forest
	R. History	0	9	Chingford, London	1	28	Waltham Forest
		9	21	Walthamstow, London	1	28	Waltham Forest
		21	23	(National Service (RoyalAirForce))	4		
		23	25	Walthamstow, London	1	28	Waltham Forest
		25	27	Travelled in Europe to Africa	4		
		27	27	Some months back to Walthamstow	1	28	Waltham Forest
		28	30	West Africa	4		West Africa
		30	50	Richmond, London	1	15	Richmond upon Thames
		50	66	Walthamstow	1	28	Waltham Forest
M16	Born in:			Sutton, Surrey	1	18	Sutton
	R. History	0	2	Sutton, Surrey	1	18	Sutton
		2	10	Cambridge (also at Cricklewood, Totteridge, Maida Vale, Streatham, Reading (Berkshire) overall about 6 years)	3	42	Cambridgeshire
				Cricklewood, Totteridge (Barnet)	1	31	Barnet
				Maida Vale (City of Westminster)	1	2	City of Westminster
				Streatham (Lambeth)	1	6	Lambeth
				Reading (Berkshire)	2	63	Berkshire
		10	66	Current Residence [*Old Coulsdon*]	1	19	Croydon

Appendix 2 Interview Section – Interview Protocol

- **What is your name?**
- **Places you have lived:**
  - Where were you born?
  - How long did you live there?
  - Which part of London have you lived so far?
  - Have you lived in any other places?
- **Can you tell me about your family members?**
  - Where do your parents live?
  - Have they lived any other places?
  - What do they do? (Or what did they do if retired?)
  - Can you tell me about your parents?
  - Do you have any brothers or sisters?
  - What do they do?
- **Can you tell me about the schools you went?**
  - School life?
  - College life?
  - Club or society?
  - What are you doing in your free time?
  - Hobby?
- **Can you tell me about your job?**
  - What kind of job is it? (Where?)
  - Any other job before? (Where?)
  - If student, what would you like to do after you graduate?
- **Can you tell me your most favourite day or exciting day in your life?**
- **Can you recommend me any places in London, or your favourite place in London?**

Appendix 3 Interview Section – Questions for pictures

All pictures are from *Where's Wally?* (Handford 1997). Picture 1 is extracted from 'In Town' pages, Picture 2 from 'The Railway Station' pages, Picture 3 from 'Department Store' pages, Pictures 4-7 from 'Safari Park' pages, Pictures 8 from 'Camp Site' pages, and Pictures 9-11 from 'Sports Stadium' pages.

Questions for pictures

Picture-1. Wally and his belongings

What does he have or wear on *which part of his body*?

For example, "He's got *a sleeping* bag *on his back*."

Could you tell me for all his belongings from 1 to 13?

Picture-2. Train

Tell me what's happening in this train picture?

Picture-3. Hat shop

What are they selling?

What kind of hats are there?

Picture-4. Elephant and tooth-brushing Hippopotamus

What kind of animals are there?

What are two men doing?

Picture-5. Hat-eating giraffe

Tell me what's happening in this zoo picture?

Picture-6. Lion and tigers

What kind of animals are there, and what are they doing?

Picture-7. Hat taking monkeys and Gorillas

What kind of animals are there, and what's happening in this picture?

Picture-8. Tent, camping, and Hippies

What are they doing?

What kind of house is the triangle one called?

How do you call these people?

Picture-9. Hammer throwing

What kind of sport are they doing?

Picture-10. Tugs of war

What kind of sport are they doing?

Picture-11. High-jumping

What kind of sport is it?

Appendix 4 Reading-Passage Section –Reading-Passage

ON THE LAKE

It was a fine Sunday morning, although it was the rainy season. After having a hasty breakfast of toast with ham and tuna, Harry was heading by car for a lake about half an hour's drive away to catch largemouth black bass.

When he got there at ten to ten, however, the sun was totally hidden behind the clouds, the sky turned terribly dark, and it looked likely to rain at any moment. He noticed that the atmosphere around the lake was different from usual. There had always been many anglers, and families and couples enjoying their holidays. But on that day there was nobody except himself. He thought this was surely due to the weather, and it made him happy. He had a hunch that he would get a big one.

He tugged the boat loose and set off for the small bay ahead. As soon as he got in the boat, he set his original hand-made lure, named 'Tough Spinner', which had always shown the best results in this lake. His choice of the lure was just right and as usual he got a good catch of largemouth bass with it. But by 2 pm, he hadn't caught a bass weighing over 122 pounds – and he was really hoping to catch one because 122 pounds was his personal record. He looked into his tidy tackle box, and suddenly an unfamiliar small square red thing caught his eye. At once he stretched out his arm to pick it up, and opened the wrapper. To his surprise, he saw in the wrapper a lure that he had been longing to get for a long time, and he also found a small pink card saying, "***Happy Birthday, honey. Enjoy fishing. Love xx Hatty***" "***Happy Birthday, Dad. Have a happy fishing day. Love xxx Cathy and Betty***".

Until then, he had totally forgotten it was his 45th birthday today. The message from his wife and little twin kids was a tad short, but at that time nothing could have given him more pleasure than their words. Touched by their tactful act, he looked up at the sky for some time, and then he replaced the first lure with the new special lure.

At that moment, it began to rain. However, since he was dying to keep fishing even if he had to put up with hard rain, he decided to throw the line six more times. Every time he threw it, it rained harder and harder, and soon it was getting so cold that he could see his breath. When he threw it for the last time, the lake was covered with thick fog. He could hardly see his surroundings. Nevertheless, he went on fishing and slowly tugging the line from the lake. At that moment he felt a shock he'd never experienced through the rod in his hand.

"Woah, what a fish!" he cried. He struggled against the strong tug. His rod bent as if it were made of wire and he could not reel in the line at all. After a few minutes, a figure suddenly appeared on the surface of the lake. He was surprised to see it. It was a terribly huge bass the like of which he'd never seen before.

Then he remembered a tale of old that he had been told by his old grandmother when he was a toddler. A tremendously huge fish lives there, went the tale, and if someone catches it, he and his family will later be able to acquire great wealth. The rumour spread rapidly and many people came from all over the country to the lake to get the huge fish. In less than a decade this pretty lake was polluted and completely spoiled. That was about the time when he was born. But no one could catch it. Even though they tried very hard. In the end people had just given up and the lake began to recover and return to its former state.

And now, just as everyone had forgotten this legend, he was in a position to catch this very fish. He tried to breathe in and out to calm himself. And then he started to consider everything he could think of.

He had enjoyed bass fishing for a long time. He thought about the great delight of fishing for largemouth bass after struggling so hard. Moreover he thought that the lake might become dirty and polluted again on account of the fact that if he tried to catch the monster bass now, many other people would try to do the same, bringing lots of rubbish and so on with them. Perhaps he would not be able to enjoy fishing in the lake any more. He regarded the monster bass as a kind of protective god of the bass in the lake. In the mean time, the boat looked as if it was on the point of rolling over. Tugging the rod tightly with his right hand, he quickly cut off the line with scissors in his left. The huge monster bass disappeared into the bottom of the lake with his special lure.

He was by now too tired out to stand any longer, and hunkered down in the boat for some time. It soon stopped raining, and the sky was covered with the sunset glow. Although he couldn't restrain his excited feelings, he decided to keep what happened here today in his mind. He was sure that it would be unforgettable and the best birthday present in his life.

Henceforth he enjoyed fishing largemouth black bass in that lake for the rest of his life. Since then nobody has seen the legendary fish in the lake ever again.

Appendix 5 Word-list Section – Word-list

1. Say	hut	again.	42. Say	happy	again.
2. Say	kit	again.	43. Say	tetched	again.
3. Say	tut	again.	44. Say	frees	again.
4. Say	after	again.	45. Say	going	again.
5. Say	hat	again.	46. Say	hidden	again.
6. Say	thought	again.	47. Say	titch	again.
7. Say	tat	again.	48. Say	habit	again.
8. Say	choice	again.	49. Say	huddle	again.
9. Say	hetero	again.	50. Say	never	again.
10. Say	force	again.	51. Say	studhorse	again.
11. Say	tetanus	again.	52. Say	nurse	again.
12. Say	carter	again.	53. Say	haddock	again.
13. Say	treacle	again.	54. Say	more	again.
14. Say	hit	again.	55. Say	tadpole	again.
15. Say	tit for tat	again.	56. Say	near	again.
16. Say	Birmingham	again.	57. Say	ahead	again.
17. Say	hut	again.	58. Say	letter	again.
18. Say	dress	again.	59. Say	teddy bear	again.
19. Say	stutter	again.	60. Say	either	again.
20. Say	dance	again.	61. Say	beetle	again.
21. Say	hatch	again.	62. Say	hid	again.
22. Say	goat	again.	63. Say	tidbit	again.
23. Say	static	again.	64. Say	honest	again.
24. Say	mouth	again.	65. Say	hunt	again.
25. Say	heterosex	again.	66. Say	trap	again.
26. Say	cure	again.	67. Say	ton	again.
27. Say	tetrapod	again.	68. Say	girl	again.
28. Say	daughter	again.	69. Say	hand	again.
29. Say	sing	again.	70. Say	goose	again.
30. Say	hitter	again.	71. Say	tan	again.
31. Say	tittle-tattle	again.	72. Say	beer	again.
32. Say	historic	again.	73. Say	hen	again.
33. Say	huddle	again.	74. Say	horses	again.
34. Say	head	again.	75. Say	ted	again.
35. Say	study	again.	76. Say	old	again.
36. Say	cloth	again.	77. Say	throne	again.
37. Say	had	again.	78. Say	hint	again.
38. Say	goal	again.	79. Say	tiddly	again.
39. Say	tad	again.	80. Say	behind	again.
40. Say	power	again.	81. Say	hunch	again.
41. Say	head	again.	82. Say	lot	again.

83. Say	tunnel	again.	124. Say	clean	again.
84. Say	fleece	again.	125. Say	nothing	again.
85. Say	handle	again.	126. Say	history	again.
86. Say	ghoul	again.	127. Say	tish	again.
87. Say	tantrum	again.	128. Say	tezzy	again.
88. Say	square	again.	129. Say	husband	again.
89. Say	hence	again.	130. Say	foot	again.
90. Say	comma	again.	131. Say	tuzzy	again.
91. Say	ten	again.	132. Say	meat	again.
92. Say	brilliant	again.	133. Say	has-been	again.
93. Say	beagle	again.	134. Say	prize	again.
94. Say	hinterland	again.	135. Say	fantasmo	again.
95. Say	tin	again.	136. Say	berth	again.
96. Say	rehearse	again.	137. Say	hesitate	again.
97. Say	hustle	again.	138. Say	fatal	again.
98. Say	strut	again.	139. Say	testy	again.
99. Say	tusk	again.	140. Say	throat	again.
100. Say	face	again.	141. Say	with	again.
101. Say	hassle	again.	142. Say	his	again.
102. Say	book	again.	143. Say	tissue	again.
103. Say	tass	again.	144. Say	tiss	again.
104. Say	start	again.	145. Say	husband	again.
105. Say	hest	again.	146. Say	bath	again.
106. Say	free	again.	147. Say	tuzzy	again.
107. Say	tent	again.	148. Say	palm	again.
108. Say	freeze	again.	149. Say	hazard	again.
109. Say	rolls	again.	150. Say	fire	again.
110. Say	hiss	again.	151. Say	phantasma	again.
111. Say	tinder	again.	152. Say	north	again.
112. Say	tez	again.	153. Say	hesitant	again.
113. Say	huss	again.	154. Say	eighty-eight	again.
114. Say	one	again.	155. Say	testable	again.
115. Say	tux	again.	156. Say	gleam	again.
116. Say	stay	again.	157. Say	us	again.
117. Say	hasp	again.	158. Say	his and hers	again.
118. Say	price	again.	159. Say	tizwas	again.
119. Say	tassel	again.	160. Say	tisk	again.
120. Say	birth	again.	161. Say	testify	again.
121. Say	hest	again.	162. Say	neither	again.
122. Say	meter	again.	163. Say	tizz	again.
123. Say	test	again.	164. Say	Tuesday	again.

Appendix 6 Mean formant values and *S*-transformed mean values of measured KIT and START and the hypothetical u', and S-values for each speaker

N.B.: ID= speaker's ID, N= number of tokens, F1= F1 in Hz, F2-F1= F2-F1 in Hz, SF1= *S*-transformed F1, SF21= *S*-transformed F2-F1

	KIT					START					(hypothetical) u'				*S*-values		
ID	N	F1	F2-F1	SF1	SF21	N	F1	F2-F1	SF1	SF21	F1	F2-F1	SF1	SF21	S(F1)	S(F2)	S(F2-F1)
F01	10	445	2119	0.85	2.29	10	684	651	1.30	0.71	445	0	0.85	0.00	524	1448	923
F02	10	423	1992	0.83	2.20	10	684	719	1.34	0.80	423	0	0.83	0.00	510	1414	904
F03	10	395	1903	0.85	2.10	10	600	818	1.29	0.90	395	0	0.85	0.00	463	1370	907
F04	10	459	2183	0.83	2.46	10	737	479	1.34	0.54	459	0	0.83	0.00	552	1439	887
F05	10	414	2407	0.82	2.54	10	684	435	1.36	0.46	414	0	0.82	0.00	504	1452	947
F06	10	422	2231	0.84	2.41	10	666	551	1.32	0.59	422	0	0.84	0.00	503	1431	927
F07	10	525	1748	0.91	2.48	10	678	369	1.18	0.52	525	0	0.91	0.00	576	1282	706
F08	10	528	1890	0.90	2.29	10	705	583	1.20	0.71	528	0	0.90	0.00	587	1412	825
F09	10	459	1874	0.85	2.23	10	704	649	1.30	0.77	459	0	0.85	0.00	541	1382	841
F10	10	495	1774	0.88	2.28	10	691	559	1.23	0.72	495	0	0.88	0.00	560	1338	777
F11	10	568	1832	0.88	2.43	10	794	428	1.23	0.57	568	0	0.88	0.00	643	1396	753
F12	10	499	1916	0.89	2.34	10	689	544	1.22	0.66	499	0	0.89	0.00	562	1382	820
F13	10	499	1680	0.91	2.21	10	653	605	1.19	0.79	499	0	0.91	0.00	550	1312	762
F14	10	447	2100	0.82	2.41	10	733	510	1.35	0.59	447	0	0.82	0.00	542	1412	870
F15	10	458	1947	0.84	2.18	10	719	734	1.32	0.82	458	0	0.84	0.00	545	1438	893
F16	10	476	1944	0.80	2.46	10	832	432	1.40	0.54	476	0	0.80	0.00	594	1386	792
M01	10	372	1626	0.81	2.24	10	637	552	1.38	0.76	372	0	0.81	0.00	461	1186	726
M02	10	367	1610	0.83	2.36	10	599	433	1.35	0.64	367	0	0.83	0.00	444	1125	681
M03	10	416	1494	0.88	2.22	10	584	527	1.24	0.78	416	0	0.88	0.00	472	1145	674
M04	10	417	1568	0.85	2.39	10	631	403	1.29	0.61	417	0	0.85	0.00	488	1145	657
M05	10	426	1767	0.86	2.23	10	634	610	1.28	0.77	426	0	0.86	0.00	495	1288	793
M06	10	436	1449	0.91	2.19	10	573	538	1.19	0.81	436	0	0.91	0.00	481	1144	662
M07	10	410	1576	0.86	2.26	10	616	512	1.29	0.74	410	0	0.86	0.00	479	1175	696
M08	10	427	1379	0.86	2.22	10	644	487	1.29	0.78	427	0	0.86	0.00	499	1121	622
M09	10	390	1619	0.82	2.45	10	645	366	1.36	0.55	390	0	0.82	0.00	475	1137	662
M10	10	390	1619	0.87	2.17	10	568	618	1.26	0.83	390	0	0.87	0.00	449	1195	745
M11	10	378	1463	0.81	2.20	10	646	533	1.38	0.80	378	0	0.81	0.00	467	1132	665
M12	10	471	1779	0.89	2.41	10	651	435	1.23	0.59	471	0	0.89	0.00	531	1269	738
M13	10	384	1773	0.81	2.32	10	659	521	1.39	0.68	384	0	0.81	0.00	476	1240	765
M14	10	414	1798	0.84	2.39	10	657	463	1.33	0.61	414	0	0.84	0.00	495	1249	754
M15	10	401	1931	0.86	2.41	10	602	469	1.29	0.59	401	0	0.86	0.00	468	1268	800
M16	10	399	1487	0.86	2.36	10	592	404	1.28	0.64	399	0	0.86	0.00	464	1094	630

Appendix 7 Raw mean formant values and s-transformed mean values for DRESS, TRAP and STRUT of each speaker in each condition

N.B.: ID= speaker's ID, Cond.= condition of speech styles/phonetic environments, N=number of tokens, F1=F1 in Hz, F2-F1=F2-F1 in Hz, SF1= *S*-transformed F1, SF21= *S*-transformed F2-F1, Av.= average

		DRESS					TRAP					STRUT				
ID	Cond.	N	F1	F2-F1	SF1	SF21	N	F1	F2-F1	SF1	SF21	N	F1	F2-F1	SF1	SF21
F01	Av.	59	614	1661	1.17	1.80	60	750	1160	1.43	1.26	60	720	825	1.37	0.89
	IS	19	635	1588	1.21	1.72	20	757	1096	1.44	1.19	20	729	784	1.39	0.85
	RPS	20	600	1571	1.14	1.70	20	791	1139	1.51	1.23	20	734	782	1.40	0.85
	WLS	20	606	1825	1.15	1.98	20	702	1246	1.34	1.35	20	697	909	1.33	0.98
	_LS	4	641	1800	1.22	1.95	4	762	1178	1.45	1.28	4	689	870	1.31	0.94
	_VS	4	572	1891	1.09	2.05	4	674	1235	1.28	1.34	4	685	983	1.31	1.06
	_N	4	654	1805	1.25	1.96	4	729	1288	1.39	1.40	4	756	910	1.44	0.99
	_LF	4	572	1876	1.09	2.03	4	717	1220	1.37	1.32	4	656	973	1.25	1.05
	_VF	4	591	1751	1.13	1.90	4	629	1309	1.20	1.42	4	699	807	1.33	0.87
F02	Av.	60	555	1608	1.09	1.78	60	690	1127	1.35	1.25	56	669	888	1.31	0.98
	IS	20	579	1596	1.14	1.77	20	726	1112	1.42	1.23	18	673	842	1.32	0.93
	RPS	20	566	1567	1.11	1.73	20	657	1152	1.29	1.27	18	655	933	1.28	1.03
	WLS	20	521	1661	1.02	1.84	20	686	1117	1.34	1.24	20	678	890	1.33	0.98
	_LS	4	513	1636	1.01	1.81	4	669	1088	1.31	1.20	4	647	939	1.27	1.04
	_VS	4	535	1680	1.05	1.86	4	703	1138	1.38	1.26	4	668	877	1.31	0.97
	_N	4	576	1572	1.13	1.74	4	718	1183	1.41	1.31	4	688	977	1.35	1.08
	_LF	4	446	1802	0.88	1.99	4	686	1046	1.35	1.16	4	710	784	1.39	0.87
	_VF	4	535	1618	1.05	1.79	4	654	1129	1.28	1.25	4	679	872	1.33	0.96
F03	Av.	60	514	1457	1.11	1.61	59	636	1117	1.37	1.23	59	627	879	1.35	0.97
	IS	20	566	1378	1.22	1.52	20	674	1041	1.45	1.15	20	599	830	1.29	0.91
	RPS	20	494	1501	1.07	1.65	20	679	1091	1.47	1.20	19	681	835	1.47	0.92
	WLS	20	481	1492	1.04	1.64	19	555	1221	1.20	1.35	20	602	974	1.30	1.07
	_LS	4	466	1618	1.01	1.79	4	688	1082	1.48	1.19	4	806	731	1.74	0.81
	_VS	4	486	1484	1.05	1.64	4	541	1241	1.17	1.37	4	527	1097	1.14	1.21
	_N	4	550	1456	1.19	1.61	4	591	1231	1.28	1.36	4	745	835	1.61	0.92
	_LF	4	479	1472	1.03	1.62	4	421	1332	0.91	1.47	4	491	1029	1.06	1.13
	_VF	4	425	1431	0.92	1.58	3	528	1216	1.14	1.34	4	441	1176	0.95	1.30
F04	Av.	60	660	1562	1.20	1.76	59	816	911	1.48	1.03	58	732	591	1.33	0.67
	IS	20	647	1503	1.17	1.69	20	785	954	1.42	1.08	19	703	612	1.27	0.69
	RPS	20	661	1599	1.20	1.80	20	859	810	1.56	0.91	19	761	588	1.38	0.66
	WLS	20	673	1586	1.22	1.79	19	804	969	1.46	1.09	20	730	572	1.32	0.65
	_LS	4	657	1631	1.19	1.84	4	863	894	1.56	1.01	4	784	541	1.42	0.61
	_VS	4	675	1602	1.23	1.81	4	760	1055	1.38	1.19	4	752	677	1.36	0.76
	_N	4	672	1711	1.22	1.93	4	812	1014	1.47	1.14	4	743	592	1.35	0.67
	_LF	4	673	1539	1.22	1.74	4	804	895	1.46	1.01	4	742	392	1.34	0.44
	_VF	4	687	1449	1.25	1.63	3	773	991	1.40	1.12	4	629	660	1.14	0.74
F05	Av.	60	621	1380	1.23	1.46	60	851	753	1.69	0.79	59	680	575	1.35	0.61
	IS	20	592	1343	1.18	1.42	20	794	743	1.58	0.78	20	635	648	1.26	0.68
	RPS	20	603	1304	1.20	1.38	20	902	737	1.79	0.78	19	714	627	1.42	0.66
	WLS	20	666	1493	1.32	1.58	20	857	779	1.70	0.82	20	690	451	1.37	0.48
	_LS	4	633	1487	1.26	1.57	4	914	731	1.81	0.77	4	684	611	1.36	0.64
	_VS	4	635	1926	1.26	2.04	4	893	656	1.77	0.69	4	688	379	1.36	0.40
	_N	4	680	1431	1.35	1.51	4	818	904	1.62	0.95	4	672	441	1.33	0.47

	_LF	4	709	1245	1.41	1.32	4	910	745	1.81	0.79	4	748	372	1.48	0.39
	_VF	4	675	1377	1.34	1.45	4	749	861	1.49	0.91	4	659	450	1.31	0.48
F06	Av.	60	648	1501	1.29	1.62	59	818	877	1.63	0.95	59	681	781	1.35	0.84
	IS	20	619	1368	1.23	1.47	19	783	922	1.55	0.99	20	646	838	1.28	0.90
	RPS	20	647	1489	1.29	1.61	20	859	849	1.71	0.92	19	674	752	1.34	0.81
	WLS	20	677	1645	1.35	1.78	20	812	860	1.61	0.93	20	723	754	1.44	0.81
	_LS	4	676	1680	1.34	1.81	4	777	962	1.54	1.04	4	731	699	1.45	0.75
	_VS	4	638	1900	1.27	2.05	4	778	1004	1.54	1.08	4	695	754	1.38	0.81
	_N	4	728	1627	1.45	1.76	4	848	846	1.69	0.91	4	765	776	1.52	0.84
	_LF	4	715	1434	1.42	1.55	4	814	774	1.62	0.83	4	783	761	1.56	0.82
	_VF	4	629	1585	1.25	1.71	4	846	714	1.68	0.77	4	639	779	1.27	0.84
F07	Av.	59	617	1243	1.07	1.76	58	744	785	1.29	1.11	58	615	540	1.07	0.76
	IS	19	600	1112	1.04	1.57	18	717	888	1.25	1.26	20	624	566	1.08	0.80
	RPS	20	603	1284	1.05	1.82	20	754	681	1.31	0.96	18	607	531	1.05	0.75
	WLS	20	647	1334	1.12	1.89	20	762	785	1.32	1.11	20	613	523	1.06	0.74
	_LS	4	676	1287	1.17	1.82	4	787	752	1.37	1.06	4	626	508	1.09	0.72
	_VS	4	596	1532	1.04	2.17	4	750	689	1.30	0.98	4	588	719	1.02	1.02
	_N	4	699	1259	1.21	1.79	4	754	950	1.31	1.35	4	661	454	1.15	0.64
	_LF	4	685	1304	1.19	1.85	4	810	661	1.41	0.94	4	635	314	1.10	0.45
	_VF	4	579	1289	1.01	1.82	4	708	873	1.23	1.24	4	557	618	0.97	0.87
F08	Av.	60	687	1196	1.17	1.45	60	771	730	1.31	0.89	57	677	644	1.15	0.78
	IS	20	689	1092	1.17	1.33	20	745	758	1.27	0.92	20	646	677	1.10	0.82
	RPS	20	676	1182	1.15	1.43	20	816	702	1.39	0.85	18	691	677	1.18	0.82
	WLS	20	696	1312	1.19	1.59	20	752	730	1.28	0.89	19	694	579	1.18	0.70
	_LS	4	653	1372	1.12	1.67	4	788	751	1.34	0.91	4	726	574	1.24	0.70
	_VS	4	706	1357	1.20	1.65	4	746	751	1.27	0.91	4	691	585	1.18	0.71
	_N	4	675	1325	1.15	1.61	4	664	891	1.13	1.08	3	695	598	1.18	0.73
	_LF	4	757	1218	1.29	1.48	4	813	660	1.38	0.80	4	658	646	1.12	0.78
	_VF	4	688	1292	1.17	1.57	4	751	599	1.28	0.73	4	700	495	1.19	0.60
F09	Av.	60	611	1530	1.13	1.82	60	765	1118	1.41	1.33	59	791	742	1.46	0.88
	IS	20	634	1485	1.17	1.77	20	746	1109	1.38	1.32	20	744	742	1.37	0.88
	RPS	20	604	1537	1.12	1.83	20	780	1107	1.44	1.32	19	828	781	1.53	0.93
	WLS	20	595	1567	1.10	1.86	20	769	1138	1.42	1.35	20	801	703	1.48	0.84
	_LS	4	631	1581	1.17	1.88	4	788	1194	1.46	1.42	4	859	648	1.59	0.77
	_VS	4	551	1670	1.02	1.98	4	770	1177	1.42	1.40	4	757	791	1.40	0.94
	_N	4	635	1554	1.17	1.85	4	778	1236	1.44	1.47	4	870	632	1.61	0.75
	_LF	4	612	1471	1.13	1.75	4	788	1010	1.46	1.20	4	787	674	1.45	0.80
	_VF	4	544	1562	1.01	1.86	4	721	1073	1.33	1.28	4	730	769	1.35	0.91
F10	Av.	60	648	1333	1.16	1.71	60	801	927	1.43	1.19	58	749	625	1.34	0.80
	IS	20	653	1260	1.17	1.62	20	782	877	1.40	1.13	20	734	664	1.31	0.85
	RPS	20	665	1290	1.19	1.66	20	821	922	1.47	1.19	18	768	549	1.37	0.71
	WLS	20	628	1448	1.12	1.86	20	799	983	1.43	1.26	20	743	662	1.33	0.85
	_LS	4	650	1418	1.16	1.83	4	882	958	1.58	1.23	4	746	647	1.33	0.83
	_VS	4	603	1513	1.08	1.95	4	773	975	1.38	1.25	4	710	711	1.27	0.91
	_N	4	642	1476	1.15	1.90	4	790	988	1.41	1.27	4	797	701	1.42	0.90
	_LF	4	643	1361	1.15	1.75	4	783	887	1.40	1.14	4	732	646	1.31	0.83
	_VF	4	603	1472	1.08	1.90	4	766	1105	1.37	1.42	4	730	604	1.30	0.78
F11	Av.	59	718	1527	1.12	2.03	58	887	1134	1.38	1.50	59	881	614	1.37	0.82
	IS	20	730	1428	1.14	1.90	19	881	1059	1.37	1.41	20	881	568	1.37	0.75
	RPS	20	692	1569	1.08	2.08	19	903	1179	1.40	1.56	19	869	698	1.35	0.93

	WLS	19	731	1584	1.14	2.10	20	876	1163	1.36	1.54	20	892	577	1.39	0.77
	_LS	3	753	1539	1.17	2.04	4	953	1082	1.48	1.44	4	937	628	1.46	0.83
	_VS	4	706	1636	1.10	2.17	4	889	1073	1.38	1.42	4	846	537	1.31	0.71
	_N	4	716	1524	1.11	2.02	4	899	1213	1.40	1.61	4	924	586	1.44	0.78
	_LF	4	753	1615	1.17	2.15	4	832	1202	1.29	1.60	4	869	521	1.35	0.69
	_VF	4	733	1596	1.14	2.12	4	805	1245	1.25	1.65	4	881	612	1.37	0.81
F12	Av.	60	651	1553	1.16	1.89	59	834	1128	1.48	1.38	60	782	743	1.39	0.91
	IS	20	695	1421	1.24	1.73	20	864	1022	1.54	1.25	20	797	653	1.42	0.80
	RPS	20	638	1574	1.14	1.92	20	843	1179	1.50	1.44	20	772	782	1.37	0.95
	WLS	20	620	1664	1.10	2.03	19	797	1183	1.42	1.44	20	778	796	1.38	0.97
	_LS	4	665	1605	1.18	1.96	4	782	1171	1.39	1.43	4	781	874	1.39	1.07
	_VS	4	577	1742	1.03	2.13	4	770	1228	1.37	1.50	4	791	825	1.41	1.01
	_N	4	601	1742	1.07	2.13	4	808	1215	1.44	1.48	4	804	758	1.43	0.93
	_LF	4	639	1638	1.14	2.00	3	855	1081	1.52	1.32	4	735	719	1.31	0.88
	_VF	4	618	1595	1.10	1.94	4	784	1195	1.40	1.46	4	779	803	1.39	0.98
F13	Av.	60	638	1290	1.16	1.69	60	724	974	1.32	1.28	58	678	757	1.23	0.99
	IS	20	642	1266	1.17	1.66	20	692	926	1.26	1.22	20	667	721	1.21	0.95
	RPS	20	638	1344	1.16	1.76	20	768	1033	1.40	1.36	18	691	822	1.26	1.08
	WLS	20	634	1259	1.15	1.65	20	712	962	1.29	1.26	20	676	727	1.23	0.95
	_LS	4	655	1277	1.19	1.68	4	731	1008	1.33	1.32	4	686	826	1.25	1.08
	_VS	4	622	1350	1.13	1.77	4	717	1010	1.30	1.33	4	682	695	1.24	0.91
	_N	4	597	1286	1.09	1.69	4	650	1064	1.18	1.40	4	653	734	1.19	0.96
	_LF	4	683	1177	1.24	1.55	4	790	965	1.44	1.27	4	694	635	1.26	0.83
	_VF	4	613	1204	1.11	1.58	4	673	764	1.22	1.00	4	667	743	1.21	0.98
F14	Av.	59	632	1303	1.17	1.50	60	751	885	1.39	1.02	59	729	734	1.35	0.84
	IS	20	649	1176	1.20	1.35	20	729	858	1.34	0.99	20	711	712	1.31	0.82
	RPS	20	615	1255	1.14	1.44	20	738	895	1.36	1.03	19	710	760	1.31	0.87
	WLS	19	631	1479	1.16	1.70	20	787	903	1.45	1.04	20	768	730	1.42	0.84
	_LS	3	644	1557	1.19	1.79	4	860	839	1.59	0.96	4	859	666	1.58	0.76
	_VS	4	618	1552	1.14	1.79	4	753	952	1.39	1.09	4	743	822	1.37	0.94
	_N	4	605	1540	1.11	1.77	4	718	963	1.32	1.11	4	680	787	1.25	0.90
	_LF	4	686	1316	1.26	1.51	4	855	817	1.58	0.94	4	838	640	1.54	0.74
	_VF	4	604	1450	1.11	1.66	4	749	945	1.38	1.09	4	721	735	1.33	0.84
F15	Av.	60	599	1721	1.10	1.93	60	797	1171	1.46	1.31	59	754	786	1.38	0.88
	IS	20	599	1651	1.10	1.85	20	766	1182	1.41	1.32	20	756	770	1.39	0.86
	RPS	20	600	1729	1.10	1.94	20	855	1093	1.57	1.22	19	763	764	1.40	0.86
	WLS	20	599	1784	1.10	2.00	20	771	1238	1.42	1.39	20	742	823	1.36	0.92
	_LS	4	641	1679	1.18	1.88	4	795	1214	1.46	1.36	4	786	850	1.44	0.95
	_VS	4	593	1964	1.09	2.20	4	797	1324	1.46	1.48	4	722	814	1.32	0.91
	_N	4	583	1851	1.07	2.07	4	766	1328	1.41	1.49	4	771	701	1.41	0.78
	_LF	4	620	1715	1.14	1.92	4	768	1097	1.41	1.23	4	742	774	1.36	0.87
	_VF	4	558	1713	1.02	1.92	4	729	1230	1.34	1.38	4	692	976	1.27	1.09
F16	Av.	60	647	1718	1.09	2.17	60	867	1131	1.46	1.43	59	851	817	1.43	1.03
	IS	20	667	1606	1.12	2.03	20	845	1118	1.42	1.41	20	837	742	1.41	0.94
	RPS	20	635	1759	1.07	2.22	20	891	1097	1.50	1.39	19	853	785	1.43	0.99
	WLS	20	639	1789	1.07	2.26	20	865	1177	1.45	1.49	20	862	923	1.45	1.17
	_LS	4	680	1834	1.14	2.32	4	896	1059	1.51	1.34	4	878	874	1.48	1.10
	_VS	4	604	1889	1.02	2.39	4	873	1235	1.47	1.56	4	909	882	1.53	1.11
	_N	4	628	1791	1.06	2.26	4	890	1221	1.50	1.54	4	878	876	1.48	1.11
	_LF	4	654	1664	1.10	2.10	4	877	1066	1.48	1.35	4	855	931	1.44	1.18

	_VF	4	627	1768	1.05	2.23	4	786	1303	1.32	1.65	4	790	1052	1.33	1.33
M01	Av.	60	506	1334	1.10	1.84	60	654	982	1.42	1.35	58	626	640	1.36	0.88
	IS	20	524	1313	1.14	1.81	20	677	962	1.47	1.33	20	638	601	1.38	0.83
	RPS	20	491	1319	1.07	1.82	20	634	988	1.38	1.36	18	602	684	1.31	0.94
	WLS	20	501	1371	1.09	1.89	20	649	995	1.41	1.37	20	639	636	1.39	0.88
	_LS	4	527	1312	1.14	1.81	4	657	1001	1.43	1.38	4	667	628	1.45	0.86
	_VS	4	502	1388	1.09	1.91	4	624	1040	1.36	1.43	4	606	693	1.32	0.96
	_N	4	559	1380	1.22	1.90	4	681	1078	1.48	1.48	4	664	610	1.44	0.84
	_LF	4	469	1367	1.02	1.88	4	648	827	1.41	1.14	4	642	587	1.39	0.81
	_VF	4	448	1408	0.97	1.94	4	636	1027	1.38	1.41	4	614	661	1.33	0.91
M02	Av.	59	515	1238	1.16	1.82	60	665	795	1.50	1.17	58	643	537	1.45	0.79
	IS	20	538	1221	1.21	1.79	20	691	727	1.56	1.07	20	650	508	1.46	0.75
	RPS	20	498	1212	1.12	1.78	20	643	882	1.45	1.29	18	640	584	1.44	0.86
	WLS	19	508	1281	1.14	1.88	20	660	775	1.49	1.14	20	640	518	1.44	0.76
	_LS	3	509	1227	1.15	1.80	4	702	696	1.58	1.02	4	677	503	1.53	0.74
	_VS	4	495	1337	1.11	1.96	4	674	828	1.52	1.22	4	616	510	1.39	0.75
	_N	4	562	1289	1.27	1.89	4	684	829	1.54	1.22	4	666	531	1.50	0.78
	_LF	4	486	1274	1.09	1.87	4	641	612	1.44	0.90	4	643	506	1.45	0.74
	_VF	4	489	1265	1.10	1.86	4	601	907	1.35	1.33	4	599	540	1.35	0.79
M03	Av.	59	531	1130	1.13	1.68	60	615	935	1.31	1.39	58	599	654	1.27	0.97
	IS	19	543	1095	1.15	1.63	20	627	911	1.33	1.35	20	593	625	1.26	0.93
	RPS	20	534	1100	1.13	1.63	20	621	947	1.32	1.41	18	606	640	1.29	0.95
	WLS	20	516	1196	1.10	1.78	20	598	947	1.27	1.41	20	599	698	1.27	1.04
	_LS	4	526	1180	1.12	1.76	4	631	899	1.34	1.33	4	589	682	1.25	1.01
	_VS	4	507	1186	1.08	1.76	4	593	897	1.26	1.33	4	606	685	1.28	1.02
	_N	4	553	1182	1.17	1.75	4	645	1039	1.37	1.54	4	642	681	1.36	1.01
	_LF	4	510	1191	1.08	1.77	4	589	913	1.25	1.35	4	582	682	1.23	1.01
	_VF	4	486	1242	1.03	1.84	4	534	987	1.13	1.47	4	574	759	1.22	1.13
M04	Av.	60	527	1175	1.08	1.79	60	638	878	1.31	1.34	58	641	573	1.31	0.87
	IS	20	532	1117	1.09	1.70	20	634	903	1.30	1.37	20	615	556	1.26	0.85
	RPS	20	522	1197	1.07	1.82	20	658	882	1.35	1.34	18	662	566	1.35	0.86
	WLS	20	527	1211	1.08	1.84	20	624	848	1.28	1.29	20	646	598	1.32	0.91
	_LS	4	521	1328	1.07	2.02	4	618	781	1.27	1.19	4	622	615	1.27	0.94
	_VS	4	538	1158	1.11	1.77	4	628	839	1.29	1.28	4	635	566	1.30	0.86
	_N	4	558	1215	1.14	1.85	4	655	918	1.34	1.40	4	670	652	1.37	0.99
	_LF	4	522	1109	1.07	1.69	4	615	810	1.26	1.23	4	680	543	1.39	0.83
	_VF	4	498	1244	1.02	1.89	4	605	891	1.24	1.36	4	621	614	1.27	0.94
M05	Av.	58	529	1396	1.07	1.76	60	662	1000	1.34	1.26	58	604	754	1.22	0.95
	IS	19	520	1353	1.05	1.71	20	665	963	1.34	1.21	20	589	721	1.19	0.91
	RPS	20	525	1362	1.06	1.72	20	653	1023	1.32	1.29	18	593	788	1.20	0.99
	WLS	19	543	1472	1.10	1.86	20	669	1016	1.35	1.28	20	632	753	1.28	0.95
	_LS	3	536	1541	1.08	1.94	4	721	937	1.46	1.18	4	648	670	1.31	0.85
	_VS	4	546	1470	1.10	1.86	4	673	1014	1.36	1.28	4	638	773	1.29	0.98
	_N	4	574	1423	1.16	1.80	4	669	1085	1.35	1.37	4	637	779	1.29	0.98
	_LF	4	559	1395	1.13	1.76	4	683	980	1.38	1.24	4	668	638	1.35	0.81
	_VF	4	496	1547	1.00	1.95	4	599	1061	1.21	1.34	4	567	907	1.15	1.14
M06	Av.	59	549	1054	1.14	1.59	60	622	828	1.29	1.25	59	555	703	1.15	1.06
	IS	20	565	1071	1.18	1.62	20	608	904	1.26	1.37	20	540	719	1.12	1.08
	RPS	20	538	1035	1.12	1.56	20	640	814	1.33	1.23	19	550	737	1.14	1.11
	WLS	19	544	1057	1.13	1.59	20	617	766	1.28	1.16	20	575	654	1.19	0.99

	_LS	3	573	991	1.19	1.49	4	632	727	1.31	1.10	4	626	599	1.30	0.90
	_VS	4	562	996	1.17	1.50	4	647	800	1.34	1.21	4	546	693	1.13	1.05
	_N	4	529	1226	1.10	1.85	4	539	810	1.12	1.22	4	578	733	1.20	1.11
	_LF	4	561	964	1.17	1.46	4	644	751	1.34	1.13	4	592	555	1.23	0.84
	_VF	4	501	1090	1.04	1.65	4	625	741	1.30	1.12	4	532	691	1.11	1.04
M07	Av.	58	547	1087	1.14	1.56	60	668	756	1.39	1.09	59	593	664	1.24	0.95
	IS	18	550	1069	1.15	1.54	20	675	741	1.41	1.06	20	594	655	1.24	0.94
	RPS	20	542	1043	1.13	1.50	20	669	755	1.40	1.09	19	571	692	1.19	0.99
	WLS	20	550	1147	1.15	1.65	20	659	772	1.38	1.11	20	615	646	1.28	0.93
	_LS	4	539	1118	1.12	1.61	4	680	773	1.42	1.11	4	623	646	1.30	0.93
	_VS	4	559	1118	1.17	1.61	4	640	818	1.34	1.18	4	596	705	1.24	1.01
	_N	4	549	1142	1.15	1.64	4	636	883	1.33	1.27	4	589	661	1.23	0.95
	_LF	4	606	1174	1.27	1.69	4	731	607	1.53	0.87	4	676	553	1.41	0.79
	_VF	4	496	1184	1.04	1.70	4	607	780	1.27	1.12	4	592	664	1.24	0.95
M08	Av.	60	532	1071	1.07	1.72	60	683	750	1.37	1.21	59	643	586	1.29	0.94
	IS	20	525	1024	1.05	1.65	20	653	722	1.31	1.16	20	609	631	1.22	1.01
	RPS	20	534	1082	1.07	1.74	20	714	740	1.43	1.19	19	661	559	1.33	0.90
	WLS	20	536	1108	1.07	1.78	20	682	787	1.37	1.26	20	658	568	1.32	0.91
	_LS	4	547	1100	1.10	1.77	4	689	806	1.38	1.30	4	631	573	1.26	0.92
	_VS	4	510	1223	1.02	1.97	4	657	835	1.32	1.34	4	651	597	1.30	0.96
	_N	4	557	1049	1.12	1.69	4	723	771	1.45	1.24	4	729	485	1.46	0.78
	_LF	4	546	1111	1.10	1.79	4	726	713	1.45	1.15	4	669	539	1.34	0.87
	_VF	4	521	1056	1.04	1.70	4	615	807	1.23	1.30	4	611	644	1.22	1.04
M09	Av.	60	533	1221	1.12	1.84	60	660	1001	1.39	1.51	58	705	582	1.48	0.88
	IS	20	540	1156	1.14	1.75	20	660	959	1.39	1.45	20	673	575	1.42	0.87
	RPS	20	530	1174	1.12	1.77	20	652	992	1.37	1.50	18	703	604	1.48	0.91
	WLS	20	527	1333	1.11	2.01	20	669	1052	1.41	1.59	20	739	567	1.55	0.86
	_LS	4	575	1227	1.21	1.86	4	681	994	1.43	1.50	4	769	470	1.62	0.71
	_VS	4	491	1384	1.04	2.09	4	649	1104	1.37	1.67	4	721	571	1.52	0.86
	_N	4	493	1510	1.04	2.28	4	582	1235	1.23	1.87	4	748	593	1.57	0.90
	_LF	4	569	1260	1.20	1.90	4	769	944	1.62	1.43	4	785	548	1.65	0.83
	_VF	4	507	1283	1.07	1.94	4	664	982	1.40	1.48	4	671	655	1.41	0.99
M10	Av.	60	495	1329	1.10	1.78	60	604	1178	1.34	1.58	58	624	771	1.39	1.03
	IS	20	498	1306	1.11	1.75	20	612	1189	1.36	1.59	20	633	769	1.41	1.03
	RPS	20	473	1345	1.05	1.80	20	596	1218	1.33	1.63	18	622	793	1.38	1.06
	WLS	20	513	1337	1.14	1.79	20	605	1128	1.35	1.51	20	619	750	1.38	1.01
	_LS	4	543	1336	1.21	1.79	4	628	1107	1.40	1.48	4	654	767	1.46	1.03
	_VS	4	504	1315	1.12	1.77	4	648	1045	1.44	1.40	4	657	773	1.46	1.04
	_N	4	556	1319	1.24	1.77	4	582	1278	1.30	1.71	4	631	773	1.40	1.04
	_LF	4	505	1306	1.13	1.75	4	614	1106	1.37	1.48	4	581	673	1.29	0.90
	_VF	4	459	1408	1.02	1.89	4	551	1103	1.23	1.48	4	570	764	1.27	1.02
M11	Av.	59	506	1134	1.08	1.70	60	601	950	1.29	1.43	59	633	674	1.36	1.01
	IS	20	509	1128	1.09	1.70	20	550	988	1.18	1.49	20	575	715	1.23	1.08
	RPS	20	498	1117	1.07	1.68	20	628	942	1.34	1.42	19	665	621	1.42	0.93
	WLS	19	509	1157	1.09	1.74	20	626	919	1.34	1.38	20	660	686	1.41	1.03
	_LS	3	519	1095	1.11	1.65	4	635	878	1.36	1.32	4	671	696	1.44	1.05
	_VS	4	488	1214	1.05	1.83	4	628	853	1.35	1.28	4	638	677	1.37	1.02
	_N	4	537	1145	1.15	1.72	4	570	1103	1.22	1.66	4	665	724	1.42	1.09
	_LF	4	530	1119	1.13	1.68	4	657	827	1.41	1.24	4	676	615	1.45	0.92
	_VF	4	474	1197	1.01	1.80	4	639	934	1.37	1.40	4	651	717	1.39	1.08

M12	Av.	60	558	1246	1.05	1.69	60	663	974	1.25	1.32	58	686	538	1.29	0.73
	IS	20	574	1188	1.08	1.61	20	663	977	1.25	1.32	20	715	554	1.35	0.75
	RPS	20	557	1249	1.05	1.69	20	666	945	1.26	1.28	18	685	522	1.29	0.71
	WLS	20	543	1302	1.02	1.76	20	658	1001	1.24	1.36	20	657	537	1.24	0.73
	_LS	4	577	1219	1.09	1.65	4	705	918	1.33	1.24	4	695	499	1.31	0.68
	_VS	4	538	1367	1.02	1.85	4	681	981	1.28	1.33	4	687	572	1.29	0.78
	_N	4	551	1416	1.04	1.92	4	619	1309	1.17	1.77	4	664	549	1.25	0.74
	_LF	4	544	1264	1.03	1.71	4	639	930	1.20	1.26	4	631	470	1.19	0.64
	_VF	4	505	1244	0.95	1.69	4	648	866	1.22	1.17	4	611	593	1.15	0.80
M13	Av.	59	566	1235	1.19	1.62	60	694	967	1.46	1.26	58	647	713	1.36	0.93
	IS	20	560	1141	1.18	1.49	20	718	909	1.51	1.19	20	653	660	1.37	0.86
	RPS	20	550	1282	1.16	1.68	20	687	993	1.44	1.30	18	641	728	1.35	0.95
	WLS	19	588	1283	1.24	1.68	20	676	999	1.42	1.31	20	647	751	1.36	0.98
	_LS	4	615	1235	1.29	1.62	4	708	967	1.49	1.26	4	705	708	1.48	0.93
	_VS	4	590	1290	1.24	1.69	4	647	1072	1.36	1.40	4	646	730	1.36	0.96
	_N	4	617	1282	1.30	1.68	4	659	1029	1.38	1.35	4	659	712	1.38	0.93
	_LF	3	592	1282	1.25	1.68	4	702	892	1.47	1.17	4	668	642	1.40	0.84
	_VF	4	528	1326	1.11	1.73	4	664	1036	1.40	1.35	4	557	963	1.17	1.26
M14	Av.	60	534	1376	1.08	1.82	60	675	1075	1.36	1.43	59	662	713	1.34	0.95
	IS	20	541	1253	1.09	1.66	20	683	997	1.38	1.32	20	663	661	1.34	0.88
	RPS	20	518	1420	1.05	1.88	20	654	1134	1.32	1.50	19	642	754	1.30	1.00
	WLS	20	543	1455	1.10	1.93	20	688	1093	1.39	1.45	20	680	724	1.37	0.96
	_LS	4	557	1398	1.13	1.86	4	708	1030	1.43	1.37	4	704	735	1.42	0.97
	_VS	4	545	1449	1.10	1.92	4	688	1058	1.39	1.40	4	689	834	1.39	1.11
	_N	4	567	1532	1.15	2.03	4	647	1295	1.31	1.72	4	691	703	1.40	0.93
	_LF	4	559	1433	1.13	1.90	4	712	1050	1.44	1.39	4	686	613	1.39	0.81
	_VF	4	485	1462	0.98	1.94	4	686	1034	1.39	1.37	4	629	733	1.27	0.97
M15	Av.	60	532	1411	1.14	1.76	60	669	948	1.43	1.19	57	666	677	1.42	0.85
	IS	20	547	1359	1.17	1.70	20	714	889	1.53	1.11	20	680	661	1.45	0.83
	RPS	20	538	1405	1.15	1.75	20	664	933	1.42	1.17	18	656	662	1.40	0.83
	WLS	20	511	1470	1.09	1.84	20	630	1023	1.35	1.28	19	661	707	1.41	0.88
	_LS	4	515	1491	1.10	1.86	4	693	939	1.48	1.17	4	743	604	1.59	0.75
	_VS	4	481	1498	1.03	1.87	4	633	1094	1.35	1.37	4	665	697	1.42	0.87
	_N	4	524	1472	1.12	1.84	4	593	1183	1.27	1.48	4	639	766	1.36	0.96
	_LF	4	537	1361	1.15	1.70	4	613	839	1.31	1.05	4	641	649	1.37	0.81
	_VF	4	495	1529	1.06	1.91	4	617	1061	1.32	1.33	3	604	857	1.29	1.07
M16	Av.	60	513	1222	1.11	1.94	60	638	872	1.38	1.38	58	578	597	1.25	0.95
	IS	20	542	1208	1.17	1.92	20	665	861	1.43	1.37	20	615	533	1.33	0.85
	RPS	20	501	1229	1.08	1.95	20	648	898	1.40	1.42	18	545	629	1.18	1.00
	WLS	20	496	1230	1.07	1.95	20	602	857	1.30	1.36	20	575	628	1.24	1.00
	_LS	4	520	1263	1.12	2.00	4	658	878	1.42	1.39	4	630	546	1.36	0.87
	_VS	4	504	1237	1.09	1.96	4	603	911	1.30	1.45	4	585	653	1.26	1.04
	_N	4	513	1212	1.11	1.92	4	606	890	1.31	1.41	4	556	746	1.20	1.18
	_LF	4	480	1201	1.04	1.90	4	599	761	1.29	1.21	4	591	596	1.27	0.95
	_VF	4	463	1236	1.00	1.96	4	546	845	1.18	1.34	4	511	598	1.10	0.95

Appendix 8 Results for the tests for the homogeneity of variance (Levene's Tests of Equality of Error Variances) and variance ratio

… It is assumed that the variances between conditions of between-subjects variables should be the same throughout the data. This assumption can be tested by the Levene's Tests of Equality of Error Variances in the process of each ANOVA. Levene's test tests the hypothesis that the variances in the groups are equal (i.e. the difference between the variances is zero). Therefore, if Levene's test is non-significant (i.e. $p>0.05$), then we can conclude that the variances are roughly equal and the assumption is tenable. If, however, Levene's test is significant at $p \leq 0.05$, then we can conclude that the variances are significantly different; that is, it indicates that the assumption of homogeneity of variances has been violated. Although our data mostly met this assumption, there were some occasions in which it was violated. However, it is said that ANOVA is robust for small and even moderate departures from homogeneity of variance (Box 1954 cited in Garson 2008), and it is fairly robust when sample sizes are equal (Filed 2005: 324). Our data were equally divided in all cases. In a case of violating the assumption, there is a suggestion to look at the variance ratio for double-check. The variance ratio is the ratio of the variances between the group with the biggest variance and the group with the smallest variance; as a rule of thumb, if this ratio is less than 4 (Moore 1995), then it is safe to assume homogeneity of variance. Given this guideline, all the variances were calculated from raw data for the groups formed by the between-subjects categorical variables (i.e. sex, age, social class, or social groupings), and the largest and the smallest variances were chosen to calculate the variance ratio for each condition of the repeated-measures variable (i.e. speech style or phonetic environments). The results of Levene's tests for all the ANOVA tests conducted in this study and calculated variance ratios are provided below. As can be seen in the table, although the Levene's tests showed a significant result (i.e. possible indication for violation of the assumption) for several conditions, most of the variance ratios were below 4. To be exact, the ratios are below 4 in 159 conditions out of 162 (i.e. 98%). The ratios are, however, above 4 in the other three conditions; that is, RPS and WLS conditions in the T14 for the SF1 of TRAP vowels, and WLS condition in the T14 for the SF1 of STRUT vowels. ANOVA, however, is said to be fairly robust when sample sizes are equal (Field 2005: 324). Since our sample sizes were equal in these conditions, ANOVA tests must have been robust enough to cope with their violation of the homogeneity assumption. Therefore, it should be safe to assume that the homogeneity assumption has been met for all the conditions.

Vowel	Formant	Tests	Conditions of Within-subjects factor	F	df1	df2	Sig.		Variance ratio
E	SF1	1-1	IS	0.265	1	30	0.610	ns	1.489
			RPS	1.240	1	30	0.274	ns	1.498
			WLS	3.202	1	30	0.084	ns	1.777
		1-2	IS	0.896	1	30	0.351	ns	1.401
			RPS	0.396	1	30	0.534	ns	1.291
			WLS	3.394	1	30	0.075	ns	1.781
		1-3	IS	1.141	1	30	0.294	ns	1.062
			RPS	1.005	1	30	0.324	ns	1.085
			WLS	2.684	1	30	0.112	ns	1.340
		1-4	IS	1.188	7	24	0.347	ns	2.507
			RPS	1.439	7	24	0.236	ns	2.625
			WLS	4.765	7	24	0.002	$p<0.01$	2.786
		2-1	_LS	0.125	1	30	0.726	ns	2.264
			_VS	2.874	1	30	0.100	ns	1.713
			_N	1.392	1	30	0.247	ns	1.507

			_LF	2.916	1	30	0.098	ns	2.912
			_VF	6.013	1	30	0.02	$p<0.05$	2.528
		2-2	_LS	2.859	1	30	0.101	ns	1.591
			_VS	2.639	1	30	0.115	ns	1.255
			_N	0.612	1	30	0.44	ns	1.669
			_LF	7.442	1	30	0.011	$p<0.05$	3.495
			_VF	6.521	1	30	0.016	$p<0.05$	2.251
		2-3	_LS	0.072	1	30	0.791	ns	1.322
			_VS	4.810	1	30	0.036	$p<0.05$	1.362
			_N	1.276	1	30	0.268	ns	1.620
			_LF	1.76	1	30	0.195	ns	1.329
			_VF	0.344	1	30	0.562	ns	1.221
E	SF21	1-1	IS	6.115	1	30	0.019	$p<0.05$	1.484
			RPS	4.764	1	30	0.037	$p<0.05$	2.034
			WLS	3.476	1	30	0.072	ns	2.057
		1-2	IS	0.080	1	30	0.779	ns	1.149
			RPS	0.489	1	30	0.490	ns	1.174
			WLS	1.394	1	30	0.247	ns	1.039
		1-3	IS	5.939	1	30	0.021	$p<0.05$	1.324
			RPS	5.189	1	30	0.030	$p<0.05$	1.762
			WLS	2.823	1	30	0.103	ns	1.999
		1-4	IS	1.971	7	24	0.102	ns	2.947
			RPS	2.516	7	24	0.043	$p<0.05$	3.612
			WLS	2.865	7	24	0.025	$p<0.05$	3.859
		2-1	_LS	0.000	1	30	0.998	ns	2.144
			_VS	2.648	1	30	0.114	ns	1.949
			_N	2.008	1	30	0.167	ns	1.194
			_LF	10.469	1	30	0.003	$p<0.01$	3.171
			_VF	5.612	1	30	0.024	$p<0.05$	2.269
		2-2	_LS	0.297	1	30	0.590	ns	1.191
			_VS	0.002	1	30	0.963	ns	1.138
			_N	2.339	1	30	0.137	ns	1.031
			_LF	0.002	1	30	0.967	ns	1.271
			_VF	0.028	1	30	0.867	ns	1.038
		2-3	_LS	2.480	1	30	0.126	ns	3.022
			_VS	2.485	1	30	0.125	ns	2.120
			_N	0.359	1	30	0.554	ns	1.143
			_LF	1.418	1	30	0.243	ns	1.983
			_VF	3.457	1	30	0.073	ns	1.976
A	SF1	1-1	IS	0.328	1	30	0.571	ns	1.394
			RPS	5.435	1	30	0.027	$p<0.05$	2.765
			WLS	2.762	1	30	0.107	ns	2.207
		1-2	IS	0.940	1	30	0.340	ns	1.289
			RPS	3.264	1	30	0.081	ns	2.282
			WLS	3.873	1	30	0.058	ns	2.008
		1-3	IS	0.705	1	30	0.408	ns	1.212
			RPS	1.112	1	30	0.300	ns	1.508
			WLS	0.630	1	30	0.434	ns	1.169
		1-4	IS	7.741	7	24	0	$p<0.001$	3.418
			RPS	9.455	7	24	0	$p<0.001$	*7.984*
			WLS	5.969	7	24	0	$p<0.001$	*4.640*

		2-1	_LS	1.727	1	30	0.199	ns	2.143
			_VS	2.832	1	30	0.103	ns	2.807
			_N	0.311	1	30	0.581	ns	1.806
			_LF	0.586	1	30	0.45	ns	3.168
			_VF	0.519	1	30	0.477	ns	1.927
		2-2	_LS	2.541	1	30	0.121	ns	1.751
			_VS	3.931	1	30	0.057	ns	3.125
			_N	1.264	1	30	0.27	ns	1.966
			_LF	0.776	1	30	0.385	ns	2.145
			_VF	2.18	1	30	0.15	ns	2.550
		2-3	_LS	0.130	1	30	0.721	ns	1.167
			_VS	0.888	1	30	0.354	ns	1.344
			_N	1.151	1	30	0.292	ns	1.158
			_LF	0.27	1	30	0.607	ns	1.189
			_VF	0.103	1	30	0.751	ns	1.559
A	SF21	1-1	IS	0.258	1	30	0.615	ns	1.211
			RPS	5.413	1	30	0.027	$p<0.05$	1.514
			WLS	5.548	1	30	0.025	$p<0.05$	1.572
		1-2	IS	0.157	1	30	0.695	ns	1.113
			RPS	1.933	1	30	0.175	ns	1.288
			WLS	1.937	1	30	0.174	ns	1.140
		1-3	IS	0.552	1	30	0.463	ns	1.011
			RPS	1.519	1	30	0.227	ns	1.120
			WLS	3.938	1	30	0.056	ns	1.199
		1-4	IS	0.555	7	24	0.785	ns	2.698
			RPS	1.204	7	24	0.338	ns	1.944
			WLS	0.754	7	24	0.63	ns	2.990
		2-1	_LS	3.196	1	30	0.084	ns	1.879
			_VS	6.710	1	30	0.015	$p<0.05$	2.905
			_N	0.002	1	30	0.969	ns	1.009
			_LF	2.887	1	30	0.1	ns	1.599
			_VF	10.158	1	30	0.003	$p<0.01$	3.047
		2-2	_LS	0.779	1	30	0.384	ns	1.419
			_VS	1.648	1	30	0.209	ns	1.393
			_N	0.188	1	30	0.668	ns	1.258
			_LF	2.66	1	30	0.113	ns	1.434
			_VF	1.592	1	30	0.217	ns	1.365
		2-3	_LS	0.839	1	30	0.367	ns	1.116
			_VS	6.770	1	30	0.014	$p<0.05$	2.124
			_N	0.056	1	30	0.814	ns	1.157
			_LF	0.871	1	30	0.358	ns	1.167
			_VF	6.393	1	30	0.017	$p<0.05$	1.824
U	SF1	1-1	IS	0.245	1	30	0.624	ns	1.332
			RPS	0.028	1	30	0.867	ns	1.493
			WLS	0.013	1	30	0.911	ns	1.706
		1-2	IS	1.328	1	30	0.258	ns	1.155
			RPS	2.120	1	30	0.156	ns	1.213
			WLS	0.093	1	30	0.762	ns	1.434
		1-3	IS	3.585	1	30	0.068	ns	1.149
			RPS	4.837	1	30	0.036	$p<0.05$	1.127
			WLS	2.132	1	30	0.155	ns	1.057

		1-4	IS	1.877	7	24	0.118	ns	2.439
			RPS	1.358	7	24	0.268	ns	2.935
			WLS	2.767	7	24	0.029	p<0.05	4.479
		2-1	_LS	0.414	1	30	0.525	ns	2.324
			_VS	0.267	1	30	0.609	ns	1.687
			_N	1.286	1	30	0.266	ns	1.952
			_LF	1.44	1	30	0.24	ns	1.308
			_VF	0.974	1	30	0.332	ns	1.779
		2-2	_LS	0.800	1	30	0.378	ns	2.013
			_VS	0.361	1	30	0.553	ns	1.247
			_N	0.263	1	30	0.612	ns	1.572
			_LF	1.249	1	30	0.273	ns	1.163
			_VF	1.026	1	30	0.319	ns	1.340
		2-3	_LS	0.005	1	30	0.945	ns	1.024
			_VS	1.182	1	30	0.286	ns	1.414
			_N	2.377	1	30	0.134	ns	1.169
			_LF	0.006	1	30	0.939	ns	1.219
			_VF	0.293	1	30	0.592	ns	1.118
U	SF21	1-1	IS	0.893	1	30	0.352	ns	1.143
			RPS	1.478	1	30	0.234	ns	1.744
			WLS	4.237	1	30	0.048	p<0.05	2.575
		1-2	IS	0.836	1	30	0.368	ns	1.133
			RPS	0.586	1	30	0.450	ns	1.079
			WLS	2.404	1	30	0.132	ns	1.418
		1-3	IS	0.139	1	30	0.712	ns	1.194
			RPS	0.480	1	30	0.494	ns	1.195
			WLS	0.048	1	30	0.829	ns	1.418
		1-4	IS	2.132	7	24	0.079	ns	2.184
			RPS	0.652	7	24	0.709	ns	3.126
			WLS	1.345	7	24	0.273	ns	2.849
		2-1	_LS	3.006	1	30	0.093	ns	3.166
			_VS	2.575	1	30	0.119	ns	3.264
			_N	1.595	1	30	0.216	ns	1.802
			_LF	6.253	1	30	0.018	p<0.05	3.646
			_VF	2.471	1	30	0.126	ns	3.041
		2-2	_LS	0.414	1	30	0.525	ns	1.108
			_VS	3.221	1	30	0.083	ns	1.714
			_N	2.241	1	30	0.145	ns	1.411
			_LF	2.283	1	30	0.141	ns	1.774
			_VF	0.793	1	30	0.38	ns	1.590
		2-3	_LS	0.320	1	30	0.576	ns	1.054
			_VS	0.049	1	30	0.826	ns	1.135
			_N	0.948	1	30	0.338	ns	1.563
			_LF	0.034	1	30	0.855	ns	1.242
			_VF	0.937	1	30	0.341	ns	2.124

Appendix 9 Results for the tests for sphericity (Mauchly's Sphericity Tests)

... Mauchly's Sphericity Test tests the hypothesis that the variances of the differences between conditions are equal. Therefore if Mauchly's test statistic is not significant then it can be safe to conclude that the variance of differences are not significantly different; that is, the condition of sphericity is met for the main effect of within-subjects variable (i.e. speech style or phonetic environments). In this case, uncorrected *F* values were used. If, however, Mauchly's test statistic is significant (i.e. $p \leq 0.05$), we should conclude that there are significant differences between the variances of differences; that is, the condition of sphericity is violated. In this case, degrees of freedom were corrected using Greenhouse-Geisser correction (denoted as ε). (cf. Field 2005: 429-431) Hence, the table below provides all the results of Mauchly's Sphericity Tests from all the tests conducted in this study, with Greenhouse-Geisser estimates of sphericity for each test.

Vowel	Formant	Tests No.	Within Subjects Effect	Mauchly's W	Approx. χ^2	df	Sig.	Greenhouse-Geisser ε	
E	SF1	1-1	sstyle	0.575	16.050	2	0.000	0.702	$p<0.001$
		1-2	sstyle	0.593	15.159	2	0.001	0.711	$p<0.01$
		1-3	sstyle	0.660	12.069	2	0.002	0.746	$p<0.01$
		1-4	sstyle	0.819	4.599	2	0.1	0.847	ns
		2-1	PhonEn	0.558	16.565	9	0.056	0.756	ns
		2-2	PhonEn	0.538	17.637	9	0.04	0.747	$p<0.05$
		2-3	PhonEn	0.638	12.765	9	0.174	0.795	ns
E	SF21	1-1	sstyle	0.976	0.707	2	0.702	0.976	ns
		1-2	sstyle	0.939	1.811	2	0.404	0.943	ns
		1-3	sstyle	0.959	1.201	2	0.549	0.961	ns
		1-4	sstyle	0.947	1.264	2	0.532	0.949	ns
		2-1	PhonEn	0.559	16.522	9	0.057	0.843	ns
		2-2	PhonEn	0.565	16.249	9	0.062	0.803	ns
		2-3	PhonEn	0.604	14.321	9	0.112	0.828	ns
A	SF1	1-1	sstyle	0.944	1.658	2	0.437	0.947	ns
		1-2	sstyle	0.954	1.377	2	0.502	0.956	ns
		1-3	sstyle	0.972	0.830	2	0.660	0.973	ns
		1-4	sstyle	0.994	0.135	2	0.935	0.994	ns
		2-1	PhonEn	0.465	21.761	9	0.01	0.723	$p<0.05$
		2-2	PhonEn	0.488	20.398	9	0.016	0.727	$p<0.05$
		2-3	PhonEn	0.529	18.118	9	0.034	0.76	$p<0.05$
A	SF21	1-1	sstyle	0.875	3.859	2	0.145	0.889	ns
		1-2	sstyle	0.947	1.580	2	0.454	0.950	ns
		1-3	sstyle	0.930	2.103	2	0.349	0.935	ns
		1-4	sstyle	0.963	0.866	2	0.648	0.964	ns
		2-1	PhonEn	0.548	17.08	9	0.048	0.819	$p<0.05$
		2-2	PhonEn	0.577	15.633	9	0.075	0.843	ns
		2-3	PhonEn	0.569	16.012	9	0.067	0.834	ns
U	SF1	1-1	sstyle	0.898	3.132	2	0.209	0.907	ns
		1-2	sstyle	0.907	2.843	2	0.241	0.915	ns
		1-3	sstyle	0.849	4.732	2	0.094	0.869	ns
		1-4	sstyle	0.872	3.153	2	0.207	0.886	ns
		2-1	PhonEn	0.323	32.086	9	0.000	0.625	$p<0.001$
		2-2	PhonEn	0.29	35.186	9	0.000	0.601	$p<0.001$
		2-3	PhonEn	0.325	31.967	9	0.000	0.605	$p<0.001$
U	SF21	1-1	sstyle	0.977	0.676	2	0.713	0.977	ns
		1-2	sstyle	0.982	0.538	2	0.764	0.982	ns
		1-3	sstyle	0.982	0.513	2	0.774	0.983	ns
		1-4	sstyle	0.889	2.71	2	0.258	0.9	ns
		2-1	PhonEn	0.725	9.15	9	0.424	0.867	ns
		2-2	PhonEn	0.794	6.565	9	0.683	0.891	ns
		2-3	PhonEn	0.805	6.17	9	0.723	0.896	ns

Appendix 10 Supplementary tables for means, standard deviations (SDs), maximum (Ma) and minimum (Mi) values, and difference between maximum and minimum

		DRESS											
		SF1						SF21					
Group / Test No.	Subgroup	Mean	Std. Error	SD	Ma	Mi	Ma-Mi	Mean	Std. Error	SD	Ma	Mi	Ma-Mi
Style	IS	1.148		0.053	1.24	1.04	0.2	1.67		0.157	2.03	1.33	0.7
	RPS	1.116		0.055	1.29	1.05	0.24	1.742		0.178	2.22	1.38	0.84
	WLS	1.127		0.073	1.35	1.02	0.33	1.829		0.157	2.26	1.58	0.68
PhonEn	_LS	1.154		0.07	1.34	1.01	0.33	1.817		0.161	2.32	1.49	0.83
	_VS	1.104		0.073	1.27	1.02	0.25	1.905		0.194	2.39	1.5	0.89
	_N	1.164		0.09	1.45	1.04	0.41	1.848		0.179	2.28	1.51	0.77
	_LF	1.152		0.109	1.42	0.88	0.54	1.764		0.191	2.15	1.32	0.83
	_VF	1.068		0.09	1.34	0.92	0.42	1.814		0.167	2.23	1.45	0.78
1-1 (by style)	Female	1.151	0.012	0.069	1.35	1.02	0.33	1.748	0.04	0.218	2.26	1.33	0.94
	Male	1.11	0.012	0.046	1.24	1.02	0.21	1.745	0.04	0.12	2.01	1.49	0.52
2-1 (by PhonEn)	Female	1.149	0.018	0.106	1.45	0.88	0.57	1.848	0.039	0.218	2.39	1.32	1.07
	Male	1.109	0.018	0.075	1.3	0.95	0.34	1.811	0.039	0.139	2.28	1.46	0.83
Female	IS	1.167	0.013	0.051	1.24	1.04	0.2	1.65	0.04	0.198	2.03	1.33	0.7
	RPS	1.138	0.013	0.062	1.29	1.05	0.24	1.748	0.045	0.229	2.22	1.38	0.84
	WLS	1.147	0.018	0.09	1.35	1.02	0.33	1.847	0.04	0.193	2.26	1.58	0.68
Male	IS	1.128	0.013	0.049	1.21	1.05	0.16	1.689	0.04	0.105	1.92	1.49	0.43
	RPS	1.094	0.013	0.038	1.16	1.05	0.11	1.736	0.045	0.114	1.95	1.5	0.45
	WLS	1.108	0.018	0.048	1.24	1.02	0.22	1.811	0.04	0.113	2.01	1.59	0.42
1-2 (by style)	Young	1.138	0.013	0.073	1.35	1.02	0.33	1.687	0.036	0.146	1.98	1.33	0.65
	Old	1.122	0.013	0.047	1.24	1.02	0.21	1.806	0.036	0.182	2.26	1.35	0.91
2-2 (by PhonEn)	Young	1.143	0.018	0.11	1.45	0.88	0.57	1.773	0.037	0.164	2.17	1.32	0.86
	Old	1.114	0.018	0.073	1.3	0.95	0.34	1.886	0.037	0.184	2.39	1.51	0.88
Young	IS	1.149	0.014	0.062	1.23	1.04	0.19	1.621	0.038	0.137	1.81	1.33	0.48
	RPS	1.124	0.014	0.064	1.29	1.05	0.24	1.668	0.041	0.141	1.82	1.38	0.44
	WLS	1.142	0.018	0.091	1.35	1.02	0.33	1.773	0.037	0.125	1.98	1.58	0.4
Old	IS	1.146	0.014	0.045	1.24	1.08	0.16	1.718	0.038	0.165	2.03	1.35	0.68
	RPS	1.108	0.014	0.045	1.19	1.05	0.14	1.816	0.041	0.184	2.22	1.44	0.78
	WLS	1.113	0.018	0.049	1.24	1.02	0.22	1.885	0.037	0.168	1.65	2.26	0.61
1-3 (by style)	WC	1.122	0.013	0.053	1.24	1.02	0.22	1.784	0.038	0.123	2.1	1.52	0.58
	UMC	1.138	0.013	0.069	1.35	1.04	0.3	1.71	0.038	0.21	2.26	1.33	0.94
2-3 (by PhonEn)	WC	1.106	0.017	0.08	1.27	0.88	0.39	1.863	0.039	0.142	2.28	1.58	0.71
	UMC	1.151	0.017	0.102	1.45	0.98	0.47	1.796	0.039	0.212	2.39	1.32	1.07
WC	IS	1.154	0.013	0.048	1.24	1.08	0.16	1.716	0.038	0.091	1.9	1.52	0.38
	RPS	1.108	0.014	0.046	1.2	1.05	0.15	1.773	0.044	0.114	2.08	1.63	0.45
	WLS	1.104	0.018	0.051	1.22	1.02	0.2	1.862	0.039	0.12	2.1	1.64	0.46
UMC	IS	1.141	0.013	0.058	1.23	1.04	0.19	1.623	0.038	0.196	2.03	1.33	0.7
	RPS	1.124	0.014	0.064	1.29	1.05	0.24	1.711	0.044	0.224	2.22	1.38	0.84
	WLS	1.151	0.018	0.086	1.35	1.07	0.28	1.796	0.039	0.185	2.26	1.58	0.68
1-4 (by style)	F-Y-WC	1.141	0.025	0.07	1.22	1.02	0.2	1.736	0.073	0.113	1.98	1.52	0.46
	F-Y-UMC	1.191	0.025	0.096	1.35	1.04	0.3	1.573	0.073	0.18	1.89	1.33	0.57

	F-O-WC	1.143	0.025	0.044	1.24	1.08	0.16	1.863	0.073	0.156	2.1	1.62	0.48
	F-O-UMC	1.128	0.025	0.04	1.2	1.07	0.13	1.822	0.073	0.282	2.26	1.35	0.91
	M-Y-WC	1.116	0.025	0.043	1.21	1.07	0.15	1.781	0.073	0.086	1.89	1.63	0.26
	M-Y-UMC	1.105	0.025	0.043	1.18	1.05	0.12	1.66	0.073	0.105	1.86	1.5	0.36
	M-O-WC	1.089	0.025	0.036	1.14	1.02	0.12	1.754	0.073	0.098	2.01	1.61	0.4
	M-O-UMC	1.129	0.025	0.056	1.24	1.05	0.19	1.786	0.073	0.147	1.95	1.49	0.46
F-Y-WC	IS	1.185	0.026	0.037	1.22	1.14	0.08	1.675	0.072	0.108	1.77	1.52	0.25
	RPS	1.13	0.027	0.055	1.2	1.07	0.13	1.72	0.083	0.063	1.8	1.65	0.15
	WLS	1.108	0.032	0.094	1.22	1.02	0.2	1.813	0.076	0.14	1.98	1.64	0.34
F-Y-UMC	IS	1.155	0.026	0.081	1.23	1.04	0.19	1.448	0.072	0.1	1.57	1.33	0.24
	RPS	1.173	0.027	0.1	1.29	1.05	0.24	1.56	0.083	0.2	1.82	1.38	0.44
	WLS	1.245	0.032	0.108	1.35	1.12	0.23	1.71	0.076	0.151	1.89	1.58	0.31
F-O-WC	IS	1.18	0.026	0.042	1.24	1.14	0.1	1.755	0.072	0.116	1.9	1.62	0.28
	RPS	1.133	0.027	0.046	1.19	1.08	0.11	1.873	0.083	0.175	2.08	1.66	0.42
	WLS	1.115	0.032	0.019	1.14	1.1	0.04	1.963	0.076	0.122	2.1	1.86	0.24
F-O-UMC	IS	1.148	0.026	0.046	1.2	1.1	0.1	1.723	0.072	0.291	2.03	1.35	0.68
	RPS	1.118	0.027	0.04	1.16	1.07	0.09	1.84	0.083	0.327	2.22	1.44	0.78
	WLS	1.12	0.032	0.042	1.16	1.07	0.09	1.903	0.076	0.284	2.26	1.65	0.61
M-Y-WC	IS	1.148	0.026	0.049	1.21	1.09	0.12	1.733	0.072	0.083	1.81	1.63	0.18
	RPS	1.098	0.027	0.032	1.13	1.07	0.06	1.763	0.083	0.09	1.82	1.63	0.19
	WLS	1.103	0.032	0.026	1.14	1.08	0.06	1.848	0.076	0.05	1.89	1.78	0.11
M-Y-UMC	IS	1.108	0.026	0.068	1.18	1.05	0.13	1.63	0.072	0.071	1.71	1.54	0.17
	RPS	1.095	0.027	0.035	1.13	1.06	0.07	1.63	0.083	0.118	1.74	1.5	0.24
	WLS	1.113	0.032	0.035	1.15	1.07	0.08	1.72	0.076	0.122	1.86	1.59	0.27
M-O-WC	IS	1.105	0.026	0.026	1.14	1.08	0.06	1.703	0.072	0.066	1.75	1.61	0.14
	RPS	1.073	0.027	0.033	1.12	1.05	0.07	1.735	0.083	0.059	1.8	1.68	0.12
	WLS	1.09	0.032	0.051	1.14	1.02	0.12	1.825	0.076	0.125	2.01	1.74	0.27
M-O-UMC	IS	1.153	0.026	0.042	1.18	1.09	0.09	1.693	0.072	0.177	1.92	1.49	0.43
	RPS	1.11	0.027	0.054	1.16	1.05	0.11	1.815	0.083	0.122	1.95	1.68	0.27
	WLS	1.125	0.032	0.048	1.24	1.07	0.17	1.85	0.076	0.123	1.95	1.68	0.27
Female	_LS	1.169	0.017	0.08	1.34	1.01	0.33	1.853	0.04	0.17	2.32	1.57	0.75
	_VS	1.113	0.018	0.085	1.27	1.02	0.25	1.978	0.046	0.212	2.39	1.64	0.75
	_N	1.174	0.023	0.106	1.45	1.06	0.39	1.85	0.046	0.205	2.26	1.51	0.75
	_LF	1.179	0.027	0.134	1.42	0.88	0.54	1.769	0.049	0.249	2.15	1.32	0.83
	_VF	1.109	0.02	0.106	1.34	0.92	0.42	1.791	0.042	0.212	2.23	1.45	0.78
Male	_LS	1.139	0.017	0.059	1.29	1.07	0.22	1.781	0.04	0.147	2.02	1.49	0.53
	_VS	1.096	0.018	0.06	1.24	1.02	0.22	1.833	0.046	0.148	2.09	1.5	0.59
	_N	1.155	0.023	0.073	1.3	1.04	0.26	1.846	0.046	0.156	2.28	1.64	0.64
	_LF	1.124	0.027	0.073	1.27	1.02	0.25	1.758	0.049	0.117	1.9	1.46	0.44
	_VF	1.028	0.02	0.044	1.11	0.95	0.16	1.837	0.042	0.109	1.96	1.65	0.31
Young	_LS	1.143	0.018	0.086	1.34	1.01	0.33	1.779	0.04	0.139	2.02	1.49	0.53
	_VS	1.128	0.018	0.08	1.27	1.02	0.25	1.851	0.047	0.188	2.17	1.5	0.67
	_N	1.205	0.02	0.091	1.45	1.1	0.35	1.768	0.041	0.129	1.96	1.51	0.45
	_LF	1.154	0.028	0.143	1.42	0.88	0.54	1.718	0.047	0.195	2.03	1.32	0.71
	_VF	1.085	0.022	0.115	1.34	0.92	0.42	1.749	0.039	0.148	1.95	1.45	0.5
Old	_LS	1.165	0.018	0.051	1.29	1.09	0.2	1.854	0.04	0.176	2.32	1.62	0.7
	_VS	1.081	0.018	0.059	1.24	1.02	0.22	1.96	0.047	0.191	2.39	1.69	0.7
	_N	1.124	0.02	0.07	1.3	1.04	0.26	1.928	0.041	0.19	2.28	1.68	0.6

	_LF	1.149	0.028	0.065	1.26	1.03	0.23	1.809	0.047	0.182	2.15	1.51	0.64
	_VF	1.051	0.022	0.055	1.14	0.95	0.19	1.879	0.039	0.164	2.23	1.58	0.65
WC	_LS	1.138	0.017	0.066	1.22	1.01	0.21	1.84	0.04	0.112	2.04	1.65	0.39
	_VS	1.079	0.017	0.052	1.23	1.02	0.21	1.908	0.049	0.149	2.17	1.64	0.53
	_N	1.16	0.023	0.071	1.27	1.04	0.23	1.889	0.044	0.164	2.28	1.61	0.67
	_LF	1.098	0.024	0.083	1.22	0.88	0.34	1.83	0.045	0.15	2.15	1.62	0.53
	_VF	1.053	0.023	0.081	1.25	0.92	0.33	1.848	0.042	0.131	2.12	1.58	0.54
UMC	_LS	1.17	0.017	0.073	1.34	1.08	0.26	1.793	0.04	0.199	2.32	1.49	0.83
	_VS	1.129	0.017	0.083	1.27	1.02	0.25	1.903	0.049	0.236	2.39	1.5	0.89
	_N	1.169	0.023	0.108	1.45	1.06	0.39	1.807	0.044	0.19	2.26	1.51	0.75
	_LF	1.206	0.024	0.108	1.42	1.04	0.38	1.698	0.045	0.209	2.1	1.32	0.78
	_VF	1.083	0.023	0.098	1.34	0.98	0.36	1.78	0.042	0.195	2.23	1.45	0.78

		TRAP											
		SF1						SF21					
Group / Test No.	Subgroup	Mean	Std. Error	SD	Ma	Mi	Ma-Mi	Mean	Std. Error	SD	Ma	Mi	Ma-Mi
Style	IS	1.391		0.102	1.58	1.18	0.4	1.232		0.176	1.59	0.78	0.81
	RPS	1.423		0.115	1.79	1.26	0.53	1.252		0.207	1.63	0.78	0.85
	WLS	1.379		0.101	1.7	1.2	0.5	1.275		0.185	1.59	0.82	0.77
PhonEn	_LS	1.443		0.108	1.81	1.27	0.54	1.228		0.177	1.5	0.77	0.73
	_VS	1.372		0.105	1.77	1.17	0.6	1.294		0.193	1.67	0.69	0.98
	_N	1.362		0.131	1.69	1.12	0.57	1.393		0.225	1.87	0.91	0.96
	_LF	1.408		0.152	1.81	0.91	0.9	1.175		0.208	1.6	0.79	0.81
	_VF	1.31		0.11	1.68	1.13	0.55	1.284		0.216	1.65	0.73	0.92
1-1 (by style)	Female	1.43	0.022	0.121	1.79	1.2	0.59	1.184	0.043	0.207	1.56	0.78	0.79
	Male	1.365	0.022	0.078	1.56	1.18	0.38	1.322	0.043	0.139	1.63	1.06	0.57
2-1 (by PhonEn)	Female	1.407	0.025	0.149	1.81	0.91	0.9	1.222	0.045	0.236	1.65	0.69	0.96
	Male	1.352	0.025	0.099	1.62	1.12	0.5	1.328	0.045	0.177	1.87	0.87	0.99
Female	IS	1.406	0.026	0.098	1.58	1.25	0.33	1.166	0.041	0.177	1.41	0.78	0.63
	RPS	1.479	0.025	0.133	1.79	1.29	0.5	1.164	0.048	0.231	1.56	0.78	0.78
	WLS	1.406	0.025	0.123	1.7	1.2	0.5	1.222	0.045	0.219	1.54	0.82	0.72
Male	IS	1.376	0.026	0.107	1.56	1.18	0.38	1.298	0.041	0.152	1.59	1.06	0.53
	RPS	1.366	0.025	0.054	1.45	1.26	0.19	1.339	0.048	0.139	1.63	1.09	0.54
	WLS	1.352	0.025	0.066	1.49	1.24	0.25	1.329	0.045	0.13	1.59	1.11	0.48
1-2 (by style)	Young	1.405	0.024	0.128	1.79	1.2	0.59	1.159	0.039	0.179	1.41	0.78	0.63
	Old	1.39	0.024	0.08	1.57	1.18	0.39	1.346	0.039	0.15	1.63	0.99	0.65
2-2 (by PhonEn)	Young	1.38	0.026	0.156	1.81	0.91	0.9	1.175	0.039	0.2	1.54	0.69	0.85
	Old	1.378	0.026	0.096	1.62	1.17	0.45	1.375	0.039	0.179	1.87	0.94	0.93
Young	IS	1.398	0.026	0.108	1.58	1.25	0.33	1.158	0.04	0.169	1.37	0.78	0.59
	RPS	1.438	0.029	0.144	1.79	1.29	0.5	1.145	0.045	0.199	1.41	0.78	0.63
	WLS	1.38	0.026	0.131	1.7	1.2	0.5	1.175	0.039	0.178	1.41	0.82	0.59
Old	IS	1.384	0.026	0.098	1.54	1.18	0.36	1.306	0.04	0.154	1.59	0.99	0.6
	RPS	1.408	0.029	0.079	1.57	1.26	0.31	1.358	0.045	0.157	1.63	1.03	0.6
	WLS	1.378	0.026	0.062	1.45	1.24	0.21	1.376	0.039	0.134	1.59	1.04	0.55
1-3 (by style)	WC	1.385	0.024	0.089	1.56	1.18	0.38	1.328	0.042	0.151	1.63	0.91	0.72
	UMC	1.41	0.024	0.121	1.79	1.25	0.54	1.178	0.042	0.194	1.5	0.78	0.73
2-3 (by PhonEn)	WC	1.36	0.025	0.116	1.62	0.91	0.71	1.354	0.042	0.173	1.87	0.9	0.97

	UMC	1.398	0.025	0.139	1.81	1.12	0.69	1.196	0.042	0.224	1.72	0.69	1.03
WC	IS	1.391	0.026	0.097	1.56	1.18	0.38	1.296	0.041	0.15	1.59	1.07	0.52
	RPS	1.403	0.029	0.086	1.56	1.26	0.3	1.334	0.048	0.169	1.63	0.91	0.72
	WLS	1.36	0.025	0.082	1.49	1.2	0.29	1.354	0.042	0.134	1.59	1.09	0.5
UMC	IS	1.391	0.026	0.109	1.58	1.25	0.33	1.168	0.041	0.181	1.41	0.78	0.63
	RPS	1.443	0.029	0.139	1.79	1.31	0.48	1.169	0.048	0.213	1.5	0.78	0.72
	WLS	1.398	0.025	0.116	1.7	1.28	0.42	1.196	0.042	0.2	1.49	0.82	0.67
1-4 (by style)	F-Y-WC	1.408	0.047	0.099	1.56	1.2	0.36	1.191	0.06	0.122	1.35	0.91	0.44
	F-Y-UMC	1.48	0.047	0.198	1.79	1.25	0.54	0.934	0.06	0.138	1.26	0.78	0.48
	F-O-WC	1.428	0.047	0.052	1.54	1.36	0.17	1.351	0.06	0.135	1.56	1.13	0.44
	F-O-UMC	1.406	0.047	0.085	1.57	1.26	0.31	1.26	0.06	0.165	1.49	0.99	0.5
	M-Y-WC	1.384	0.047	0.092	1.56	1.27	0.29	1.311	0.06	0.105	1.41	1.07	0.34
	M-Y-UMC	1.348	0.047	0.051	1.43	1.26	0.17	1.201	0.06	0.091	1.37	1.06	0.3
	M-O-WC	1.318	0.047	0.07	1.41	1.18	0.23	1.46	0.06	0.113	1.63	1.28	0.35
	M-O-UMC	1.408	0.047	0.068	1.53	1.3	0.23	1.315	0.06	0.118	1.5	1.11	0.39
F-Y-WC	IS	1.433	0.049	0.015	1.45	1.42	0.03	1.163	0.07	0.064	1.23	1.08	0.15
	RPS	1.458	0.053	0.118	1.56	1.29	0.27	1.153	0.065	0.164	1.27	0.91	0.36
	WLS	1.335	0.051	0.106	1.46	1.2	0.26	1.258	0.061	0.123	1.35	1.09	0.26
F-Y-UMC	IS	1.413	0.049	0.177	1.58	1.25	0.33	0.988	0.07	0.202	1.26	0.78	0.48
	RPS	1.55	0.053	0.236	1.79	1.31	0.48	0.878	0.065	0.079	0.96	0.78	0.18
	WLS	1.478	0.051	0.209	1.7	1.28	0.42	0.938	0.061	0.124	1.11	0.82	0.29
F-O-WC	IS	1.423	0.049	0.079	1.54	1.37	0.17	1.278	0.07	0.118	1.41	1.13	0.28
	RPS	1.453	0.053	0.043	1.5	1.4	0.1	1.378	0.065	0.159	1.56	1.19	0.37
	WLS	1.408	0.051	0.032	1.43	1.36	0.07	1.398	0.061	0.12	1.54	1.26	0.28
F-O-UMC	IS	1.358	0.049	0.074	1.42	1.26	0.16	1.235	0.07	0.181	1.41	0.99	0.42
	RPS	1.458	0.053	0.095	1.57	1.36	0.21	1.25	0.065	0.164	1.39	1.03	0.36
	WLS	1.403	0.051	0.076	1.45	1.29	0.16	1.295	0.061	0.194	1.49	1.04	0.45
M-Y-WC	IS	1.415	0.049	0.122	1.56	1.3	0.26	1.28	0.07	0.141	1.37	1.07	0.3
	RPS	1.375	0.053	0.056	1.45	1.32	0.13	1.35	0.065	0.05	1.41	1.29	0.12
	WLS	1.363	0.051	0.106	1.49	1.27	0.22	1.303	0.061	0.119	1.41	1.14	0.27
M-Y-UMC	IS	1.33	0.049	0.063	1.41	1.26	0.15	1.2	0.07	0.129	1.37	1.06	0.31
	RPS	1.37	0.053	0.054	1.43	1.32	0.11	1.2	0.065	0.084	1.29	1.09	0.2
	WLS	1.345	0.051	0.045	1.38	1.28	0.1	1.203	0.061	0.081	1.28	1.11	0.17
M-O-WC	IS	1.295	0.049	0.097	1.39	1.18	0.21	1.463	0.07	0.112	1.59	1.32	0.27
	RPS	1.325	0.053	0.047	1.37	1.26	0.11	1.458	0.065	0.147	1.63	1.28	0.35
	WLS	1.335	0.051	0.07	1.41	1.24	0.17	1.46	0.061	0.109	1.59	1.36	0.23
M-O-UMC	IS	1.463	0.049	0.07	1.53	1.38	0.015	1.248	0.07	0.119	1.37	1.11	0.26
	RPS	1.395	0.053	0.053	1.44	1.32	0.12	1.348	0.065	0.144	1.5	1.17	0.33
	WLS	1.365	0.051	0.052	1.42	1.3	0.12	1.35	0.061	0.074	1.45	1.28	0.17
Female	_LS	1.479	0.026	0.125	1.81	1.31	0.5	1.185	0.044	0.205	1.44	0.77	0.67
	_VS	1.391	0.026	0.134	1.77	1.17	0.6	1.241	0.047	0.238	1.56	0.69	0.87
	_N	1.4	0.032	0.142	1.69	1.13	0.56	1.304	0.052	0.21	1.61	0.91	0.7
	_LF	1.431	0.038	0.186	1.81	0.91	0.9	1.148	0.052	0.243	1.6	0.79	0.81
	_VF	1.332	0.027	0.129	1.68	1.14	0.54	1.232	0.053	0.279	1.65	0.73	0.92
Male	_LS	1.408	0.026	0.077	1.58	1.27	0.31	1.271	0.044	0.137	1.5	1.02	0.48
	_VS	1.352	0.026	0.063	1.52	1.26	0.26	1.348	0.047	0.118	1.67	1.18	0.49
	_N	1.323	0.032	0.11	1.54	1.12	0.42	1.482	0.052	0.21	1.87	1.22	0.65
	_LF	1.386	0.038	0.11	1.62	1.2	0.42	1.203	0.052	0.169	1.48	0.87	0.61

	_VF	1.289	0.027	0.087	1.4	1.13	0.27	1.336	0.053	0.113	1.48	1.12	0.36
Young	_LS	1.441	0.027	0.135	1.81	1.27	0.54	1.129	0.037	0.161	1.38	0.77	0.61
	_VS	1.368	0.027	0.141	1.77	1.17	0.6	1.193	0.041	0.193	1.43	0.69	0.74
	_N	1.393	0.032	0.153	1.69	1.12	0.57	1.265	0.047	0.177	1.54	0.91	0.63
	_LF	1.398	0.039	0.188	1.81	0.91	0.9	1.083	0.047	0.212	1.47	0.79	0.68
	_VF	1.301	0.028	0.138	1.68	1.13	0.55	1.202	0.051	0.227	1.47	0.73	0.74
Old	_LS	1.446	0.027	0.077	1.59	1.33	0.26	1.327	0.037	0.135	1.5	0.96	0.54
	_VS	1.376	0.027	0.055	1.47	1.28	0.19	1.396	0.041	0.132	1.67	1.09	0.58
	_N	1.331	0.032	0.1	1.5	1.17	0.33	1.521	0.047	0.197	1.87	1.11	0.76
	_LF	1.418	0.039	0.11	1.62	1.2	0.42	1.268	0.047	0.163	1.6	0.94	0.66
	_VF	1.32	0.028	0.076	1.4	1.18	0.22	1.366	0.051	0.175	1.65	1	0.65
WC	_LS	1.428	0.027	0.094	1.58	1.27	0.31	1.291	0.042	0.15	1.5	1.01	0.49
	_VS	1.352	0.026	0.082	1.52	1.17	0.35	1.354	0.046	0.119	1.67	1.19	0.48
	_N	1.368	0.033	0.104	1.54	1.17	0.37	1.481	0.053	0.204	1.87	1.14	0.73
	_LF	1.358	0.036	0.159	1.62	0.91	0.71	1.266	0.047	0.18	1.6	0.9	0.7
	_VF	1.293	0.028	0.094	1.4	1.13	0.27	1.378	0.049	0.13	1.65	1.12	0.53
UMC	_LS	1.459	0.027	0.122	1.81	1.31	0.5	1.165	0.042	0.184	1.39	0.77	0.62
	_VS	1.391	0.026	0.124	1.77	1.27	0.5	1.234	0.046	0.234	1.56	0.69	0.87
	_N	1.355	0.033	0.157	1.69	1.12	0.57	1.306	0.053	0.217	1.72	0.91	0.81
	_LF	1.459	0.036	0.13	1.81	1.29	0.52	1.085	0.047	0.199	1.39	0.79	0.6
	_VF	1.328	0.028	0.125	1.68	1.18	0.5	1.19	0.049	0.246	1.65	0.73	0.92

		STRUT											
		SF1						SF21					
Group / Test No.	Subgroup	Mean	Std. Error	SD	Ma	Mi	Ma-Mi	Mean	Std. Error	SD	Ma	Mi	Ma-Mi
Style	IS	1.307		0.099	1.46	1.08	0.38	0.871		0.097	1.08	0.68	0.4
	RPS	1.331		0.107	1.53	1.05	0.48	0.9		0.115	1.11	0.66	0.45
	WLS	1.338		0.098	1.55	1.06	0.49	0.892		0.138	1.17	0.48	0.69
PhonEn	_LS	1.398		0.138	1.74	1.09	0.65	0.867		0.138	1.1	0.61	0.49
	_VS	1.32		0.107	1.53	1.02	0.51	0.927		0.154	1.21	0.4	0.81
	_N	1.375		0.124	1.61	1.15	0.46	0.896		0.155	1.18	0.47	0.71
	_LF	1.348		0.13	1.65	1.06	0.59	0.817		0.17	1.18	0.39	0.79
	_VF	1.249		0.113	1.41	0.95	0.46	0.952		0.182	1.33	0.48	0.85
1-1 (by style)	Female	1.327	0.024	0.107	1.53	1.05	0.48	0.854	0.025	0.129	1.17	0.48	0.69
	Male	1.324	0.024	0.096	1.55	1.12	0.43	0.922	0.025	0.096	1.11	0.71	0.4
2-1 (by PhonEn)	Female	1.335	0.025	0.147	1.74	0.95	0.79	0.857	0.034	0.194	1.33	0.39	0.94
	Male	1.341	0.025	0.115	1.65	1.1	0.55	0.926	0.034	0.122	1.26	0.64	0.62
Female	IS	1.299	0.025	0.101	1.42	1.08	0.34	0.839	0.023	0.082	0.95	0.68	0.27
	RPS	1.346	0.027	0.115	1.53	1.05	0.48	0.864	0.028	0.125	1.08	0.66	0.42
	WLS	1.336	0.025	0.107	1.48	1.06	0.42	0.858	0.034	0.17	1.17	0.48	0.69
Male	IS	1.314	0.025	0.1	1.46	1.12	0.34	0.903	0.023	0.103	1.08	0.75	0.33
	RPS	1.316	0.027	0.099	1.48	1.14	0.34	0.937	0.028	0.095	1.11	0.71	0.4
	WLS	1.341	0.025	0.091	1.55	1.19	0.36	0.926	0.034	0.09	1.04	0.73	0.31
1-2 (by style)	Young	1.286	0.021	0.105	1.47	1.05	0.42	0.87	0.027	0.131	1.11	0.48	0.64
	Old	1.365	0.021	0.079	1.55	1.18	0.38	0.906	0.027	0.102	1.17	0.71	0.46
2-2 (by PhonEn)	Young	1.301	0.023	0.139	1.74	0.95	0.79	0.861	0.034	0.185	1.3	0.39	0.9
	Old	1.375	0.023	0.114	1.65	1.1	0.55	0.922	0.034	0.137	1.33	0.64	0.69

Young	IS	1.258	0.022	0.104	1.46	1.08	0.38	0.868	0.025	0.107	1.08	0.68	0.4
	RPS	1.298	0.026	0.118	1.47	1.05	0.42	0.881	0.029	0.125	1.11	0.66	0.45
	WLS	1.301	0.023	0.097	1.44	1.06	0.38	0.861	0.034	0.159	1.07	0.48	0.59
Old	IS	1.356	0.022	0.067	1.45	1.21	0.24	0.875	0.025	0.089	1.08	0.75	0.33
	RPS	1.364	0.026	0.085	1.53	1.18	0.35	0.919	0.029	0.106	1.08	0.71	0.37
	WLS	1.375	0.023	0.086	1.55	1.23	0.32	0.923	0.034	0.109	1.17	0.73	0.44
1-3 (by style)	WC	1.364	0.021	0.074	1.55	1.23	0.32	0.881	0.027	0.113	1.08	0.65	0.43
	UMC	1.286	0.021	0.11	1.45	1.05	0.4	0.895	0.027	0.124	1.17	0.48	0.69
2-3 (by PhonEn)	WC	1.366	0.024	0.128	1.74	0.95	0.79	0.895	0.035	0.146	1.3	0.44	0.85
	UMC	1.31	0.024	0.13	1.59	0.97	0.62	0.889	0.035	0.183	1.33	0.39	0.94
WC	IS	1.344	0.023	0.069	1.46	1.23	0.23	0.859	0.024	0.103	1.08	0.69	0.39
	RPS	1.382	0.024	0.073	1.53	1.28	0.25	0.888	0.029	0.111	1.06	0.66	0.4
	WLS	1.366	0.024	0.079	1.55	1.24	0.31	0.896	0.035	0.124	1.07	0.65	0.42
UMC	IS	1.269	0.023	0.112	1.45	1.08	0.37	0.883	0.024	0.092	1.08	0.68	0.4
	RPS	1.28	0.024	0.113	1.43	1.05	0.38	0.913	0.029	0.122	1.11	0.66	0.45
	WLS	1.31	0.024	0.109	1.45	1.06	0.39	0.888	0.035	0.155	1.17	0.48	0.69
1-4 (by style)	F-Y-WC	1.34	0.04	0.058	1.47	1.27	0.2	0.877	0.048	0.144	1.07	0.65	0.43
	F-Y-UMC	1.23	0.04	0.139	1.44	1.05	0.38	0.748	0.048	0.11	0.9	0.48	0.43
	F-O-WC	1.389	0.04	0.061	1.53	1.31	0.22	0.853	0.048	0.084	0.97	0.71	0.26
	F-O-UMC	1.348	0.04	0.082	1.45	1.21	0.24	0.938	0.048	0.103	1.17	0.82	0.35
	M-Y-WC	1.348	0.04	0.075	1.46	1.26	0.21	0.88	0.048	0.082	1.04	0.75	0.29
	M-Y-UMC	1.225	0.04	0.065	1.33	1.12	0.2	0.976	0.048	0.068	1.11	0.9	0.21
	M-O-WC	1.38	0.04	0.094	1.55	1.23	0.32	0.914	0.048	0.133	1.08	0.71	0.37
	M-O-UMC	1.342	0.04	0.076	1.45	1.18	0.28	0.918	0.048	0.07	1	0.83	0.17
F-Y-WC	IS	1.318	0.038	0.053	1.39	1.27	0.12	0.845	0.044	0.109	0.93	0.69	0.24
	RPS	1.383	0.048	0.078	1.47	1.28	0.19	0.865	0.053	0.155	1.03	0.66	0.37
	WLS	1.32	0.048	0.014	1.33	1.3	0.03	0.92	0.061	0.185	1.07	0.65	0.42
F-Y-UMC	IS	1.18	0.038	0.105	1.28	1.08	0.2	0.8	0.044	0.09	0.9	0.68	0.22
	RPS	1.248	0.048	0.165	1.42	1.05	0.37	0.76	0.053	0.073	0.82	0.66	0.16
	WLS	1.263	0.048	0.174	1.44	1.06	0.38	0.683	0.061	0.142	0.81	0.48	0.33
F-O-WC	IS	1.368	0.038	0.045	1.42	1.31	0.11	0.82	0.044	0.057	0.88	0.75	0.13
	RPS	1.405	0.048	0.084	1.53	1.35	0.18	0.88	0.053	0.114	0.95	0.71	0.24
	WLS	1.395	0.048	0.062	1.48	1.33	0.15	0.858	0.061	0.083	0.97	0.77	0.2
F-O-UMC	IS	1.33	0.038	0.091	1.41	1.21	0.2	0.893	0.044	0.063	0.95	0.82	0.13
	RPS	1.35	0.048	0.079	1.43	1.26	0.17	0.95	0.053	0.105	1.08	0.86	0.22
	WLS	1.365	0.048	0.097	1.45	1.23	0.22	0.97	0.061	0.141	1.17	0.84	0.33
M-Y-WC	IS	1.34	0.038	0.098	1.46	1.26	0.2	0.84	0.044	0.074	0.93	0.75	0.18
	RPS	1.348	0.048	0.067	1.44	1.29	0.15	0.903	0.053	0.049	0.95	0.86	0.09
	WLS	1.355	0.048	0.075	1.44	1.27	0.17	0.898	0.061	0.115	1.04	0.76	0.28
M-Y-UMC	IS	1.193	0.038	0.053	1.24	1.12	0.12	0.985	0.044	0.076	1.08	0.91	0.17
	RPS	1.215	0.048	0.081	1.33	1.14	0.19	0.998	0.053	0.086	1.11	0.9	0.21
	WLS	1.268	0.048	0.055	1.32	1.19	0.13	0.945	0.061	0.034	0.99	0.91	0.08
M-O-WC	IS	1.353	0.038	0.087	1.42	1.23	0.19	0.933	0.044	0.151	1.08	0.75	0.33
	RPS	1.393	0.048	0.08	1.48	1.29	0.19	0.903	0.053	0.145	1.06	0.71	0.35
	WLS	1.395	0.048	0.127	1.55	1.24	0.31	0.908	0.061	0.141	1.03	0.73	0.3
M-O-UMC	IS	1.373	0.038	0.054	1.45	1.33	0.12	0.855	0.044	0.021	0.88	0.83	0.05
	RPS	1.308	0.048	0.094	1.4	1.18	0.22	0.945	0.053	0.08	1	0.83	0.17
	WLS	1.345	0.048	0.073	1.41	1.24	0.17	0.955	0.061	0.053	1	0.88	0.12

Female	_LS	1.4	0.035	0.158	1.74	1.09	0.65	0.85	0.035	0.16	1.1	0.61	0.49
	_VS	1.307	0.027	0.12	1.53	1.02	0.51	0.899	0.038	0.192	1.21	0.4	0.81
	_N	1.385	0.031	0.141	1.61	1.15	0.46	0.841	0.037	0.168	1.11	0.47	0.64
	_LF	1.333	0.033	0.149	1.56	1.06	0.5	0.797	0.043	0.224	1.18	0.39	0.79
	_VF	1.253	0.029	0.132	1.39	0.95	0.44	0.899	0.044	0.219	1.33	0.48	0.85
Male	_LS	1.397	0.035	0.119	1.62	1.25	0.37	0.884	0.035	0.114	1.05	0.68	0.37
	_VS	1.333	0.027	0.094	1.52	1.13	0.39	0.954	0.038	0.103	1.11	0.75	0.36
	_N	1.364	0.031	0.107	1.57	1.2	0.37	0.951	0.037	0.124	1.18	0.74	0.44
	_LF	1.363	0.033	0.111	1.65	1.19	0.46	0.838	0.043	0.085	1.01	0.64	0.37
	_VF	1.246	0.029	0.095	1.41	1.1	0.31	1.005	0.044	0.121	1.26	0.79	0.47
Young	_LS	1.347	0.032	0.148	1.74	1.09	0.65	0.835	0.034	0.13	1.04	0.61	0.43
	_VS	1.269	0.024	0.103	1.39	1.02	0.37	0.908	0.039	0.19	1.21	0.4	0.81
	_N	1.361	0.031	0.131	1.61	1.15	0.46	0.861	0.038	0.175	1.11	0.47	0.64
	_LF	1.318	0.032	0.142	1.56	1.06	0.5	0.789	0.042	0.208	1.13	0.39	0.74
	_VF	1.211	0.027	0.123	1.35	0.95	0.4	0.913	0.045	0.204	1.3	0.48	0.82
Old	_LS	1.45	0.032	0.108	1.62	1.25	0.37	0.899	0.034	0.142	1.1	0.68	0.42
	_VS	1.37	0.024	0.027	1.53	1.24	0.29	0.945	0.039	0.11	1.11	0.71	0.4
	_N	1.388	0.031	0.119	1.61	1.19	0.42	0.93	0.038	0.129	1.18	0.74	0.44
	_LF	1.377	0.032	0.114	1.65	1.19	0.46	0.845	0.042	0.12	1.18	0.64	0.54
	_VF	1.288	0.027	0.091	1.41	1.1	0.31	0.991	0.045	0.154	1.33	0.78	0.55
WC	_LS	1.428	0.034	0.14	1.74	1.25	0.49	0.87	0.035	0.146	1.07	0.61	0.46
	_VS	1.34	0.027	0.087	1.52	1.14	0.38	0.929	0.039	0.135	1.21	0.71	0.5
	_N	1.435	0.027	0.098	1.61	1.25	0.36	0.901	0.039	0.129	1.09	0.67	0.42
	_LF	1.344	0.033	0.133	1.65	1.06	0.59	0.836	0.043	0.164	1.13	0.44	0.69
	_VF	1.284	0.027	0.12	1.41	0.95	0.46	0.938	0.046	0.148	1.3	0.74	0.56
UMC	_LS	1.369	0.034	0.133	1.59	1.09	0.5	0.864	0.035	0.134	1.1	0.64	0.46
	_VS	1.299	0.027	0.122	1.53	1.02	0.51	0.924	0.039	0.175	1.11	0.4	0.71
	_N	1.314	0.027	0.119	1.52	1.15	0.37	0.891	0.039	0.182	1.18	0.47	0.71
	_LF	1.351	0.033	0.131	1.56	1.1	0.46	0.799	0.043	0.178	1.18	0.39	0.79
	_VF	1.214	0.027	0.097	1.33	0.97	0.36	0.966	0.046	0.216	1.33	0.48	0.85

Appendix 11 Raw mean data for TEST Set-3 (§7.1)

Column1: vowel type. Column2: Social groups. Columns3&8: Number of raw mean values of individual speakers in different speech styles for F1&F2-F1. Columns4&9: S-transformed F1&F2-F1 values. Columns5&10: Standard Deviations for S-transformed formant values of F1&F2-F1. Columns6&11: Test number. Columns7&12: The results of the ANOVA for age comparisons. All the results for the ANOVA are shown with the F-ratio and degree of freedom (df). (ns: non-significant, * p<0.05, ** p<0.01, *** p<0.001).

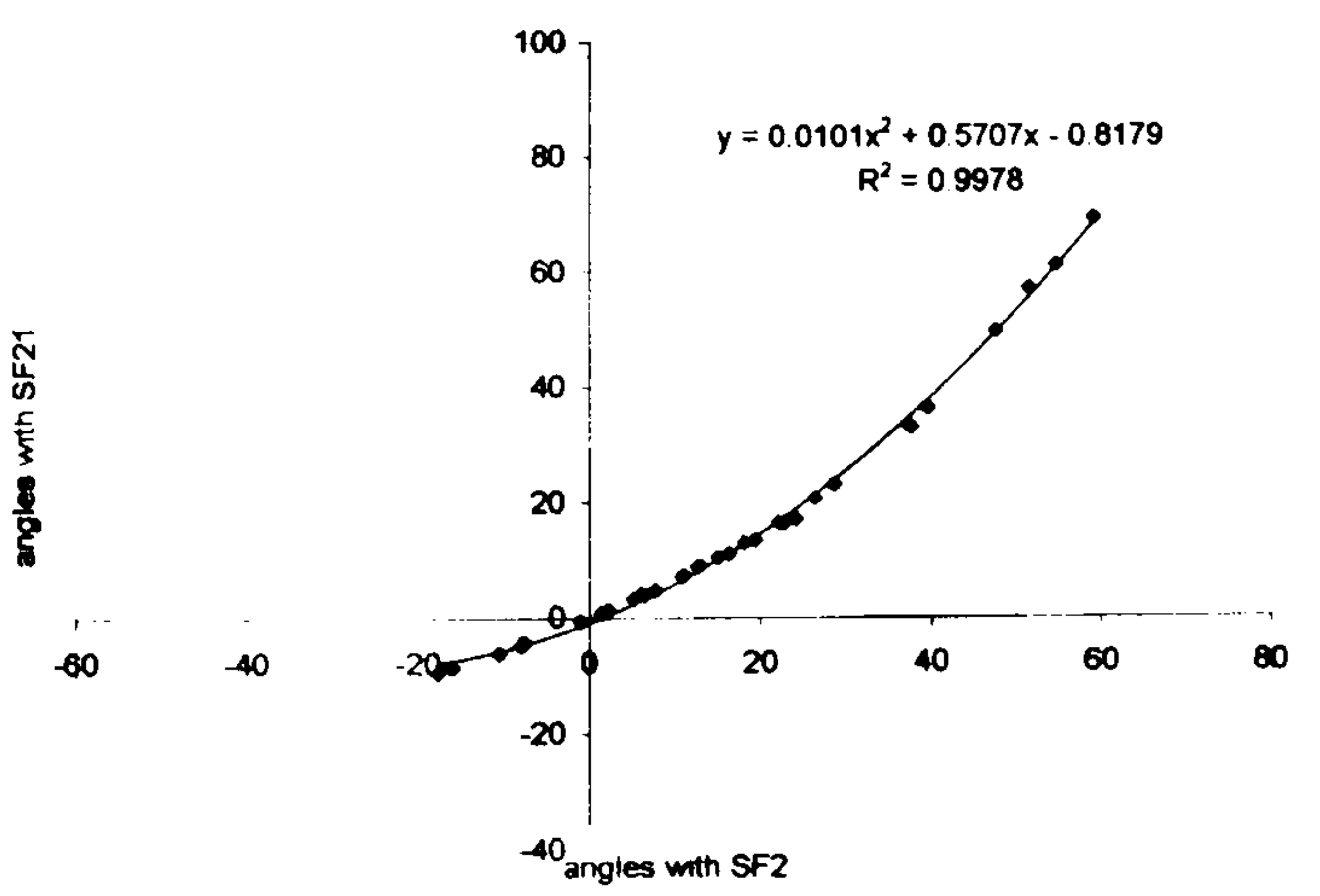
		F1					F2-F1				
1	2	3	4	5	6	7	8	9	10	11	12
Vowel	Grp	N	mean (S-value)	SD (S-value)	Test	ANOVA (Age Comparison)	N	mean (S-value)	SD (S-value)	Test	ANOVA (Age Comparison)
DRESS	Y-WC	24	1.128	0.057	T31	ns (p=0.418)	24	1.758	0.102	T31	*
	O-WC	24	1.116	0.049		F(1, 46)=0.669	24	1.809	0.138		F(1, 46)=2.074
	Y-F-WC	12	1.141	0.069	T32	ns (p=0.945)	12	1.736	0.115	T32	*
	O-F-WC	12	1.143	0.045		F(1, 22)=0.005	12	1.863	0.155		F(1, 22)=5.247
	Y-M-WC	12	1.116	0.041	T33	ns (p=0.110)	12	1.781	0.086	T33	ns (p=0.483)
	O-M-WC	12	1.089	0.037		F(1, 22)=2.778	12	1.754	0.097		F(1, 22)=0.510
	Y-UMC	24	1.148	0.086	T34	ns (p=0.346)	24	1.616	0.151	T34	**
	O-UMC	24	1.129	0.049		F(1, 46)=0.907	24	1.804	0.222		F(1, 46)=11.718
	Y-F-UMC	12	1.191	0.097	T35	ns (p=0.052)	12	1.573	0.180	T35	*
	O-F-UMC	12	1.128	0.041		F(1, 22)=4.224	12	1.822	0.283		F(1, 22)=6.609
	Y-M-UMC	12	1.105	0.044	T36	ns (p=0.259)	12	1.660	0.106	T36	*
	O-M-UMC	12	1.129	0.057		F(1, 22)=1.343	12	1.786	0.147		F(1, 22)=5.766
TRAP	Y-WC	24	1.396	0.095	T31	ns (p=0.368)	24	1.251	0.127	T31	***
	O-WC	24	1.373	0.082		F(1, 46)=0.0827	24	1.405	0.132		F(1, 46)=17.021
	Y-F-WC	12	1.408	0.100	T32	ns (p=0.564)	12	1.191	0.123	T32	** (p=0.006)
	O-F-WC	12	1.428	0.054		F(1, 22)=0.343	12	1.351	0.133		F(1, 22)=9.403
	Y-M-WC	12	1.384	0.092	T33	ns (p=0.061)	12	1.311	0.104	T33	** (p=0.003)
	O-M-WC	12	1.318	0.070		F(1, 22)=3.890	12	1.460	0.112		F(1, 22)=11.398
	Y-UMC	24	1.414	0.156	T34	ns (p=0.834)	24	1.068	0.178	T34	***
	O-UMC	24	1.407	0.076		F(1, 46)=0.045	24	1.288	0.143		F(1, 46)=22.344
	Y-F-UMC	12	1.480	0.197	T35	ns (p=0.246)	12	0.934	0.138	T35	***
	O-F-UMC	12	1.406	0.086		F(1, 22)=1.423	12	1.260	0.165		F(1, 22)=27.420
	Y-M-UMC	12	1.348	0.052	T36	*	12	1.201	0.091	T36	*
	O-M-UMC	12	1.408	0.068		F(1, 22)=5.720	12	1.315	0.116		F(1, 22)=7.175
STRUT	Y-WC	24	1.344	0.065	T31	ns (p=0.054)	24	0.878	0.113	T31	ns (p=0.879)
	O-WC	24	1.385	0.077		F(1, 46)=3.911	24	0.883	0.113		F(1, 46)=0.023
	Y-F-WC	12	1.340	0.059	T32	ns (p=0.058)	12	0.877	0.142	T32	ns (p=0.617)
	O-F-WC	12	1.389	0.062		F(1, 22)=3.984	12	0.853	0.083		F(1, 22)=0.258
	Y-M-WC	12	1.348	0.074	T33	ns (p=0.352)	12	0.880	0.081	T33	ns (p=0.454)
	O-M-WC	12	1.380	0.093		F(1, 22)=0.903	12	0.914	0.132		F(1, 22)=0.580
	Y-UMC	24	1.228	0.108	T34	***	24	0.862	0.146	T34	ns (p=0.063)
	O-UMC	24	1.345	0.077		F(1, 46)=18.824	24	0.928	0.087		F(1, 46)=3.641
	Y-F-UMC	12	1.230	0.142	T35	*	12	0.748	0.109	T35	***
	O-F-UMC	12	1.348	0.082		F(1, 22)=6.258	12	0.938	0.103		F(1, 22)=19.211
	Y-M-UMC	12	1.225	0.067	T36	***	12	0.976	0.067	T36	ns (p=0.051)
	O-M-UMC	12	1.342	0.074		F(1, 22)=16.473	12	0.918	0.070		F(1, 22)=4.268

Appendix 12 Angles obtained with *S*-normalised F2 values and their correlations with those obtained with *S*-normalised F2-F1 values (§8.1)

Tables below present angles and Euclidean distance calculated with *S*-normalised F2 values instead of *S* -normalised F2-F1 values as in Table 93 and Table 94. The subsequent nine graphs present the regressions for the two different angles, those with SF2 (on x axis) and those with SF21 (on y axis), with the correlation coefficients squared (R^2) and the equations of the trend lines, in nine different conditions (i.e. entire data, three speech styles and five phonetic environments).

ID	Age	Birth Year	Sex-Age-Class	IS		RPS		WLS		ALL	
				Ang.	Dist.	Ang.	Dist.	Ang.	Dist.	Ang.	Dist.
F01	18	1985	F-Y-WC	13	0.241	21	0.307	2	0.237	13	0.259
F02	22	1981	F-Y-WC	24	0.250	2	0.157	5	0.167	13	0.188
F03	25	1979	F-Y-WC	38	0.264	-1	0.185	-35	0.178	6	0.181
F04	30	1974	F-Y-WC	27	0.330	38	0.284	22	0.353	29	0.320
F05	20	1983	F-Y-UMC	61	0.361	61	0.426	44	0.475	55	0.416
F06	21	1982	F-Y-UMC	60	0.312	62	0.417	52	0.224	59	0.317
F07	21	1983	F-Y-UMC	26	0.362	48	0.345	39	0.411	38	0.369
F08	25	1978	F-Y-UMC	53	0.210	63	0.238	34	0.179	51	0.205
F09	54	1952	F-O-WC	1	0.267	-24	0.220	-11	0.298	-11	0.258
F10	65	1939	F-O-WC	23	0.213	17	0.332	19	0.299	19	0.281
F11	68	1936	F-O-WC	0	0.352	8	0.372	-4	0.409	1	0.376
F12	73	1931	F-O-WC	20	0.336	20	0.361	7	0.296	16	0.329
F13	50	1954	F-O-UMC	15	0.181	33	0.261	17	0.217	23	0.217
F14	51	1952	F-O-UMC	16	0.121	24	0.127	14	0.141	18	0.129
F15	61	1942	F-O-UMC	4	0.294	30	0.338	10	0.313	15	0.309
F16	70	1934	F-O-UMC	3	0.277	14	0.261	1	0.185	7	0.240
M01	22	1982	M-Y-WC	14	0.348	14	0.292	4	0.312	11	0.316
M02	24	1983	M-Y-WC	22	0.249	2	0.268	10	0.250	11	0.253
M03	25	1979	M-Y-WC	15	0.289	6	0.282	0	0.217	8	0.262
M04	29	1974	M-Y-WC	7	0.322	-2	0.272	-12	0.204	-1	0.264
M05	17	1987	M-Y-UMC	32	0.292	28	0.259	18	0.245	26	0.264
M06	20	1984	M-Y-UMC	32	0.262	52	0.237	33	0.161	40	0.217
M07	22	1982	M-Y-UMC	50	0.220	56	0.247	32	0.171	48	0.210
M08	23	1980	M-Y-UMC	36	0.149	28	0.229	13	0.222	24	0.197
M09	51	1951	M-O-WC	-5	0.327	-20	0.316	-22	0.393	-16	0.342
M10	54	1949	M-O-WC	-8	0.337	-10	0.339	-6	0.306	-8	0.327
M11	59	1944	M-O-WC	-14	0.226	-18	0.263	-23	0.191	-18	0.226
M12	61	1942	M-O-WC	-18	0.309	-6	0.320	0	0.366	-8	0.329
M13	59	1944	M-O-UMC	29	0.288	21	0.268	15	0.232	22	0.261
M14	59	1944	M-O-UMC	8	0.287	5	0.315	3	0.303	5	0.302
M15	65	1938	M-O-UMC	19	0.219	5	0.222	-17	0.234	2	0.217
M16	66	1938	M-O-UMC	17	0.362	33	0.406	14	0.242	23	0.333

ID	Age	Birth Year	Sex-Age-Class	_LS		_VS		_N		_LF		_VF	
				Ang.	Dist.	Ang.	Dist.	Ang.	Dist.	Ang.	Dist.	Ang.	Dist.
F01	18	1985	F-Y-WC	28	0.299	-8	0.167	-12	0.248	29	0.243	-24	0.326
F02	22	1981	F-Y-WC	19	0.128	18	0.220	19	0.176	-15	0.175	-16	0.172
F03	25	1979	F-Y-WC	-56	0.306	15	0.121	-62	0.376	-42	0.227	64	0.211
F04	30	1974	F-Y-WC	25	0.332	3	0.269	20	0.364	16	0.408	38	0.421
F05	20	1983	F-Y-UMC	62	0.515	51	0.525	35	0.510	41	0.489	27	0.389
F06	21	1982	F-Y-UMC	23	0.233	35	0.284	57	0.197	64	0.067	76	0.423
F07	21	1983	F-Y-UMC	42	0.422	70	0.299	19	0.487	37	0.507	40	0.412
F08	25	1978	F-Y-UMC	32	0.200	31	0.183	-16	0.192	66	0.290	39	0.140
F09	54	1952	F-O-WC	-21	0.368	5	0.289	-25	0.408	1	0.244	-4	0.214
F10	65	1939	F-O-WC	36	0.414	25	0.269	-4	0.209	23	0.237	9	0.406
F11	68	1936	F-O-WC	4	0.337	9	0.421	-5	0.432	-7	0.465	-16	0.416
F12	73	1931	F-O-WC	1	0.216	-8	0.279	1	0.333	32	0.410	2	0.287
F13	50	1954	F-O-UMC	25	0.190	14	0.274	-1	0.249	28	0.369	25	0.022
F14	51	1952	F-O-UMC	1	0.123	10	0.101	25	0.167	13	0.141	17	0.177
F15	61	1942	F-O-UMC	4	0.259	19	0.430	-1	0.433	11	0.247	19	0.213
F16	70	1934	F-O-UMC	12	0.149	-15	0.236	4	0.259	18	0.119	-2	0.179
M01	22	1982	M-Y-WC	-4	0.307	7	0.310	5	0.410	3	0.207	8	0.330
M02	24	1983	M-Y-WC	16	0.200	21	0.359	8	0.284	-3	0.093	1	0.327
M03	25	1979	M-Y-WC	22	0.243	-9	0.176	1	0.315	4	0.207	-27	0.184
M04	29	1974	M-Y-WC	-4	0.141	-4	0.233	-8	0.221	-37	0.221	-8	0.231
M05	17	1987	M-Y-UMC	29	0.303	18	0.225	14	0.271	6	0.279	24	0.159
M06	20	1984	M-Y-UMC	6	0.118	49	0.278	-67	0.088	26	0.241	57	0.229
M07	22	1982	M-Y-UMC	37	0.198	34	0.163	23	0.249	51	0.147	16	0.116
M08	23	1980	M-Y-UMC	24	0.284	4	0.219	-3	0.250	29	0.235	4	0.150
M09	51	1951	M-O-WC	-26	0.426	-20	0.433	-40	0.545	-6	0.335	-3	0.282
M10	54	1949	M-O-WC	-13	0.269	-6	0.221	-16	0.397	11	0.398	-9	0.272
M11	59	1944	M-O-WC	-31	0.151	-8	0.149	-39	0.323	-14	0.175	-8	0.183
M12	61	1942	M-O-WC	3	0.339	-2	0.317	-9	0.570	2	0.369	16	0.253
M13	59	1944	M-O-UMC	2	0.212	1	0.277	0	0.257	17	0.240	57	0.266
M14	59	1944	M-O-UMC	2	0.239	-1	0.179	-11	0.449	8	0.374	22	0.308
M15	65	1938	M-O-UMC	-26	0.249	-13	0.296	-18	0.309	-26	0.141	10	0.174
M16	66	1938	M-O-UMC	10	0.334	9	0.256	31	0.207	7	0.159	16	0.268



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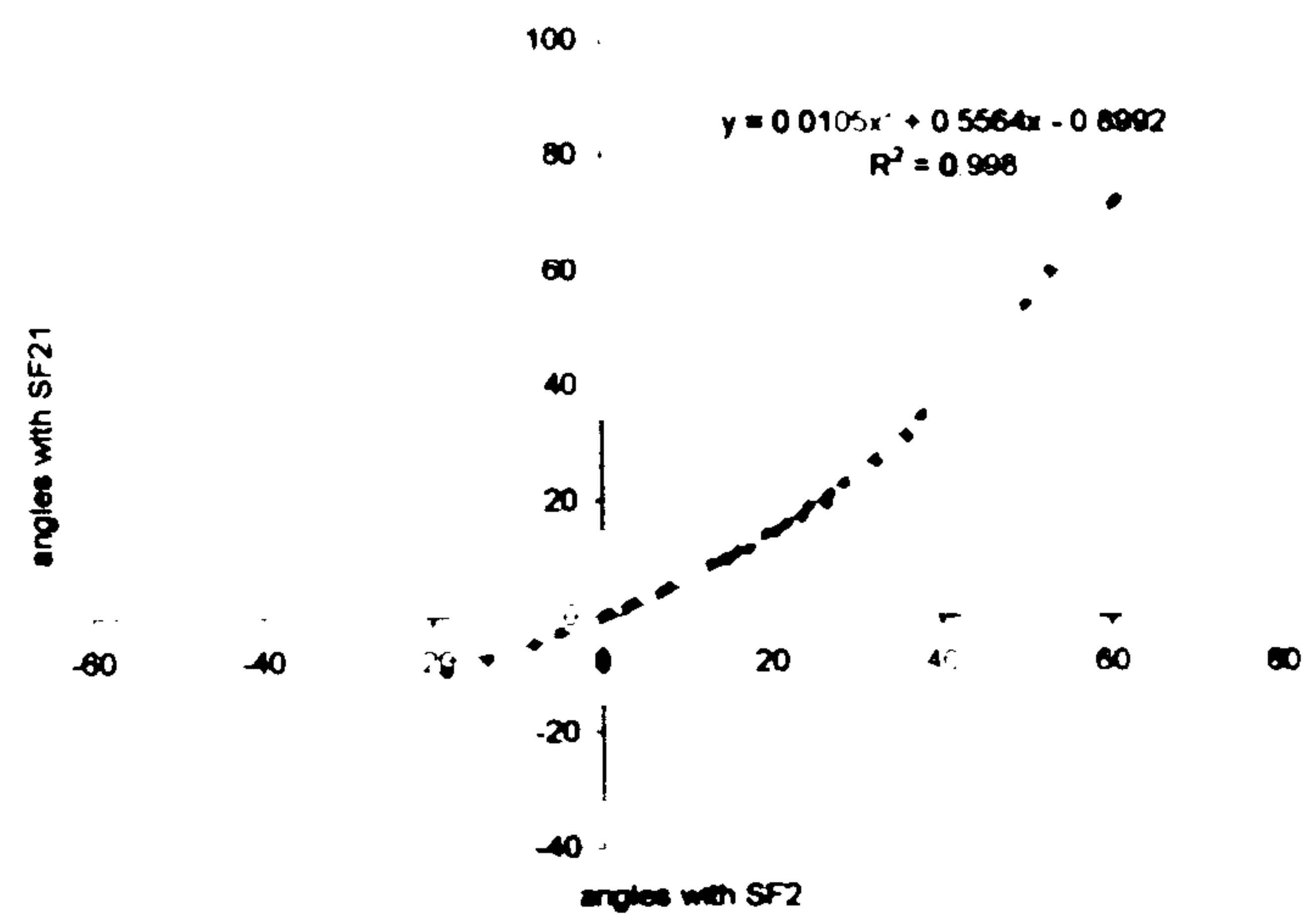

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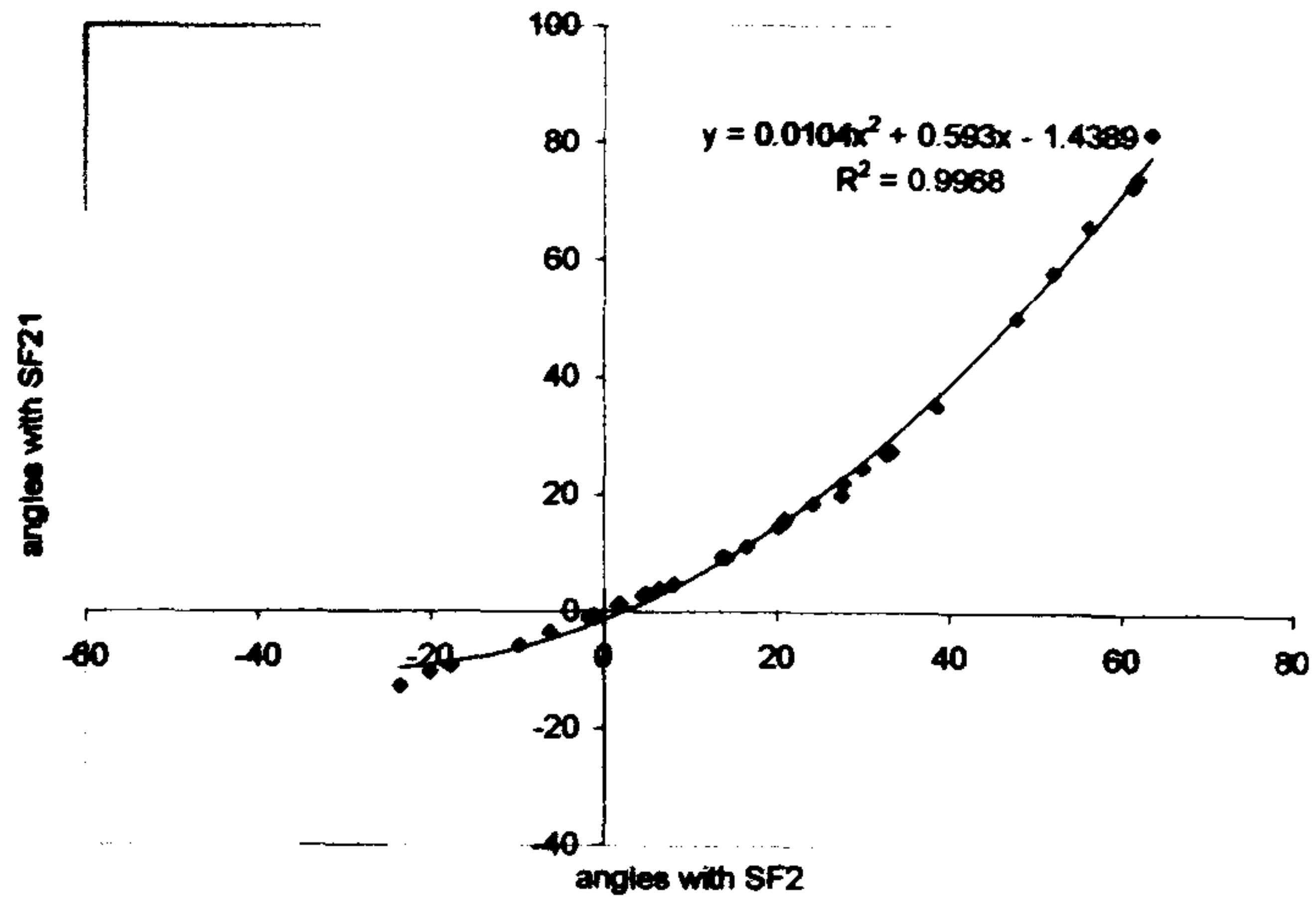

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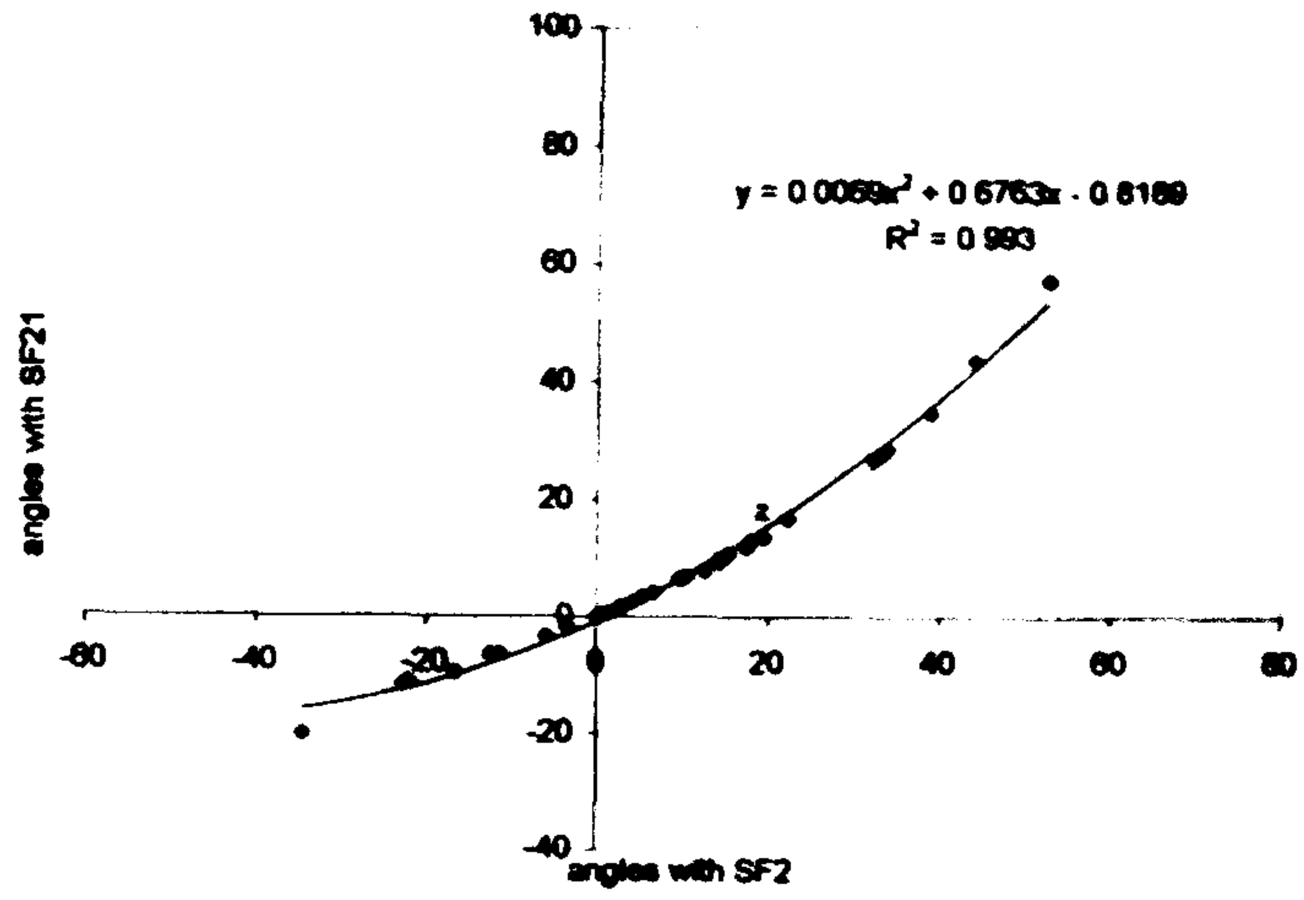

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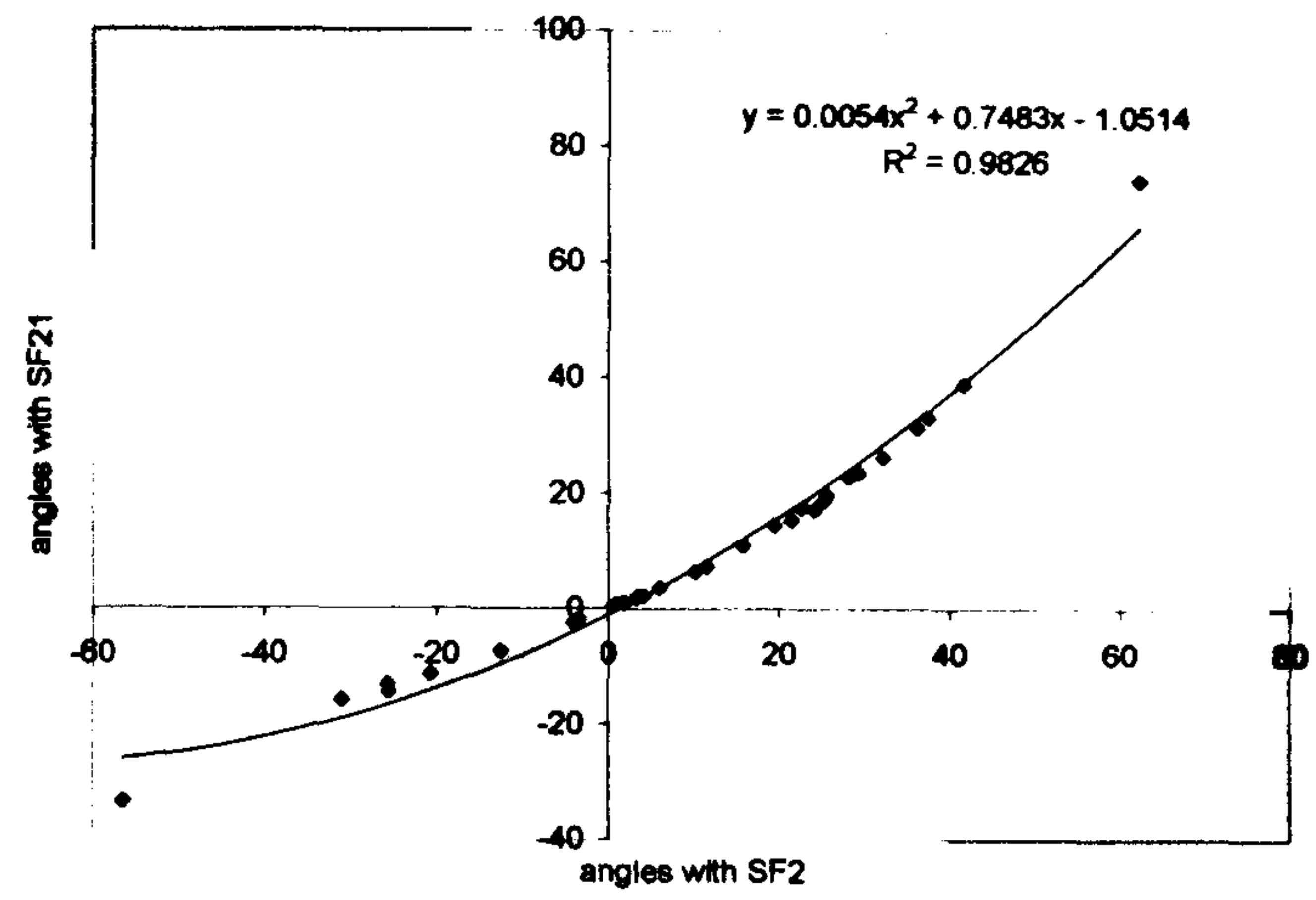

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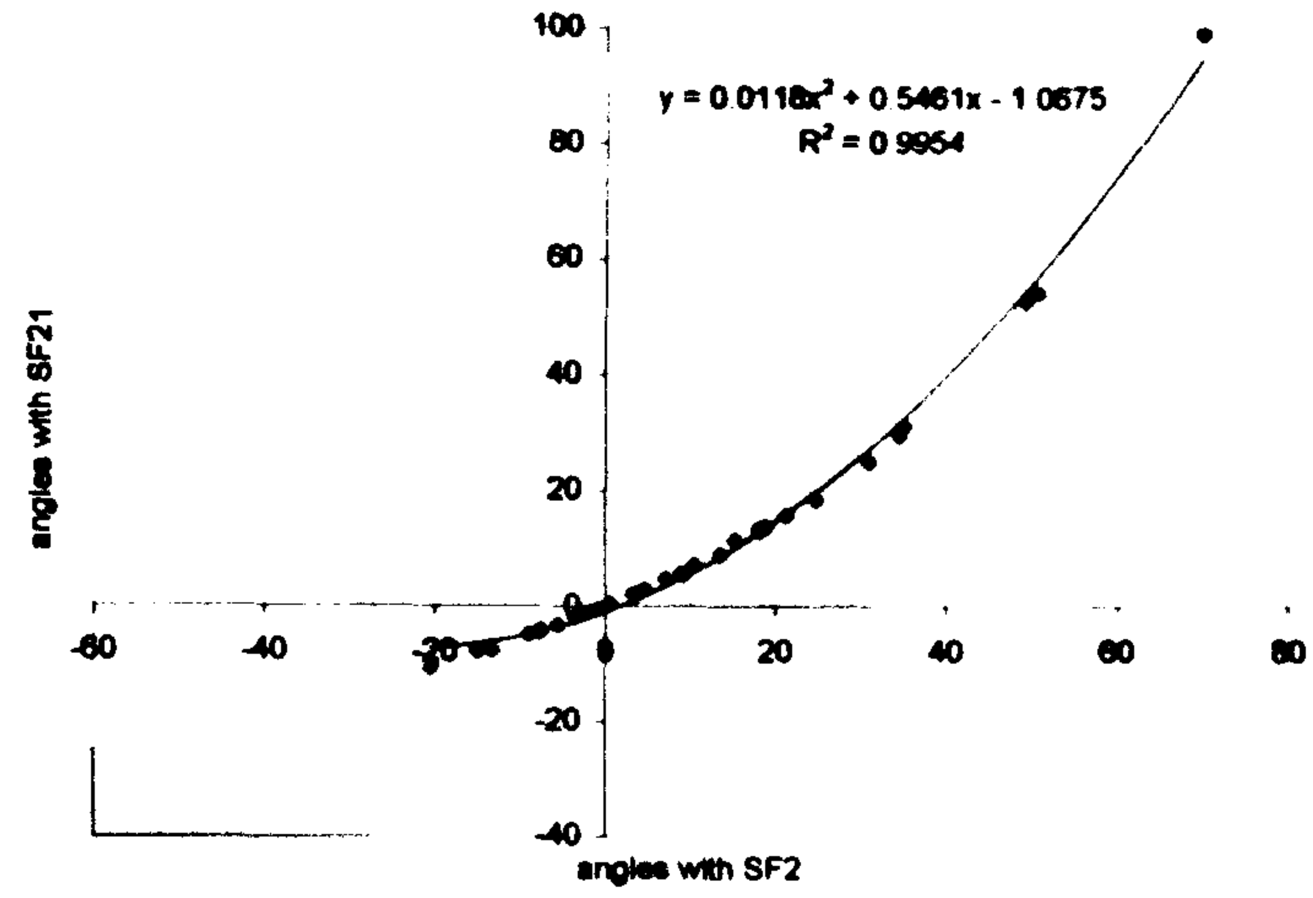

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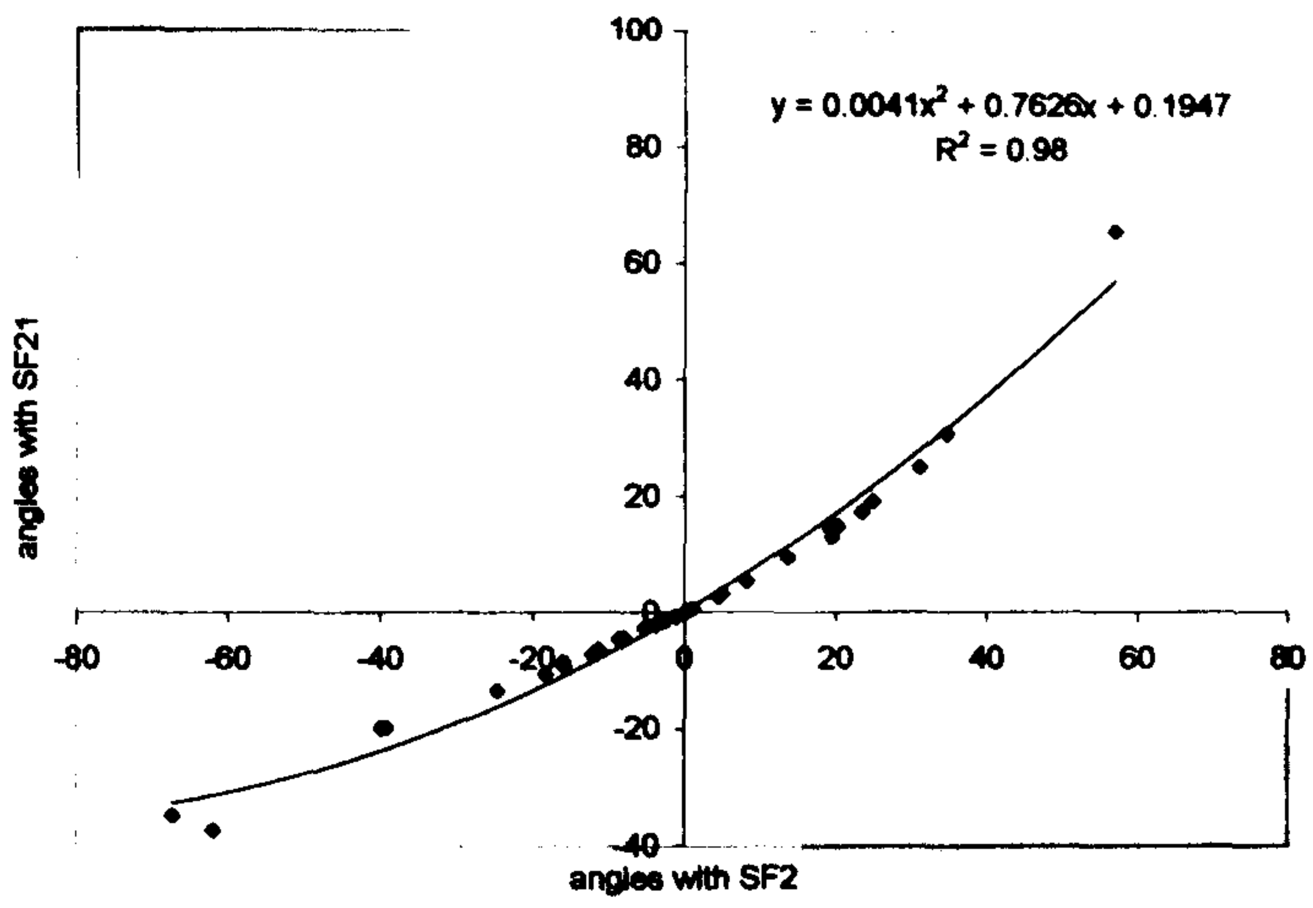

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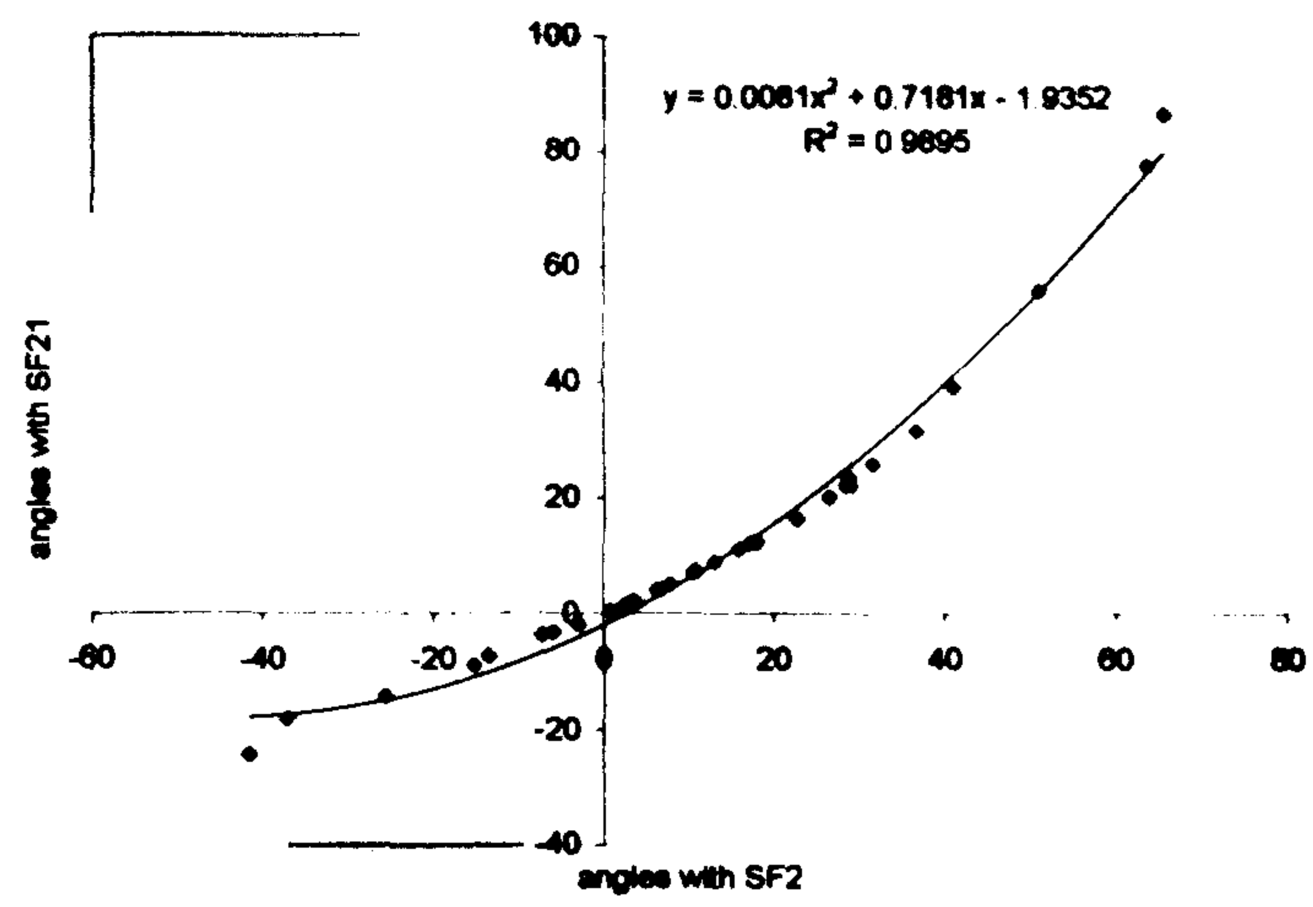

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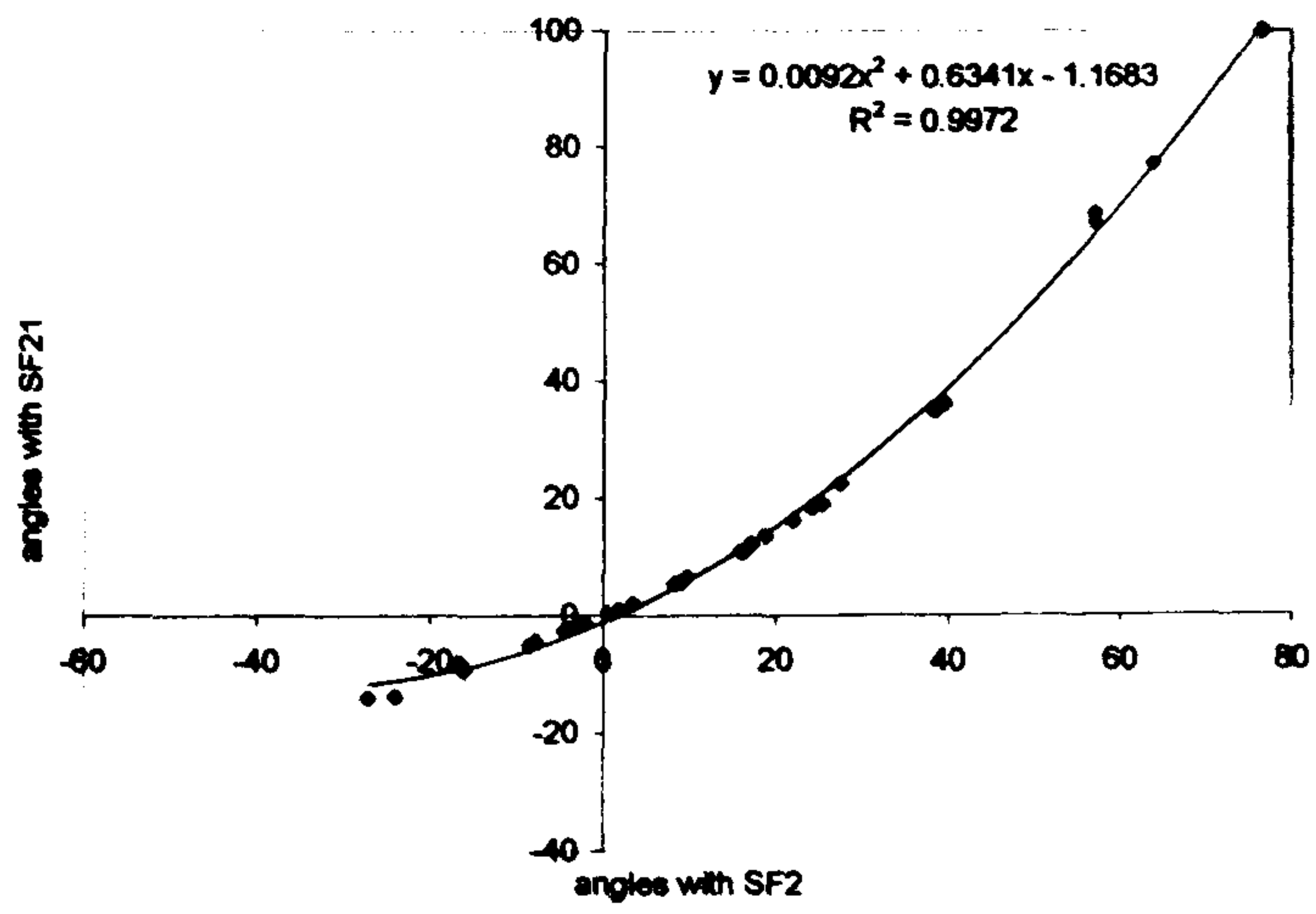

In _VF

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