Phonological and phonetic marking of information status in Foreign Accent Syndrome

Anja Kuschmann andAnja Lowit[*],

University of Strathclyde, Glasgow UK

Abstract

Background: Foreign Accent Syndrome (FAS) is a motor speech disorder in which a variety of segmental and suprasegmental errors lead to the perception of a new accent in speech. Whilst changes in intonation have been identified to contribute considerably to the perceived alteration in accent, research has rarely focused on how these changes impact on the pragmatic use of intonation. However, a greater understanding of the role of intonational changes in FAS and its impact on the functional use of intonation is fundamental to developing appropriate assessment and subsequently treatment strategies for FAS.

Aims: This study investigated intonation patterns in speakers with FAS and matched control participants with regard to their ability to signal new and given information (information status) within sentences. A phonetic and phonological perspective was taken with the aim to identify the characteristics that were compromised in FAS to convey this linguistic function.

Methods & Procedures: Four speakers with FAS and four control participants participated in the speech production experiment. The speech data were assessed perceptually, and examined in relation to the use of the phonetic parameters fundamental frequency (f0), intensity and duration as well as phonological categories, i.e. pitch accents and de-accentuation, using the autosegmental-metrical (AM) framework of intonational analysis.

[*] Anja Lowit, Speech and Language Therapy, School of Psychological Sciences and Health, Strathclyde University Graham Hills Building, 40 George Street, Glasgow G1 1QE, UK; e-mail: a.lowit@strath.ac.uk

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Outcomes & Results: Both speaker groups employed all three phonetic parameters to differentiate between new and given information. However, groups differed regarding the use of phonological markers, with speakers with FAS frequently placing pitch accents on given information instead of de-accenting these elements. According to the perceptual evaluation, three of the four speakers with FAS had problems signalling information status.
Conclusions & Implications: The fact that speakers with FAS marked information status similarly to control speakers at the phonetic level, but failed to do so using phonological categories highlights the importance of assessing phonetic as well as phonological features to gain detailed information about the functional use of intonation in FAS.

What this paper adds

What is already known on this subject

Foreign accent syndrome (FAS) is characterised by a combination of segmental as well as suprasegmental, i.e. intonational and rhythmic, speech errors. Whilst intonational changes have been identified to play a major role in FAS, little is known about how these changes affect the role of intonation in signalling pragmatic-linguistic function.

What this study adds

This study addressed this knowledge gap by providing details about the functional use of intonation in an information signalling task in FAS. The study results highlight the importance of assessing both the phonetic and phonological features of intonation. The detailed findings contribute to our understanding of intonation disturbances in FAS and may assist the development of adequate assessment and treatment strategies in this disorder.

Introduction

Foreign accent syndrome (FAS) can be defined as a motor speech disorder in which a combination of segmental and suprasegmental changes result in the emergence of a new accent in speech. As a consequence, speakers are perceived either as non-native or dialectally different from their own community. The label FAS is traditionally confined to speech changes associated with a neurological incident, although recently Verhoeven and Mariën (2010) have suggested to also include psychogenic origin under the same label. Research into the underlying nature of neurogenic FAS is still ongoing, with most current views supporting the notion that speech changes in FAS may have the same physiological basis as alterations associated with other motor speech disorders such as dysarthria or apraxia of speech (e.g. Miller *et al.* 2006).

Numerous studies have investigated the combination of speech features that lead to the perception of the new accent. The majority of studies recognised the relevance of segmental as well as suprasegmental disturbances in defining FAS.

At the segmental level, articulation errors concerning the production of vowels and consonants are common. Vowel errors include alterations in length (Blumstein *et al.* 1987, Carbary *et al.* 2000, Mariën *et al.* 2006, Perkins *et al.* 2010, Scott *et al.* 2006) and tenseness (e.g. Blumstein *et al.* 1987, Ingram *et al.* 1992, Katz *et al.* 2008, Whitaker 1982). Changes in manner and place of articulation (Ardila *et al.* 1988, Mariën and Verhoeven 2007, Miller *et al.* 2006, Scott *et al.* 2006, Whitaker 1982) as well as voicing/devoicing (e.g. Gurd *et al.* 1988, Kurowski *et al.* 1996, Laures-Gore *et al.* 2006, Miller *et al.* 2006, Verhoeven and Mariën 2010) are frequently reported in relation to consonantal errors.

At the suprasegmental level, deviations in rhythm and, in particular, intonation have been identified to contribute to the perceived accent in FAS speech. In relation to the latter,

terms such as ‘strange’, ‘monotonous’ and ‘impaired’ have been used to characterise intonation in FAS (Verhoeven and Mariën 2010). Reported changes include deviations in pitch height and pitch range (e.g. Blumstein *et al*. 1987, Coelho and Robb 2001, Dankovičovà *et al.* 2001, Perkins *et al.* 2010), resulting in inappropriately large excursions (Avila *et al.* 2004, Blumstein *et al.* 1987), as well as exaggerated terminal rises or falls (Ingram *et al.*1992, Moen 2006). In other cases a reduced pitch range was observed (e.g. Berthier *et al.* 1991, Graff-Radford *et al.* 1986, Kanjee *et al.* 2010, Verhoeven and Mariën 2010). Studies into the appropriateness of pitch movements have found sharply rising pitch at the end of sentences where a fall would be expected (Berthier *et al.* 1991, Blumstein *et al.* 1987, Graff-Radford *et al.* 1986, Miller *et al.* 2006, Monrad-Krohn 1947) or alternatively, a falling pitch instead of rising contours (Berthier *et al.* 1991, Graff-Radford *et al.* 1986, Moen 2006).

Despite the strong prevalence of intonational changes in FAS (Coelho and Robb 2001) and their relevance in defining the disorder, formal investigations regarding the impact of these changes on the functional effectiveness of intonation in FAS are scarce. So far, only Graff-Radford *et al.* (1986) and Berthier *et al.* (1991) have investigated the ability to highlight specific words in a sentence and found that their speakers with FAS frequently struggled to do so. In some utterances, almost every single content word was highlighted, whereas in others words were unaccented where an accent was expected. These findings suggest difficulties with using accentuation to signal the pragmatic structuring of utterances. The ability to highlight relevant information in an utterance represents an essential communicative aspect of everyday speech. It directs the listener to the important part of the speech signal, that way contributing significantly to successful interaction and information exchange. Disturbances in the ability to structure information in discourse are detrimental to

effective communication and efficient speaker-listener relations, and therefore of considerable clinical relevance.

In West Germanic languages, including English, intonation is considered to be the most important marker of information structuring (e.g. Baumann 2006). Although Graff-Radford *et al.* (1986) and Berthier *et al.* (1991) identified problems in the FAS speakers in this area, their investigation primarily focused on the pathogenesis of FAS, and their findings therefore do not lend themselves to gauging the nature and extent of impairment of the functional use of intonation. The current study was designed to address this knowledge gap by examining the abilities of speakers with FAS to structure information, with particular focus on signalling information status, i.e. the differentiation of new and given information, by means of intonational variation.

The concept of information status, or givenness, refers to the pragmatic role of an element within the ongoing discourse (Chafe 1994, Halliday 1967, Lambrecht 1994). A binary distinction is assumed, whereby new information refers to the informative part of an utterance, and given information is considered non-informative as it represents the part of the utterance that can be inferred from the preceding utterance or the context. The most robust context for an element to be defined as *given* is for it to be directly mentioned in the preceding utterance.

Information status can be investigated from a phonological as well as a phonetic perspective. Phonologically, information status is signalled in a binary, categorical fashion: new information is marked by a pitch accent, whereas given information is generally de-accented (e.g. Baumann 2006, Chafe 1994, Cruttenden 2006, Hirst and Di Cristo 1998, Ladd 1996). Specifically, de-accentuation is expected to occur in post-focal position, whereas pre-focally, given information may be pitch-accented for rhythmical reasons (Gussenhoven 2002). Some researchers additionally argue that the type of pitch accent is of relevance. For

instance, Pierrehumbert and Hirschberg (1990) found that in American English given information is either de-accented or marked by a low pitch accent, whereas new information is marked by a high pitch accent. For British English, Brazil *et al.* (1980) identified new information to be marked by a falling pitch accent.

Phonetically, information status is primarily marked by the acoustic parameters of f0, duration and intensity. With regard to f0, there is general agreement that new information is indicated by high f0 levels and/or a raising of f0 values (Cruttenden 2006, Féry and Kügler 2008). Given information, on the other hand, is marked by lowered f0 values (Cooper *et al.* 1985, Féry and Kügler 2008, Hirst and Di Cristo 1998, Ladd 1996). Analyses of durational and intensity patterns have shown that given words have a significantly shorter mean duration and lower peak amplitude than their previously introduced new counterparts (Fowler and Housum 1987, Shields and Balota 1991).

The division of intonation into phonological and phonetic levels is reflected in the literature, which frequently focuses either on descriptions of intonation patterns by phonological means or on their acoustic-phonetic features, with the latter approach predominating in clinical research. However, given the intrinsic link between both aspects - phonological elements are mapped onto acoustic parameters, and acoustic parameters in turn have specific perceptual correlates - a joint approach to analysing intonation in terms of phonological representation and phonetic implementation appears to be the most informative one. Ladd (1996) proposes to describe intonational structures in terms of a small set of distinct phonological categories, i.e. pitch accents and boundary tones, which are translated into physical entities by means of phonetic implementation rules defining the way in which the acoustic parameters vary. There is growing evidence from research on intonation in unimpaired speech that supports the notion of such a combined approach as the most successful way to provide new insights into functional aspects of intonation. Arvaniti *et al.*

(2006), for instance, concluded that an empirically adequate description of the phonetic correlates of focus cannot be based on the manipulation of phonetic parameters only, but should also take account of local phonological events. With regard to disordered speech, the combined investigation of phonological and phonetic features has the added advantage of potentially being able to determine whether the observed intonation patterns are the result of differences in the underlying structure of intonation, or the way these underlying structures are realised (Mennen *et al.* 2008). Assessing both levels in disordered speech may thus contribute to identify the level of breakdown, and may therefore help to obtain a more complete picture of the effects any intonational deficit has on a speaker's communicative function.

So far, very few studies have investigated the phonology-phonetics interface of intonation in disordered speech to gain a deeper understanding of the relationship between both levels. The present study is the first of its kind to explore this in speakers with FAS, with the aim to provide a detailed account of the use of intonation to mark information status from both a phonological and a phonetic perspective.

Methods

Participants

Four speakers with foreign accent syndrome (FAS) and four age-, gender- and dialect-matched control speakers (CON) participated in the speech production experiment (FAS: 49-61 years, M_{age} = 56 years, 2 female, 2 male; CON: 46-61 years, M_{age} = 55, 2 female, 2 male). Speakers were right-handed and educated to college- or university degree-level. An overview of the participants of the study is provided in table 1.

Several inclusion and exclusion criteria were applied to this study. All speakers had a confirmed neurogenic origin for FAS as established from the case history and relevant health

care professionals, although a psychogenic contribution could not be entirely excluded. Information about the perceived accents of the speakers with FAS had been obtained by the responsible speech and language therapists as well as family members, and confirmed by the authors of the study. All participants were monolingual speakers of a variety of British English dialects. The original dialect of each speaker was established through case history and interviews with relatives. Control participants were matched for this parameter as intonation realisation is sensitive to dialectal variation. Formal and informal assessment ensured that the participants had no uncorrected visual or auditory impairment, no signs of depression and no history of speech and language difficulties before the neurological incident. None of the speakers presented with any type of reading difficulties or severe cognitive impairments as they were required to read a substantial number of sentences and follow instructions appropriately.

All speakers with FAS presented with some form of speech difficulties directly after the neurological incident. FAS1 and FAS3 were reported to have slurred speech; FAS4 had voice problems related to difficulties with generating a sufficient air stream; FAS2 was the only one presenting with mild aphasic symptoms, which primarily manifested in word finding difficulties. All of them had received speech and language therapy in the months following the neurological incident. The main focus for FAS1 and FAS3 had been on oral motor activities to improve articulation; FAS4 had received therapy that focused on breathing exercises; and FAS2's therapy had been geared towards improving word finding.

At the time of testing, the participants were at least 15 months post onset, and at least six months post therapy. As part of the study, speakers FAS2 to FAS4 were screened for dysarthria and apraxia of speech using parts of the Frenchay Dysarthria Assessment (FDA-2, Enderby and Palmer 2008) and the Apraxia Battery for Adults (Dabul 2000) to establish the presence of other motor speech disorders (no data are available for FAS1). Results of the

dysarthria screening showed restrictions in respiratory and phonatory support as well as changes in voice support for all three remaining speakers. The results of the apraxia screening suggested a mild impairment for FAS2, as indicated by schwa insertions in initial position, non-phonemic vowel changes and occasional difficulties to initiate speech.

--- Table 1 about here ---

Speech production experiment

The sentence reading task that formed the basis of the current investigation was part of a larger study on FAS that elicited scripted as well as unscripted speech data. To investigate the marking of information status, i.e. the signalling of new and given information, a set of ten sentences was designed, controlled for length, syntactic structure as well as lexical stress patterns (appendix A). In order to optimize pitch tracking, the sonorance of the sentence materials had been maximized. Each sentence contained three target words, which were systematically varied with regard to information status (new vs. given) and sentence position (initial vs. medial vs. final), resulting in four experimental conditions (cf. Lowit *et al.* (2010) or Patel and Campellone (2009) for examples of this setup). In the baseline condition, all three target words were contextually new. In the remaining three conditions the position of the new information varied between initial, medial and final position, i.e. in each of these three conditions one target word was new and two were given. Each speaker was asked to produce 40 sentences, yielding 120 target words for analysis, of which 60 were new and 60 were given. The sentences were randomised and separated by filler sentences to prevent the participants from becoming accustomed to particular intonation or information status patterns.

Sentences containing omissions of target words, hesitations or self-corrections were not analysed as these types of errors would have altered the length of the utterances or the phrasing structure. Overall, a total of 276 sentences and 828 target words were analysed with regard to information status, of which 416 were contextually new and 412 given.

Task presentation

A question-answer paradigm was used to elicit the four different sentence conditions (see Appendix A). The sentences were presented via PowerPoint, starting with the question (presented with auditory and visual prompts) and followed by the target utterance, which participants were asked to read out. The auditory prompts for questions were spoken by a male and a female speaker of Standard Southern British English to ascertain that each participant was provided with the same stimulus material and performance differences could not be ascribed to differences in the way questions were elicited. As is common practice, the word to be highlighted in the sentences was underlined to ensure that a failure to emphasize the correct word could not be attributed to poor linguistic processing. This should not have affected the participants' performance. To further ensure maximum compliance with the task, each participant completed four practice items to familiarize themselves with the procedure before starting the experiment.

Speech recordings

Speech recordings were made in a quiet room in the participants' home or at university facilities using a portable DAT-recorder (TASCAM DA-P1) and a condenser microphone (Beyerdynamic MPC 65 V SW) at a sampling rate of 44.1 kHz. Microphone to mouth distance was 50cm.

Analyses

The speech data were prepared using Praat speech analysis software (version 5.0.11 © Boersma and Weenink 1992-2012). The f0 contour was checked to detect halving and doubling errors of the pitch tracker which, if necessary, were corrected by hand. The adjusted data served as input for the subsequent phonological and phonetic analyses.

Phonological analyses

The speech data were analyzed within the autosegmental-metrical (AM) framework of intonational analysis (Pierrehumbert 1980, for a comprehensive overview see Ladd 1996) that characterizes intonational structures in terms of sequences of H(igh) and L(ow) target tones. Data annotation followed the IViE transcription guidelines (Grabe 2004). IViE represents a variant of the AM approach that allows the annotation of different British English dialects within one system. This was relevant for the present study as participants with different dialectal backgrounds were investigated. In this transcription approach several levels are annotated to arrive at the phonological description of the intonation contour. This includes the labelling of syllables, phrase boundaries (%) and prominences (P) as well as the phonetic make-up of the pitch movements. For the phonological transcription, which primarily focused on the description of the accentuation patterns surrounding the stressed syllables of the target words, the structural labels of the IViE system were used. These were H* (high level tone), L* (low level tone), H*L (falling tone), !H*L (downstepped falling tone), L*H (rising tone), L*HL (rise-fall) and H*LH (fall-rise). De-accentuation was marked using DE. The intonation patterns of the present study were analysed in relation to the overall pitch accentuation, i.e. (de-)accentuation patterns as well as the type and frequency of pitch accents used to indicate new and given information.

Phonetic Analyses

The phonetic analyses focused on the parameters of duration, intensity and f0. The intervals relevant to the duration and intensity measures were the stressed syllables of the target words. For duration, the length of the stressed syllable of the target words was measured (in ms); for intensity, the peak decibel (dB) value on this syllable was captured; and for the analysis of f0, the f0 maxima on the stressed syllable of the target words were captured. The intervals and specific points were labelled manually. A Praat script was then employed to extract the length of the marked intervals, the peak intensity on these intervals and the Hz values on the specified points. For each parameter, three values per sentence were obtained, resulting in 12 values per baseline sentence set and 120 measures per speaker and parameter.

Perceptual analysis

In addition to the phonological and phonetic analyses, a perceptual evaluation was conducted about three months after completing transcription and analysis to assess whether the information status of the target words could be identified correctly. That way it could be established whether both speaker groups successfully signalled new and given information by means of intonation. In order to establish whether speakers succeeded in marking the two different types information status using (de-)accentuation, the perceptual evaluation concentrated on sentences containing post-focally given information, i.e. sentences in which either the initial or the medial target word were new, and hence in which de-accentuation of the following words would be expected. This means that the perceptual evaluation was completed on 50% of the speech corpus. The sentences were played to two judges, who worked independently of each other to decide which target words were highlighted. The first judge was the first author of the study; the second judge was a trained speech-and language therapist, who was not familiar with the speech corpus and blinded as to the purpose of the

study. The sentences were randomised by a third person to blind judges as to type of sentence and participant, if possible. A sentence was rated correct if the listeners perceived the expected target word as highlighted. Any deviation from this pattern meant that the information status of the overall sentence could not be identified correctly, resulting in a score of 0 for that sentence. The degree of agreement between both judges was established by calculating Cohen's Kappa (Cohen 1960). Cohen's Kappa measures the agreement between the evaluations of judges taking into account the occurrence of chance agreement. The calculation yielded a Kappa of 0.86, indicating a very high level of agreement between both judges as to the overall information status of sentences. Cases of disagreement were subsequently discussed to arrive at a joint decision as to which target words were highlighted.

Statistical analysis of the data

Due to the small number of participants in most previous research, the literature contains few group analyses of speakers with FAS. Meta-analyses of existing results are problematic due to the varied nature of tasks and analysis approaches, and it is thus difficult to draw any conclusions relating to the commonality or individuality of reported symptoms for the FAS population. Although four speakers do not constitute a large group, the high number of speech stimuli collected allowed the application of statistical analyses to the current data, thus adding a new perspective to the results of this study. At the same time, one has to exercise caution as individual variations are easily masked by group means. In order to validate to what degree observed group differences actually reflected common behaviours, each result was also cross-checked in terms of individual speaker performances. These are reported where performances differed amongst the speakers with FAS or between the CON and FAS group. Otherwise the results are presented in group form to align with the statistical results.

A variety of statistical tests were employed to establish potential performance differences between speaker groups in relation to the phonological and phonetic marking of information status. Significance was determined at p=.05. Only significant statistical results are reported in full.

Group differences pertaining to the phonological marking were established using the non-parametric Mann-Whitney-U-Test to account for the small number of speakers within each group. In order to evaluate whether both groups employed the same phonetic parameters, a parametric test was necessary to account for the number of factors involved in the analysis. Specifically, a series of mixed model ANOVAs were conducted for each phonetic parameter, i.e. duration, intensity and f0. Information status (two levels: new, given) and sentence position (three levels: initial, medial, final) served as within-subject factors and group (two levels: CON, FAS) as between-subject factor. In cases where Mauchly's test of sphericity was violated, the more stringent F value provided by the Greenhouse-Geisser correction was used.

Intra- and Interrater-reliability

Intra- and inter-rater reliability for transcription was completed on 10% of the clinical and 10% of the control data for phrase boundaries, prominent syllables and classification of the pitch accents. Intra-rater agreement was conducted by the first author, inter-rater agreement was carried out by another researcher with experience in prosodic transcription following a designated labelling protocol. The protocol, which was specifically developed for this study, included a detailed description of the annotation system, the analysis procedure, and the different intonational labels, i.e. pitch accents and boundary tones, available for annotation. Reliability for intra-rater transcription was consistently over 95% indicating a high degree of agreement (phrase boundaries: 96%; prominent syllables: 98%; phonological labels: 94%).

Inter-rater agreement was equally high for phrase boundaries (96%). The congruence levels pertaining to the labelling of the prominent syllables (88%) and pitch accents (86%) reflected very good agreement (Pitrelli *et al.* 1994).

Intra- and inter-rater agreement of the phonetic measures, i.e. duration, intensity and f0, was tested on 10% of the data using Pearson correlation coefficient (two-tailed) and independent samples t-test. The Pearson correlation suggested a high level of agreement between the two different analyses (intra-rater: duration r=0.986, intensity r=1.0, f0 r=0.996; inter-rater: duration r=0.937, intensity r=1.0, f0 r=0.992). The independent samples t-tests, employed to detect systematic differences between the measurements of both raters, were non-significant (duration: $t(190) = -0.415$, $p = 0.68$; intensity: $t(190) = 0.001$, $p = 1.00$; f0: $t(318) = -0.245$, $p = 0.81$).

Results

Phonological marking of information status

Figure 1 displays the group results for the phonological marking of the different information status categories, table 2 provides the individual data.

The figure shows that both speaker groups employed the same pitch accents to signal new information. It also demonstrates that both groups consistently assigned a pitch accent to new information, most frequently the falling pitch accent H*L, followed by the high level tone H*. The remaining pitch accents were only marginally employed; de-accentuation (DE) and L* did not occur. The statistical analysis using Mann-Whitney U did not reveal any differences between groups regarding the prevalence of the pitch patterns used to mark new information.

The analysis of the marking of given information revealed that both speaker groups assigned pitch accents in pre-focal position, predominantly H*L, followed by H* (figure 1).

The FAS group additionally employed L*H in 25% of all realisations. The remaining pitch accents were only infrequently observed. As was the case for the marking of new information, the statistical examination did not yield any differences between groups in the use of pitch patterns to mark givenness in pre-focal position. On the other hand, significant differences emerged regarding post-focally given information (DE: $U = 0$, $Z = -2.32$, $p = .02$; H*L: $U = 0$, $Z = -2.37$, $p = .018$; !H*L: $U = 0$, $Z = -2.48$, $p = .013$). These differences were due to the fact that the CON group de-accented given information in most utterances, whereas the FAS group predominantly marked this information with pitch accents, either the falling pitch accent H*L or, less commonly, the downstepped version !H*L (figure 1, table 2). The statistical analysis of the remaining pitch patterns did not reach significance.

In summary, the phonological results revealed strong similarities between the speaker groups in terms of type and frequency of pitch accents used to mark new and pre-focally given information. Significant differences occurred with regard to the marking of post-focal givenness, with de-accentuation prevailing in the CON group, whilst in the FAS group pitch accents dominated.

--- figure 1 and table 2 about here ---

Phonetic marking of information status

Table 3 summarizes the results of the mixed model ANOVA for the within-subject effects *information status* and *sentence position*, the between-subject effect *group* and the interaction between both effects for each parameter.

--- table 3 about here ---

Duration: Table 3 shows that there was a significant main effect of group. This reflects the fact that the speakers with FAS generally took longer to produce new as well as given target words than the CON group (figure 2a), indicative of a slower articulation rate. A significant main effect was further observed for information status, but not for sentence position. The interactions between the two within-subject factors and speaker group were also not significant. These results suggest that, although the FAS group spoke more slowly overall, both speaker groups employed duration to differentiate between new and given information, with new information being significantly elongated compared to given information in all sentence positions.

--- figures 2a, 2b, and 2c about here

Intensity: As the recordings had not been calibrated for intensity, no group comparisons could be performed for this parameter. Instead, the analysis focused on the relationship between information status and sentence position across the two speaker groups, which showed a significant main effect (table 3). This indicates that both speaker groups manipulated intensity levels to differentiate between new and given information, with new information being louder than given information (figure 2b). The positional effects further suggest that new as well as given information were louder in initial position than in medial and final position. The significant interaction effects that were observed between the two within-subject factors and group show that the difference in intensity between positions as well as between new and given information was greater in the CON group than in the FAS group.

f0: The significant main effect observed for group indicates performance differences between the two groups in terms of f0 realisation, with figure 2c revealing that f0 levels were overall higher in the FAS group than in the CON group. Furthermore, significant main effects were observed for both within-subject factors (table 3). These findings suggest that overall f0 levels were higher for new information than for given information. In addition, f0 levels for both types of information were again higher in initial position than in medial and final position. The interactions between these within-subject factors and speaker group were not significant.

In summary, the statistical analysis established that both speaker groups employed duration, intensity and f0 to differentiate between new and given information, with new information being significantly longer, louder and higher in pitch than given information.

Perceptual analysis

The perceptual analysis revealed that new information was consistently identified correctly in the utterances produced by the CON group. On the other hand, only 55% of the utterances of the FAS group were perceived to have the expected information status pattern. Individual analyses revealed differences in this group. Whilst FAS1 mirrored the perceptual results of the control speakers (100% correct), new and given information were only correctly identified in 30% of the utterances for FAS2, in 50% for FAS3, and in 40% for FAS4. In those cases where the information status of target words was not identified correctly, all target words were perceived as new information rather than the wrong target being highlighted.

Discussion

The phonological marking of information status

The analysis of the phonological marking of new information revealed strong similarities between the performances of the CON and FAS groups, both in the available repertoire of pitch accents as well as their frequency of use. The current results, which show the predominant use of pitch accents H*L and H* to mark new information in both groups, are in agreement with previous reports in the literature on the signalling of newness (Brazil *et al.* 1980, Pierrehumbert and Hirschberg 1990). The fact that both groups consistently marked new information by assigning the same types of pitch accents with a similar frequency indicates that the speakers with FAS were able to select and use the appropriate pitch accent types to mark new information.

In relation to the marking of given information group comparisons again showed good agreement for the pre-focal position. Both speaker groups assigned pitch accents to the target items, primarily H*L and H*, supporting previous findings in the literature that given information in pre-focal position may be marked for rhythmical reasons (Gussenhoven 2002). However, marked differences between speaker groups occurred for post-focally given information. The CON group showed a strong prevalence of de-accentuation, confirming general assumptions on givenness in the literature (Baumann 2006, Chafe 1994, Cruttenden 2006, Hirst and Di Cristo 1998). On the other hand, the performance of the FAS group clearly deviated from this pattern as accentuation strongly prevailed over de-accentuation. The low de-accentuation rate resulted in both new and given information being assigned pitch accents. The fact that most items were assigned a pitch accent, irrespective of their actual information status, suggests a limited ability in the FAS group to effectively use (de-) accentuation to signal information status. This finding is in line with the perceptual results

which found that in cases where the information status of target words was not identified correctly, all target words were perceived as new information.

Although there are no previous reports on performances by speakers with FAS specific to this task, difficulties in the use of accentuation to structure utterances have been reported in the FAS literature. Studies conducted by Graff-Radford *et al.* (1986) and Berthier *et al.* (1991) found that these speakers experienced problems when asked to focus on specific words in utterances. In many utterances almost every content word was highlighted indicating a tendency to over-accentuate. This finding ties in with the results of the current study, which found accentuation in FAS to be more frequent than de-accentuation. The exact underlying nature of this problem still remains to be explored in greater detail, but neuromotor difficulties and control issues related to the motoric nature of the speech problems may have contributed to the difficulties (Kuschmann *et al.* 2012).

The phonetic marking of information status

The results of the phonetic analysis revealed that both groups employed all three parameters to signal information status, with new information being marked by significant increases in duration, intensity and f0 compared to given information in the same position. This confirmed previous findings on the phonetic marking of givenness (Féry and Kügler 2008, Fowler and Housum 1987, Shields and Balota 1991). In addition, for intensity and f0 both groups exhibited similar positional effects, with new as well as given information being louder in initial position than in medial and final position. At the same time, the contrast between new and given increased from initial to final position. These results are in line with previous findings on differences in degree of difference between new and given information across sentence positions (Cooper *et al.* 1985).

Although the results suggest that the speakers with FAS generally employed phonetic cues to differentiate between new and given information similar to the control speakers, some differences could be observed in the manipulation of intensity. The significant interaction effects revealed that the difference in intensity between sentence positions as well as between both types of information status was greater in the control speakers than in the speakers with FAS. That is, the control speakers employed intensity differences to a greater extent than the speakers with FAS to signal the respective information status. Amongst the three acoustic parameters manipulated to signal focus, i.e. duration, f0 and intensity, the latter usually presents with the smallest degree of difference between new and given information. The fact that the FAS speakers did not match the performance of the control group in this parameter could suggest that they either experienced difficulties in the manipulation of intensity per se (i.e. a phonetic problem) or in coordinating intensity variation in line with the other two parameters. Lowit *et al.* (2010) report similar problems with intensity manipulation in focus tasks for speakers with ataxic dysarthria, and this parameter might thus be particularly susceptible to problems in motor control. In order to corroborate these observations further controlled experiments on a wider range of disordered speakers are necessary.

The relationship between phonological and phonetic marking and the perception of information status

Taking both the phonological and the phonetic levels into account, the analysis of marking information status has yielded somewhat diverging results as to the functionality of intonation in FAS speech. From a phonological perspective, none of the FAS speakers effectively signalled information status by categorical means, i.e. the presence versus absence of pitch accents, suggesting problems with the marking of information status in FAS. From a purely phonetic perspective, though, the FAS group appeared to manipulate the investigated

parameters by and large in the same way as the control speakers to differentiate between new and given information. The perceptual evaluation, which was conducted to examine the relationship between both levels further, is more reflective of the findings of the phonological level as three of the four speakers with FAS were not perceived to mark information status effectively. It is likely that this inability to signal the pragmatic structure of utterances by means of accentuation contributes to the frequent characterisation of intonation in FAS as 'strange' or 'impaired' (Verhoeven and Mariën 2010). At the same time, the perceptual analysis revealed that FAS1 was perceived to mark information status correctly throughout; even though she only de-accented 26% of all post-focally given words (cf. table 2). This finding suggests that FAS1 was to some degree able to compensate for her phonological insufficiency, i.e. the inability to completely de-accent, by phonetically manipulating the other words in the utterance in such a way that the target still stood out. Confirmation for this assumption comes from the two judges who conducted the perceptual evaluation. Both agreed that FAS 1 seemed to exaggerate the available phonetic cues to mark information status within the utterances. As a result of this 'overuse', FAS1's intonation is likely to be perceived as abnormal too; even though she succeeded in marking information status correctly. Consequently, all four speakers with FAS seemed to have produced deviant intonation patterns which could affect communication negatively, but for different reasons.

The findings of the present study suggest that the phonetic manipulation by three of the four speakers with FAS - despite being similar to that of the control speakers - may not have been sufficient to result in the de-accentuation of given items at the phonological level. As a result of these phonetic issues, the functional use of intonation was restricted. This suggests that the intonation deficits observed in the speakers with FAS may originate at the level of

phonetic implementation with secondary effects observable on the execution of pragmatic function.

Limitations and future directions

To our knowledge this study was the first to explore the phonological and phonetic marking of information status in FAS. By combining the analysis of both phonetic and phonological features, information on the nature of the intonational deficit and the relationship between the parameters in conveying linguistic function in FAS was provided. However, the conclusions derived from the data have to be considered preliminary until further research with more participants is conducted which confirms or disproves these findings.

In addition, there are a number of issues that were not investigated in this study which would be worth exploring in future studies. This includes in-depth investigations of the causal factors that contribute to the changes in the marking of information status and investigations of a broader range of linguistic functions to establish whether the phonological and phonetic patterns observed at present are specific to the marking of information status or whether they reflect more general patterns of intonation impairment in FAS. In addition, more extensive investigations regarding the impact of the observed changes on listener perception are necessary to validate such results.

With regard to the perceptual analysis, a further aspect worth pursuing concerns the possibility of other acoustic parameters to be more appropriate predictors of listeners' ability to identify the word in focus. As discussed above, the phonetic properties investigated in the present study did not necessarily reflect the perceptual findings. This raises the question whether phonetic parameters other than duration, intensity and f0 such as pitch excursion or phrasing could be more suitable markers to reflect the perceptual judgements.

Despite these limitations, the results of the present study highlight the relevance of both phonological and phonetic aspects in determining the functionality of intonation in

marking of information status in FAS. It further demonstrates the close inter-relationship of both aspects in the perception of intonation, emphasising that intonation should not be investigated by means of phonetic parameters only. Furthermore, the paper has provided detailed information on differences in the marking of information status between FAS and control speakers which can form the basis for future investigations and development of potential treatment strategies.

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Appendix A

List of sentences with target words underlined

1) The landlord owned dwellings in Reading.

2) The diva made a movie in Venice.

3) The lawyer met the model in London.

4) The widow bought a villa in Ealing.

5) The model wrote her memoirs in Lima.

6) The gardener grew roses in London.

7) The minister made money in London.

8) The milliner got a memo from Mona.

9) The murderer met his lover in Venice.

10) The minister had a nanny from Norway.

Example elicitation:

What did the landlord own in Reading?

The *landlord* owned **dwellings** in *Reading*.

given pre-focal new given post-focal

Table1

Information on the participants of the study including age, gender, dialect, neurological condition and accent perceived by listeners

speaker	age	gender	dialect	neurological condition	perceived accent
FAS1	61	female	North-East England	left-hemispheric CVA, 2006	French, Italian
FAS2	49	female	Scottish (East)	left-hemispheric CVA, 2006	Italian, South African
FAS2	61	male	Southern Standard British	brain stem infarct, 2003	Italian
FAS4	54	male	North-West England	left-hemispheric CVA, 2007	Italian
CON1	60	female	North-East England	---	---
CON2	46	female	Scottish (East)	---	---
CON3	61	male	Southern Standard British	---	---
CON4	53	male	North-West England	---	---

Table 2

Type and frequency of pitch accent per speaker for new and given information in %

	New information								Pre-focal Given Information								Post-focal Given Information							
	CON1	CON2	CON3	CON4	FAS1	FAS2	FAS3	FAS4	CON1	CON2	CON3	CON4	FAS1	FAS2	FAS3	FAS4	CON1	CON2	CON3	CON4	FAS1	FAS2	FAS3	FAS4
DE											3			3			80	93	70	90	26		17	17
L*											7			3			7			3	7			
L*H		2				37	2	0	14		3			74	3							20		
H*	27	25	5	8	13	20	17	12		73	30	27	20	20	43	37					7	13	3	3
H*L	73	70	92	72	80	43	79	86	86	10	54	66	80		47	60			3		20	40	50	63
!H*L		3	3	20	7		2	2		17	3	7			7	3	13	7	27	7	40	27	30	17

Table 3

Mixed model ANOVA results by phonetic parameter

	duration			intensity			f0		
	df	*F*	*p*	*df*	*F*	*p*	*df*	*F*	*p*
Mixed model ANOVA									
between-subject effects									
group	1	143.97	<.001	na	na	na	1	21.07	<.001
within subject effects									
status	1	97.88	<.001	1	144.21	<.001	1	93.56	<.001
position	1.69	1.05	.343	1.87	128.70	<.001	1.57	182.29	<.001
interaction effects									
status*group	1	.72	.399	1	13.99	<.001	1	.80	.371
position*group	1.69	.80	.452	1.87	6.15	.003	1.57	3.01	.064

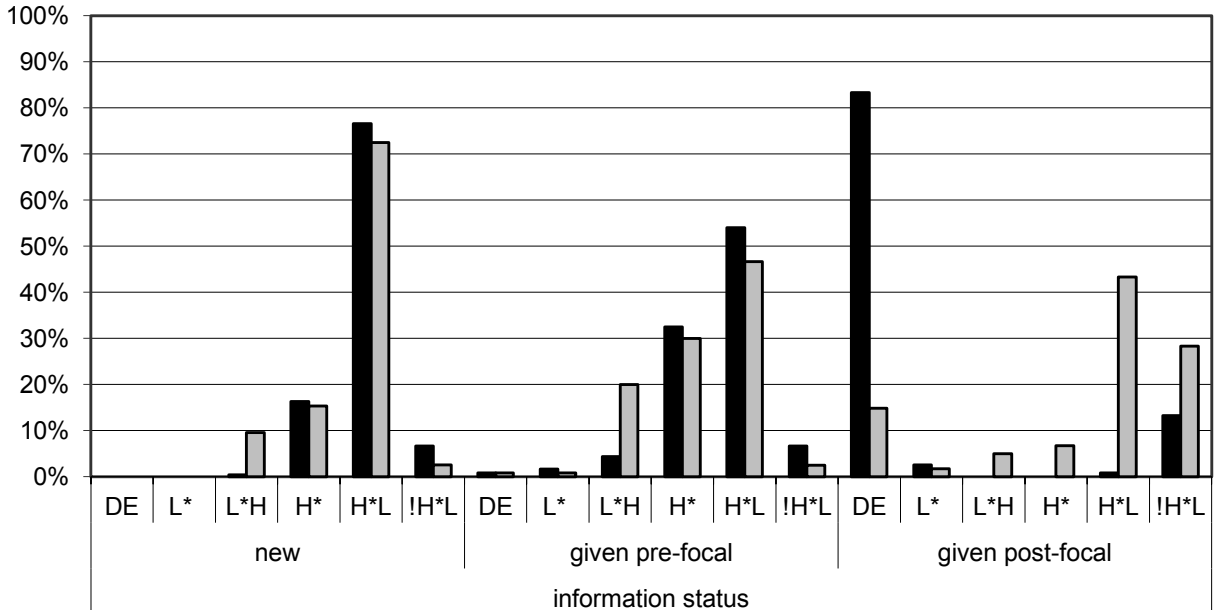

Figure 1

Mean frequency (in %) of pitch patterns per information status category for CON and FAS groups

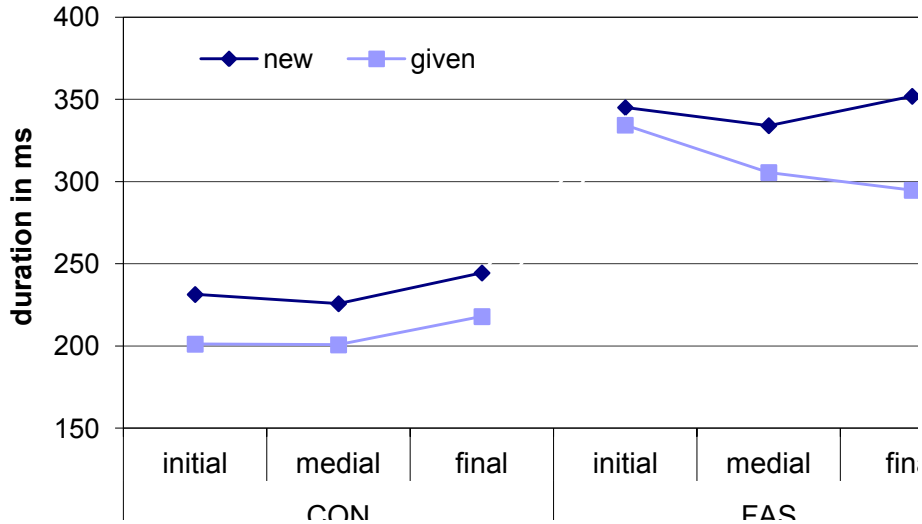

Figure 2a

Mean duration of new and given target words in the different sentence positions for CON and FAS groups

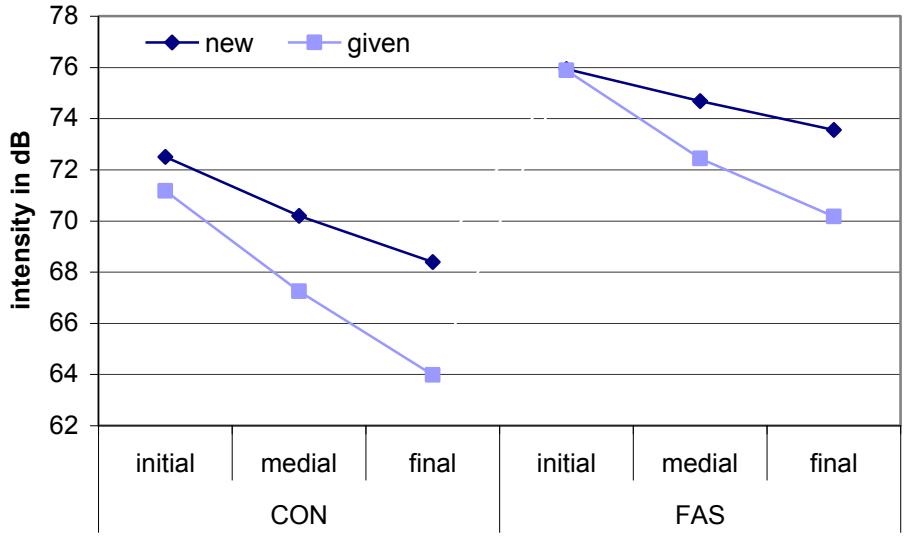

Figure 2b

Mean intensity of new and given target words in the different sentence positions for CON and FAS groups

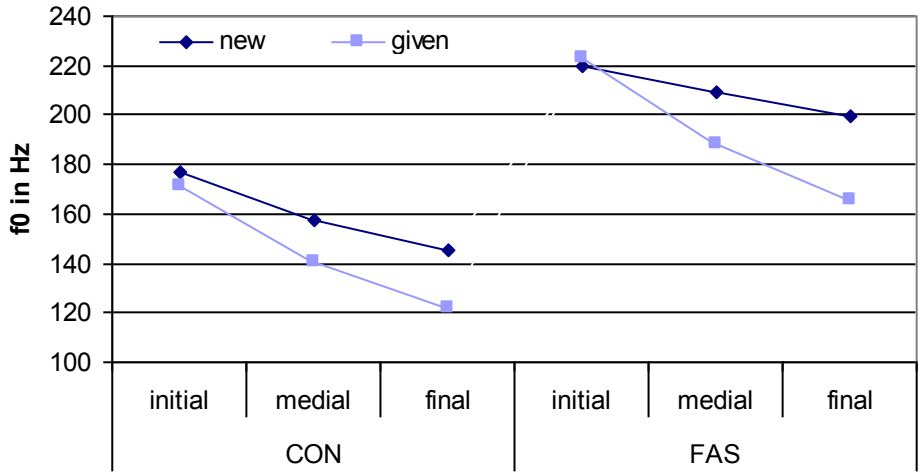

Figure 2c

Mean f0 of new and given target words in the different sentence positions for CON and FAS groups