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Rhotic Emphasis And Uvularization In Moroccan Arabic

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Abstract

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My findings indicate that the rhotic emphasis constrast remains both distributionally and phonetically ambiguous at the level of the individual, and that its variation is not sociolinguistically determined. Furthermore, there is evidence that the ambiguity of the contrast is diachronically stable. I propose that this behavior reflects an underlying representational ambiguity related to the perceptual confusability of uvular and upper pharyngeal place and to the phonetic imprecision of rhotics in general.

The document is structured as follows: first, I provide an overview of work on phonological categories, representational frameworks for ambiguous variants, and post-velar place specification (Chapter 1), then proceed to describe and problematize the relevant phonological phenomena in Moroccan Arabic (Chapter 2). Chapter 3 describes the methods used in fieldwork, data collection and preparation, while Chapters 4 and 5 present the results of my speaker analysis for Fessi Arabic with respect to acoustic correlates of post-velarization spread and rhotic emphasis distributions respectively. Finally, Chapter 6 offers a theoretical framework for interpreting these results and suggests some areas for further research.

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RHOTIC EMPHASIS AND UVULARIZATION IN MOROCCAN ARABIC

Nû ist des menschen eigen werk minnen und bekennen.

—*Meister Eckhart*

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ABSTRACT

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This study investigates the phonological behavior of secondarily post-velarized ('emphatic') consonants in Colloquial Moroccan Arabic, focusing primarily on variant pronunciations of the approximant /r/ and the relationship of pharyngeal to uvular articulation. In certain contexts, /r/ independently exhibits phonetic characteristics similar to those of the primary 'emphatic' phonemes /ṭ ḍ ṣ/, and for many speakers a combination of borrowing and analogy has extended the context of emphatic variants outside of the original conditioning environment, resulting in a pattern of contrast that approaches phonemic status. Through analysis of interviews with individual speakers, I establish the parameters of phonetic and phonological variation in /r/ and evaluate the phonemic character of these segments through processes associated with phonological emphasis, as well as investigating how post-velar coarticulations in Moroccan Arabic align with uvular and/or pharyngeal place in phonetic and structural terms.

My findings indicate that the rhotic emphasis constrast remains both distributionally and phonetically ambiguous at the level of the individual, and that its variation is not

sociolinguistically determined. Furthermore, there is evidence that the ambiguity of the contrast is diachronically stable. I propose that this behavior reflects an underlying representational ambiguity related to the perceptual confusability of uvular and upper pharyngeal place and to the phonetic imprecision of rhotics in general.

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Chapter 1. Phonological Representations, Ambiguity, and Post-Velar Place

In the following pages, I will present a detailed description of the way in which certain individuals living in the Moroccan city of Fes pronounce certain consonants in certain words. At first glance, this may seem to be a peculiar and impractical exercise, such as describing how many flowers bloom on each branch of a particular tree, and how many of each of those flowers is visited by a pollinating insect on a given day. However, just as mapping the flowering and pollination contours of one tree can teach a biologist about environmental and epigenetic constraints on growth and the foraging behavior of bees, mapping the phonetic contours of an individual's speech can yield insights about how our minds store and process the basic units of language.

This introductory chapter lays the groundwork for that relationship between the particular and the general, discussing theoretical approaches to the mental representation of speech sounds (§1.1), how language change and unpredictability in the speech signal can affect the organization of these representations (§§1.2-1.3), and the tricky question of understanding how language users represent sounds made in and around the upper throat (§1.4). All of these issues come together in the problem of Moroccan Arabic /r/, whose context and behavior is described in detail in Chapter 2. The relationships between different variants of this sound test the limits of our models of phonological representation, and enhance our understanding of how the lower vocal tract is organized in speech. As discussed in Chapter 6, uncertainty plays a major role in its analysis, and the formation of mental representations may have some similarity to foraging behavior after all.

1.1 Representational Fundamentals in Phonology

1.1.1 Phonemes and Oppositional Contrasts

The idea that speech sounds are represented in our mental grammar in terms of discrete representational units based on oppositional contrasts is a foundational principle of modern linguistic science. While the idea of the phoneme, the abstract segmental representation of a distinctive sound category in a language, was most fully developed in structural linguistics by Roman Jakobson and Nikolai Trubetzkoy, its first articulation by Ferdinand de Saussure remains the most illustrative of the fundamental properties of phonemic analysis:

> Chaque idiome compose ses mots sur la base d'un système d'éléments sonores dont chacun forme une unité nettement délimitée et dont le nombre est parfaitement déterminé. Or ce qui les caractérise, ce n'est pas, comme on pourrait le croire, leur qualité propre et positive, mais simplement le fait qu'ils ne se confondent pas entre eux. Les phonèmes sont avant tout des entités oppositives, relatives et négatives. (Saussure 1971[1916]:164)

In Saussure's definition, the phoneme is delimited in the representational space of grammar by the fact that it minimally contrasts with other phonemes – it is an 'oppositive, relative, and negative' category. In modern approaches to phonology, these dimensions of contrast have been theorized as individual phonological features (Jakobson and Halle 1956), and much of the debate about the representation of speech sounds has centered around the decomposability and abstractness of these feature bundles (§1.1.2).

An aspect of phonemic representation which has remained axiomatic in many approaches, including the recent constraint-based filtering approaches to phonology known collectively as Optimality Theory, is the notion that the contrastive units are 'clearly delimited'

('*nettement délimité*') and have a number which is 'perfectly determined' ('*parfaitement déterminé*') within each grammar. A number of well-studied linguistic phenomena, however, are difficult to reconcile with this assumption, including the near-merger of low back vowels in some American English varieties and word-initial gemination in the Romance dialects of Southern Italy (§1.2). Recent approaches which incorporate uncertainty and probabilistic learning into phonological models, problematizing the Saussurian assumption of clear and perfectly determined delimitation, allow us to understand how these difficult cases may fit into the phonological system (§1.3).

1.1.2 The Nature of Phonological Representations

The phonological feature model which has been dominant since at least Jakobson and Halle (1956) assumes that phonemes are specified by clusters of features grounded in phonetic perceptual and articulatory cues, but opinions differ widely as to how abstract or concrete these features need be. Generally, theorists have agreed that both acoustic and articulatory characteristics need to be taken account in the composition of features, acknowledging the bidirectional nature of the speech chain and, at the physiological level, the role of both motor and auditory processing in the production and perception of speech.

Since the generative approach to linguistics emerged in the mid-twentieth century, phonology has been taken to be a module of Universal Grammar, and as such is expected to encode certain characteristics about the structure of speech sounds which are innate and crosslingustically invariant (Miller, Myler, and Vaux 2016). In the Parallel Structures model of Morén (2003), for example, structural analogies between signed and spoken languages are used to motivate a universal abstract feature geometry based on telicity and directional relations. Most frameworks, however, acknowledge that phonetic grounding is a necessary characteristic

of phonological features due to the fact that the features, however abstract, are encoding tangible properties of the speech signal that derive from its particular mechanism of transmission. The Sound Pattern of English features (Chomsky and Halle 1968), to take a prominent example, gave primacy to articulation-based distinctive contrasts based on the manner and location of vocal tract constriction in spoken language, while the earlier Jakobson and Halle system (1956) favored features grounded in acoustic characteristics of speech. Subsequent proposals for spoken language have fallen somewhere along this spectrum between articulatory and acoustic specification, with articulatory place, manner, and phonation forming the basis of the most commonly used feature systems.[1]

Since some relationship clearly does exist between constrastive phonological features and gradient phonetic properties, the question arises of what this relationship is. The most extreme answer from the generative perspective is that the phonetic content of phonology is as minimal as possible, and that most phonetic attributes are redundantly assigned to segments at a late stage of grammatical derivation (Archangeli 1988, Kiparsky 1995). This proposal is known as 'underspecification,' since it entails that the representational content of the phonology is underspecified with respect to phonetics. A related approach views features as radically abstract divisions of representational space, which are only tenuously and contingently related to concrete phonetic properties (Hale and Reiss 2008). On the other extreme are theories that view phonological representations as being composed of feature bundles granularly reproducing the phonetic properties of each word in great detail, such as Articulatory Phonology (Browman and Goldstein 1986), which does away with the phoneme in favor of 'gestural scores.' Ohala (1990a, 1990b) engages in a logical extension of this view by claiming that most of phonology simply *is* phonetics, and that we should be viewing 'sound structure' as a dynamic and contigent

[1] See Hall (2007) for a representative sketch of segmental feature inventories.

aspect of speech which interfaces with the grammar rather than forming part of it. Between these extremes, there is a consensus view that lexical representations are composed of ordered bundles of features, most of which can be parsed as segments (Hall 2007), and that the individual features correspond to perceptual or articulatory properties of speech.

Even once such phonetically grounded distinctive features are accepted as the basis for representation, the question of how the featural space is organized still remains. Most modern analyses of featural contrasts operate within some variation of Feature Geometry (Clements and Hume 1995), which proposes that features are associated with different representational nodes and subnodes, arranged in a hierarchical structure, and each of which can be specified for only a particular subset of the full featural inventory.[2] The Place node, for example, cannot be associated with the feature [sonorant], since this feature does not specify place. Figure 1.1, reproduced from Halle, Vaux, and Wolfe (2000:389), illustrates the feature geometry endorsed by Revised Articulatory Theory, one variation on this theme.

[2] Clements and Hume even go so far as to liken the structure of featural node hierarchies to a Calder mobile (1995:250).

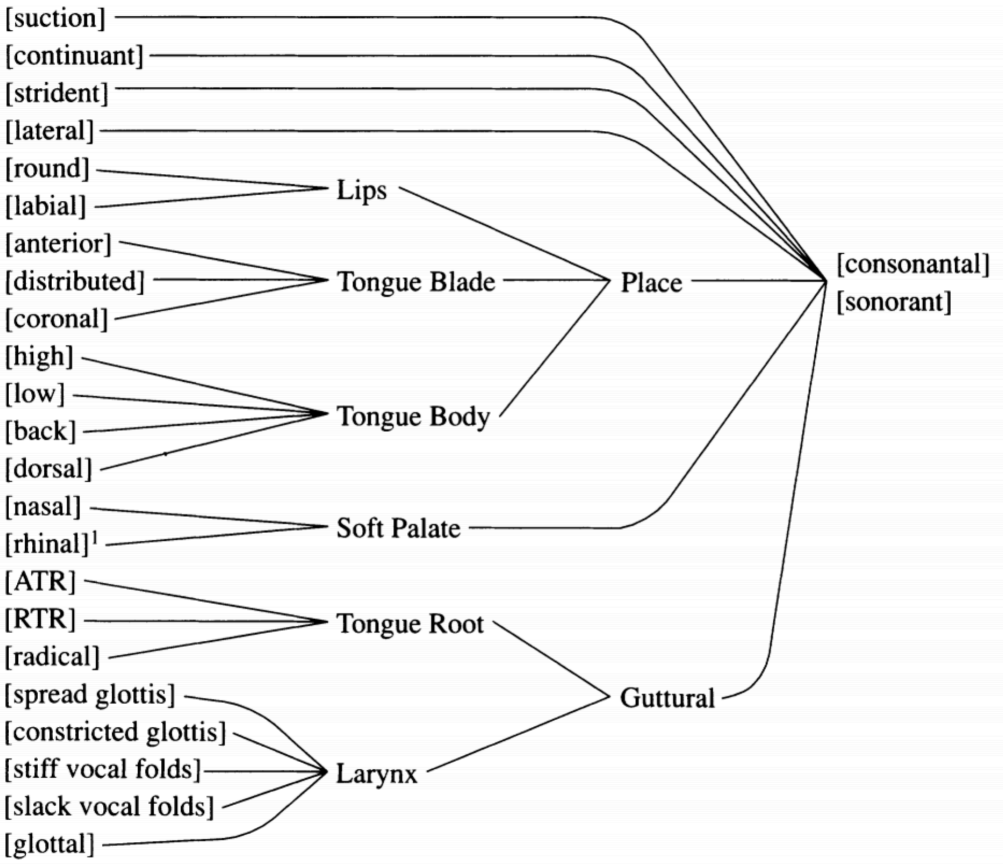

Figure 1.1: The RAT feature geometry (Halle et al. 2000).

Note that each active articulator is assigned its own place node, such that the blade, body, and root of the tongue are all associated with a different set of features. Other feature geometries propose different dimensions on which to split the hierarchical nodes, such as 'C-Place' versus 'V-Place' (Clements and Hume 1995) or primary '1Place' versus secondary '2Place' (Trigo 1991). We will return to feature geometries when discussing post-velar place in §1.4 below.

In the past two decades, the rise of Optimality Theory (OT) as a framework for understanding phonology has led to a decreased focus on underlying representations in the field. OT takes a radically restructured approach to phonological processes, proposing that ranked

constraints in a filter rather than ordered rules in a derivation determine patterns of phonological behavior in language (Prince and Smolensky 2004[1993]). This has a great advantage for Universal Grammar in that the set of constraints can be claimed to approach universality, whereas descriptive phonological rules trend towards language-specificity. The organization of the input of the OT constraint filter is, however, somewhat underdetermined. The principle of 'Richness of the Base' asserts that all possible outputs for the representation of the word must be considered when choosing the optimal candidate from the filter, and only the general acquisition-based mechanism of Lexicon Optimization operates to constrain the representational range of the input (Prince and Smolensky 2004[1993]:209).

Under this output-oriented view, features and structured underlying representations are of a dubious ontological status, since what matters most to the grammar is whether a given phonetic form satisfies the conditions of each constraint. Nevertheless, output candidates in OT analyses are almost always expressed in terms of segment strings and/or distinctive featural properties, suggesting the continued usefulness of featural classes and bundles in the theoretical analysis of language. As Sylak-Glassman puts it,

> Features allow phonological theory to encode fundamental facts about the perception of phonemes, i.e. categorical distinctions between speech sounds. Features also abstract over low-level phonetic variation while simultaneously incorporating essential aspects of phonetic substance that play a role in defining contrasts. In addition, the choice of features that represent phonemes significantly impacts the mechanical operation of rules and constraints, sometimes making phonetically simple structures formally complex. (2014:123)

In the pages that follow this defense of featural analysis, Sylak-Glassman uses mechanisms of entailment and ASSOCIATE constraints to formally derive the constructs of natural classes and feature bundles within an optimality theoretic framework. While the details of the proposal need

not concern us here, it is an excellent proof of concept that underlying representations do have a place in output-oriented theories of phonology, and that the shift towards constraint-based theories of phonological phenomena does not render questions of featural opposition obsolete.

1.2 Diachrony and Variation: Inconsistent Contrasts and Quasi-Phonemes

Phonemes or similar atomic units defined by contrastive opposition, then, remain a foundational element of modern linguistic theory. Indeed, it is difficult to theorize language as a symbolic semiotic system without them. So what are we to do when data from language itself challenges the applicability of phonemic analysis? This section outlines three well-documented cases of representational ambiguity in natural language: the near-merger of low back vowels in transitional varieties of American English, the near-split of low front vowels in other American English dialects, and the perceptually and structurally marginal process of word-initial geminiation in Romance dialects of southern Italy. We shall see that these phenomena require incorporation of diachronic and/or cognitive perspectives into their analysis in order to be interpreted as part of a synchronic grammar, except when the analyst chooses to make arbitrary judgments about their categorization based on equivocal data.

1.2.1. Near-Mergers: The Case of the Low Back Merger

The merger of /ɑ/ and /ɔ/ is well documented in many American English varieties, and it is characteristic of eastern New England, the western U.S., and Canada. In the United States, the merger appears to have spread to the West from the dialect region known as the ‘Midland,’ which stretches west in a narrow band from western Pennsylvania to the Mississippi river

(Labov, Ash, and Boberg 2008). However, in parts of this region, as well as in communities at the periphery of the New England dialect area, many speakers are found to exhibit linguistic behavior which is transitional between a merged and unmerged phonological system, and is entirely consistent with neither (Herold 1990, Johnson 2007, Dinkin 2009). In the most typical pattern, dubbed the 'Bill Peters effect' by Labov after a characteristic individual (Labov et al. 1972), speakers will produce a measurable phonetic contrast between tokens of each vowel category but will not judge the vowels to be perceptibly different from each other (Labov et al. 1991, Johnson 2007).

Labov, Karen, and Miller (1991) consider this as a particular case of a more general phenomenon of 'near-merger,' which challenges theoretical notions of symmetry between production and perception (p. 36) and problematizes the systematicity of phonemic categorization (p. 45-47). Citing experimental evidence on the perception of variable Swedish vowel categories (Janson and Schulman 1983), they demonstrate that even the well-established psycholinguistic phenomenon of categorical perception (Liberman et al. 1957) does not hold up in cases of near-merger. While a conclusive theoretical analysis is not offered, the authors postulate that the characteristic near-merger is diachronically transitional and stylistically variable,[3] perhaps governed by variation between competing phonological systems. Their summary of the characteristics of near-mergers, reproduced below, bears a striking resemblance to the characteristics of the Moroccan /r/ problem investigated here. As discussed in Chapter 6, points (1-3) are demonstrably true of the rhotic emphasis contrast. Point (6) can be confirmed anecdotally, and points (4-5) must only be omitted here because perceptual tests were not part of the present study.

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[3]More recent work such as Johnson (2007), Dinkin (2009), and Yang (2009) confirms that the near-merger of /ɑ/ and /ɔ/ may be accurately characterized as a change in progress with stylistic differentiation.

1. The opposing phonemes are differentiated by a smaller phonetic distance than the normal phonetic difference.
2. This difference is most often an F2 difference, instead of a combination of F1 and F2.
3. There is considerable individual variation within the community. Some individuals show a near-merger, others show a complete merger, and others a distinction.
4. Speakers who make a consistent difference in spontaneous speech often reduce this difference in more monitored styles.
5. Speakers judge the sounds to be the same in minimal pair tests and fail commutation tests.
6. Phoneticians from other areas are better able to hear the difference than the native speakers. (Labov, Karen, and Miller 1991:45)

1.2.2 Near-Splits: the Case of Mid-Atlantic /æ/

If 'near-mergers' are explicable as changes in progress exhibiting synchronic liminality, what about 'near-splits'? The diachronic process by which new phonemes typically emerge, what Hoenigswald (1960) calls 'secondary split,' necessarily involves a transitional stage during which segments are ambiguous between an allophonic and contrastive synchronic analysis. Under models akin to the Competing Grammars hypothesis for syntactic change (Kroch 1989), speakers acquiring the language during this stage will be forced to choose between one or the other representational framework, perhaps encoding both as discrete grammatical objects which can be selected for different utterances depending on context. This schizotypic grammatical situation is, however, inherently unstable, since properties of acquisition and population dynamics will tend to resolve the grammar towards structured consistency (Nettle 1999, Yang 2002, Hamann 2015, Ringe and Eska 2013).

How, then, do we explain the many cases in natural language in which historical phonemic splits have not gone to completion, but remain stably incomplete, with conflicting

evidence for complementarity and contrast? The structuralist solution was, as Labov, Karen, and Miller put it, to 'merge this situation with all other phonemic constrasts under the slogan, "Once a phoneme, always a phoneme"' (1991:34) on the basis of isolated minimal pairs.[4] From a generative perspective, however, this is unacceptably arbitrary, since it abstracts away from important generalizable patterns in the phonology of the language. Thus, 'the generative solution to this problem is the opposite one: to derive the contrasting forms from a single underlying form by a rule at the lexical level' (p. 34). The case of /æ/-tensing in urban Mid-Atlantic varieties of American English illustrates the complexities of this issue, and the inadequacy of a purely synchronic and oppositional phonology to deal with quasi-phonemic splits.

In many dialects of North American English, there is a split in pronunciation between lax and tense variants of the /æ/ vowel. This split is particularly prominent in urban dialects of the middle Atlantic coast, where it tends to depend on a complex mixture of phonetic and lexical conditioning. An early structural analysis of 'split short a' is given by Trager (1940), who after describing the complexities of the system in his own idiolect endorses a phonemic split on the structuralist principle that some (rather forced) minimal pairs can be found (p. 256). Much later, Labov, Steiner, and Yager (1972) undertook a detailed investigation of the phenomenon, which has since given rise to an extensive and ongoing sociolinguistic literature describing the dynamic interaction of variant /æ/ systems (Payne 1976; Kroch 1996; Boberg and Strassel 2000; Becker and Wong 2010; Durian 2012; Labov et al. 2016; Carmichael and Becker 2018).

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[4] This is precisely what Harris (1942) and Jakobson (1957) did with the Arabic marginal emphatics, as I discuss in Chapter 2.

The main opposition described in the 1972 report and in subsequent literature is between a supralocal system of strict allophony, in which /æ/ tenses to [æ̰ːᵊ] before front nasals but surfaces as [æ] everywhere else, and more complex locally specific systems which combine phonetic, morphological, and lexical conditions in determining the distribution of tense [æ̰ːᵊ]. The traditional Philadelphia dialect, described as follows in Labov et al. (2016), has one of the most complicated sets of conditioning factors:

1. Short-a is tense in syllables closed by front nasals, front voiceless fricatives, and three affective adjectives *mad*, *bad*, *glad*, but lax in the irregular verbs *ran*, *swam*, *began*, in function words *can*, *am*, and, *an*, and elsewhere. The syllable is closed by inflectional boundaries so that the vowel is tense in *pan* and *panning* but not in *panel*.
2. Short-a is lax in polysyllabic words with zero onset before voiceless fricatives (tense *ask* but lax *aspirin*, *asterisk*, *athletic*) but variable with other coda clusters (*master*, *plaster*).
3. Short-a is lax in learned words (*alas*, *wrath*) and onomatopoetic words (*wham*, *bam*). (Labov et al. 2016: 275).

That a system with this level of arbitrary nuance is gradually giving way to a simpler system of allophonic variation (Labov et al. 2016, Becker and Wong 2018) is perhaps not surprising. What *is* surprising is that such a representationally ambiguous system has survived as the stable grammatical norm for a speech community, and that it can be found reproduced with only slight variations in urban dialects as far-flung as New York (Labov 1966), Cincinatti (Boberg and Strassel 2000), New Orleans (Carmichael and Becker 2018), and Columbus (Durian 2012). Opinions are split as to whether the [æ]~[æ̰ːᵊ] distinction is phonemically contrastive; taking the path forged by Trager (1940), Labov et al. (2013) presents Philadelphia /æ̰ːᵊ/ as a separate phoneme, while others such as Kiparsky (1995) see it as arising from complexly rule-governed behavior.

It turns out that adding diachronic perspective to the analysis goes a long way towards resolving this conundrum. Kiparsky (1995), for example, judges that the mechanism of /æ/-tensing in the traditional urban dialects is the phonological[5] counterpart to morphological analogic change, which has been recognized since the time of the neogrammarians as a distinct process governing linguistic change (Hock 1991). Unlike regular *Lautgesetze*, analogy is difficult to interpret within Saussurian synchronic grammar, and would appear to operate through the gradual long-term accumulation of acquisition errors at the level of lexical and morphological representation. Discussing the problem of analogy in the morphological conditioning of phonological rules, Ringe and Eska (2013) comment that 'the fact that the morphological conditioning took place while the sound change was still in the variable stage seems significant [...] Apparently if a sound change that affects a range of different inflectional markers stabilizes, even temporarily, at the variable stage for a long enough period, native learners can reanalyse the variation differently for different inflectional markers' (p. 148).

Such observations about the interleaving of diachrony and synchrony[6] have led to the development of approaches which prioritize the historical perspective in phonological explanation over synchronic formalisms. This idea is pursued to its fullest by Evolutionary Phonology (Blevins 2006), while Kiparsky (2015) and Bermúdez-Otero (2007) concern themselves with contextualizing diachronic effects into generative phonology. Bermúdez-Otero, going beyond the core issue of phonologization – how regular phonetic effects become encoded in the grammar as systematic phonological processes – considers phonemicization through

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[5]Kiparksy is, of course, using the cyclic framework of lexical phonology to support his analysis, so /æ/-tensing is specifically posited to occur at the *lexical level* of the phonology.

[6] A different aspect of the problem is the ease with which diachronic sound change can be recapitulated in synchronic phonological description, as illustrated by the infamous 'nightingale' example in Chomsky and Halle (1968).

secondary split and the subsequent decoupling of distributional patterns from phonological control through morphological or lexical analogy to be separate stages in the 'life cycle of sound patterns' (pp. 503-4). He describes segments at the boundary between phonologization and phonemicization as 'quasi-phonemes,'[7] which combine predictable phonological patterns with a degree of abstraction or arbitrariness. Though he treats [æ]~[æːˀ] as a more fully developed phonemic distinction undergoing phonologically-influenced lexical diffusion (pp. 508-12), using Sanskrit palatalization instead as his prime example of quasi-phonemic rule stabilization (506-8), this underdeveloped concept of the diachronically transitional and synchronically ambiguous quasi-phoneme is valuable for understanding near-splits, since it allows recognition of a special status for variable phonological distinctions which have, however temporarily, stabilized in the grammar.

1.2.3 Structurally Ambiguous Processes: The Case of *Radoppiamento Sintattico*

As indicated by the Ringe and Eska quote above, the issue of structural ambiguity is not limited to representational categories, but extends to suprasegmental phonological processes as well. Morphologically-conditioned rules are commonplace across the world's languages, including such clear-cut examples as voicing assimilation and dissimilatory epenthesis in the English plural suffix and total regressive assimilation to coronals in the Arabic definiteness prefix. In some cases, however, morphological conditioning of a process can be as complex and variable as the constraints on Mid-Atlantic /æ/-tensing, and these cases may exhibit the same kind of perceptual ambiguity discussed by Labov et al. (1991) in the context of near-mergers. Here we

[7] This term is attributed by Bermúdez-Otero to Janda (1999).

briefly consider one such example, the process of word-initial geminiation or *radoppiamento sintattico* as it occurs in the local vernaculars of southern Italy.

Unlike most Romance varieties, the contrastive consonantal gemination of Latin was preserved in central and southern Italian, and has been supplemented by a phrase-level prosodic process of gemination across word boundaries known as *radoppiamento sintattico* (Nagy 1996) or *radoppiamento fonosintattico* (Loporcaro 1997). As described by Loporcaro (1997) for Standard Italian, which is based on a Tuscan dialect, *radoppiamento sintattico* doubles the initial conosnant of any word following (a) any word with a final stressed vowel or (b) certain specific unstressed monosyllabic or penultimate-stressed polysyllabic words with final vowels (p. 42). (a) is a simple phonological condition involving syllable weight, and (b) would provide an elegant puzzle for theorists of foot structure to solve were it not for the fact that it is lexically arbitrary. Instead, generative linguists have posited a feature [±RF] specifying word-initial gemination at the lexical level (Loporcaro 1997:42), and attributed its patterning to a 'Well-Formedness Constraint.' Like the structuralist take on near-split, this solution cuts the Gordian knot of formal description without addressing the predictable patterns underlying the phenomenon.

Radoppiamento sintattico appears with many variations across central and southern Italian dialects, just as /æ/-tensing appears with many variations across American English. A number of southern dialects lack the regular stress-conditioning of gemination altogether, and vary primarily in which words or kinds of words trigger the process (Loporcaro 1997:44-48). Naomi Nagy (1996) studied the behavior of geminates which were borrowed from adjacent Italian dialects into Faetar, a Francoprovençal isolate spoken in Apulia. She found that while word-medial gemination contrasts were robustly supported by both acoustic and perceptual data (pp. 185-191), reported word-initial gemination contrasts, including those conditioned by a

preceding word, were supported by neither (pp. 217-233). She concluded that 'word-initial geminates are in a state of flux: they are in the process of becoming phonemic, but are not yet.' (226). In other words, they are quasi-phonemes.

1.3 Self-Organization and Emergence in Phonological Systems

1.3.1 The Problem of Oppositionality in Dynamic Structures

Consider for a moment that Saussure's notion of oppositional contrast, in the decades after his *Cours de Linguistique Générale* was published, was taken up enthusiastically not only by linguists but also more generally within anthropology. It reached its culmination in that field with the structural anthropological theory of Claude Lévi-Strauss (1958), which sought to define the whole domain of human culture in terms of oppositional systems. This strict structuralism did not, however, remain predominant for long, as the more fluid, recursive, and gradient aspects of culture and society became difficult to reconcile with a structuralist framework. Ultimately, while remaining grounded in ethnography, the majority of anthropologists moved towards qualitative theoretical approaches informed by 'post-modern' philosophers such as Foucault, who gave priority to processes of social construction and reappropriation of meaning (Kurzweil 1998).

Linguistic science has not drifted in the same direction, and with good reason – it is impracticable to conduct quantitative empirical research within a theoretical framework that actively defies quantification. Binary oppositions, however, are at their core neither quantitative nor empirical, and the modern anthropological critique of social and cultural categories can point us towards an explanation for why the minimal contrast model of phonological

categorization sometimes fails. Modern pyscholinguistic and cognitive approaches can then offer a solution by way of quantitative and computational models for mechanisms of non-oppositionality, which are certain to have applicability to phonological theory if language is taken to be a system integrated into our more general cognitive apparatus.

Take the social category of gender as an example. The performative theory of gender, which has gained wide acceptance in the humanities since its first exposition in Butler (1990), asserts that an individual's gender is constituted by their iterative reproduction of behaviors that are associated by their community with the gender category of which they are a member. The characteristics associated with each gender are influenced by immutable biological characteristics of each individual which are correlated with sex,[8] but not determined by them, and the performative target of a gender category is inherently unstable since it is being continually constructed and re-evaluated through gendered interactions between members of the community.

From an strict empiricist perspective, phonological categories are similarly constituted. Sounds heard and produced by members of a speech community during the period of acquisition are mapped onto artificially constructed categories (distinctive features or phonemes) based on contrasts in meaning between the words in which they appear. The structure and content of these categories is dependent on, but not entirely determined by, biological characteristics of the human vocal tract and auditory perception system. Since language changes and new indexical meanings continually emerge, we also know that speakers dynamically update their linguistic categories based on the individualized context of their interactions, and as with gender, indeterminate spaces may form around the edges of a generally categorical system.

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[8] This concept, relating to physiological characteristics, is distinguished from the sociocultural construct of gender following de Beauvoir (1949).

The main objection to this viewpoint from generative linguistics has been that unlike other sociocultural systems, the mental structure of language becomes fixed at the end of the critical period for acquisition, so it is reasonable to assume that as Saussure proposed, phonological categories are both 'clearly delimited' and 'perfectly determined' for each adult member of a speech community. Chomsky's distinction between 'I-Language' and 'E-Language' (1986) is fundamentally an extension of this argument, claiming that variable characteristics of language such as pragmatics, speech processing, and social indexicality are essentially epiphenomenal in nature and need not be taken into account in representational theory, since each speaker has a perfectly determined 'I-Language' underlying their linguistic behavior. Studies of language change in progress have, however, found extensive evidence for age grading among adult speakers (Wagner 2012). Even though these individual changes are not as robust or substantial as intergenerational change, they prove that adult speakers of a language engage with their environment and continue to update the content (if not the structure) of their linguistic system after the end of the critical period. And if even adult grammars are performatively dynamic, how much more so must be the grammars of children acquiring language.

1.3.2 Probabilistic Learning Models of Language

While it is easy to caricature classical generative theory as incompatible with social and psychological facts, modern theories informed by cognitive science do in fact take variable environmental influence into account. The exemplar-based models of representation typified by Pierrehumbert (2001a) or Bybee (2002) accomplish this by proposing that phonological categories and perhaps even individual words are stored as a moving target generalized from all instances of that category or word which a language user has experienced, known as an

'exemplar cloud.' This model even explicitly relates itself to sociolinguistic variation in studies such as Bybee and Torres (2008) and Stanford and Kenny (2013). However, in its extreme reliance on Bayesian updating and lexical frequency effects, a pure exemplar theory fails to account for diachronic stability and the many structure-based aspects of language dynamics, and it cannot replace structural theory as a model of the grammar (Abramowicz 2007, Dinkin 2008, Tamminga 2014, Bermúdez-Otero et al. 2015).

More promising are approcahes which frame claims about representational malleability within the context of a generative structural framework. Mielke's (2005) emergent feature proposal, for example, restricts itself to the claim that phonological classes emerge from pattern-based generalizations specific to the linguistic input and only incidentally relate to universal categories. For Arabic, this particular proposal provides some basis for acknowledging the multiplicitous intersecting categories of post-velarity set forth by medieval grammarians[9] yet left untouched by modern phonologists with an eye towards parsimony, but does little to address the larger issue of categorial ambiguity.

In a survey of recent literature on self-organization and emergence in linguistic structure, Wedel (2011) identifies probabilistic learning based on error feedback as a common underpinning of these approaches. This is, of course, in contrast to the earlier generative stance that universal features are naturally 'hardwired' into linguistic structure, and is what makes even a relatively modest proposal such as Mielke's innovative from a theoretical perspective. In addition to the property of emergence, Wedel notes that 'self-organized systems frequently exhibit phase transitions between semi-stable states defined by *attractors,*'[10] where an attractor is defined as 'a system state (or set of states) that nearby states tend to evolve toward' (p. 4).

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[9] See Al-Nassir (1993) and the discussion in §2.4.

[10] Emphasis in original.

The modern optimality theoretic assumptions discussed at the end of §1.1.2, which see base representations as derived from a 'Lexicon Optimization' process of feedback loops during acquisition, are consistent with the idea that such representations exist within a self-organized system in which categories emerge by coalescing around probabilistic attractors. In fact, recent probabilistic approaches to OT assert just this, by proposing that each constraint ranking is associated with a probability distribution by the language learner (Boersma 1997), and a structure-based version of exemplar phonology incorporating stochasticity is proposed by Pierrehumbert (2001b). A growing literature on the agent-based modeling of language, discussed in §6.3 below, adds a population-dynamic motivation to the case for probabilistic grammar. As Boersma (1997) sums up the argument:

> Variation is controlled by the grammar, though indirectly: it follows automatically from the robustness requirement of learning … In the perception grammar, even the slightest degree of randomness in constraint evaluation will automatically cause the learner to become a probability-matching listener, whose categorization distributions match the production distributions of the language environment. (p. 43)

In Chapter 6, I will sketch out an argument in favor of seeing the quasi-phonemic contrast in Moroccan rhotic emphasis as evidence for a stochastic grammar with an unstable system of attractors. Certainly, these systems of phonological organization, while computationally difficult due to their multidimensional system dynamics (Wedel 2011), account better for ambiguous structural behavior than classical representational models do – and have the added benefit of preserving the theoretical primitive of categorical contrast.

1.4 Phonological Place in the Lower Vocal Tract

A separate set of representational issues relevant to this dissertation is the question of how place of articulation is organized in the grammar for sounds produced in the lower vocal tract. Although pharyngeal and uvular articulations have been historically underrepresented in the literature due to their typological rarity, there is an important thread of literature accounting for their featural representation. The most comprehensive recent survey and analysis of lower vocal tract phonology is provided by Sylak-Glassman (2014), and issues of featural organization in Arabic are discussed in detail by Bin-Muqbil (2006) and Youssef (2013).

The guttural feature geometry of McCarthy (1994) is one of the most influential modern analyses of pharyngeal place. On the basis of primarily Semitic data, McCarthy argues for the existence of a natural class of 'gutturals' comprising uvular and pharyngeal consonants, which are characterized by the place feature [pharyngeal]. Since uvulars share some properties with velars, they are specified by a double place specification of [dorsal] and [pharyngeal]. Emphatics, as might be expected, are specified as both [coronal] and [pharyngeal], but also have a third place specification as [dorsal], since according to Ghazeli's (1977) X-ray tracings they appear to be more uvularized than pharyngealized. All of these features attach directly to the place node, with no hierarchy of primary versus secondary place. Bessell (1992) uses primarily data from Salishan languages to derive a similar system, but with [tongue root] in place of [pharyngeal] and no [dorsal] specification for emphatics.

While the systems of McCarthy and Bessell account for the existence of the natural class of gutturals and successfully model processes such as Arabic emphasis spread as feature spreading of the radical/pharyngeal feature, they are not quite descriptively adequate. Two major problems relevant to Arabic are the association of pharyngeals and emphatics with the same place feature, and the specification of uvulars as doubly articulated 'dorso-pharyngeals.' A

more general typological problem addressed by Sylak-Glassman (2014) is the inability of these systems to account for pharyngealized uvulars or uvularized pharyngeals, both of which are attested in Salishan and Caucasian languages.

As discussed in the next chapter, secondary post-velar (typically thought to be pharyngeal) and primary pharyngeal place have markedly different phonetic and phonological effects in Arabic. Primary pharyngeals, for instance, characteristically raise the first formant of an adjacent vowel, whereas secondary pharyngeal place raises the second formant. While first-formant effects are sporadically claimed for secondary pharyngeals, the backing effect is never observed for primary pharyngeals (Bin-Muqbil 2006). This acoustic observation is backed up by a body of recent instrumental work, such as Moisik (2013) and Esling (1996), which demonstrates that primary pharyngeals /ħ ʕ/ are primarily articulated by structures in the lower pharynx such as the epiglottis and arytenoid cartilages rather than the tongue root, while secondary pharyngeals are articulated in the upper pharynx by the tongue root and the pharyngeal wall. McCarthy's assignation of both [dorsal] and [pharyngeal] to emphatics, while capturing the notion that secondary pharyngealization is higher up, fails to account for this fundamental difference in the articulatory gesture from primary pharyngeals.

Youssef (2013) resolves this problem by doing away with place specification for primary pharyngeals altogether and by assigning a [dorsal] V-place feature to emphatics, to match the [dorsal] C-place feature on the velar realizations of /χ ʁ/ as well as on /q/ and /k/ (the difference between /q/ and /k/ is theorized as manner underspecification for /q/). This solution solves the upper/lower pharyngeal problem at the expense of doing away with gutturals as a featural class, and raises the additional issue of subsuming /k/ in the class of back-articulated consonants containing both uvulars and emphatics (discussed in §2.4 below).

McCarthy also treats the uvulars as doubly specified for place, although at least the fricatives /χ/ and /ʁ/ sometimes pattern phonetically with pharyngeals. An additional problem with the treatment of uvulars is that there is no evidence that they have a phonetically complex articulation in the sense of [k͡p]. McCarthy does recognize that there are articulatory differences between primary and secondary pharyngealization, but he argues that these are phonologically irrelevant due to the lack of sensorimotor precision in the pharyngeal region (1994:201), a claim which is no longer admissible in light of recent phonetic work. To account for the phonological differences, he suggests that /χ ʁ ħ ʕ/ may all actually be approximants (p. 222)[11] but does not account for the ambiguous behavior of /q/. Davis (1995) uses evidence from Palestinian Arabic to argue that both primary uvular and secondary post-velar place can be handled by the [RTR] feature associated with the active articulator, with [RTR] associated with a secondary place node in 'pharyngealized' consonants and with a primary place node in uvulars. Primary pharyngeals, however, have a different feature, [constricted pharynx].

The idea of a feature for lower pharyngeals (the primary pharyngeals in both Semitic and many other languages) was first introduced by Czaykowska-Higgins (1987), as a formalism for the phonetically motivated separation of place features in the upper and lower pharynx. In the original conception, these are binary features dominated by a 'tongue root' node, but in the more recent proposal of Sylak-Glassman (2014), based on Esling (2005), the asymmetry in active articulator is taken into account, and a feature system is proposed based on lingual and epiglottal gestures. Uvular and upper pharyngeal constriction is characterized by the feature [±retracted], and lower pharyngeal or epiglottal constriction is characterized by the feature [±constricted epiglottis] ([±ce]). The [+retracted] feature (similar to [RTR], but without restrictive reference to the tongue root) also characterizes low and low-mid back vowels /ɑ ɔ/

[11] This is probably true, at least in Moroccan Arabic; see Yeou and Maeda (2011).

which involve retraction of the tongue body by the hyoglossus muscle, whereas upper back vowels involving 'movement of the tongue by the styloglossus upward and backward' share a feature [+raised] with dorsal consonants (Sylak-Glassman 2014:137). A final distinctive feature is [±open], which correlates with jaw lowering and characterizes both pharyngeal and epiglottal consonants and low and low-mid vowels. Low front vowels are [+open] and [-retracted].

Under the analysis that emphatics are [+retracted] but not distinctively [+ce], pharyngeals are characterized by [+ce] and [+open] but not [+retracted], and uvulars are [+raised] and [+retracted], the vowel effects fall out naturally from feature spreading to vowels in this system. Pharyngeals should cause vowel lowering but not backing, emphatics should cause vowel backing, and only some lowering, and uvulars should cause only backing. A possible criticism is that this system does not account for the patterning of /χ ʁ/ with pharyngeals, but this asymmetry between uvular fricatives and stops is not accounted for by the McCarthy-Bessell system either.

Ultimately, while the structural conventions of post-velar feature geometry are not at stake in this dissertation, the question of whether velar, uvular, upper pharyngeal, and lower pharyngeal articulations are mutually distinguishable at the level of primary and/or secondary place *is*. In Chapter 4, I argue that from an acoustic perspective that abstracts away from the primary/secondary distinction, they are all distinguishable, but that the uvular/upper pharyngeal constrast is more subtle than the distinction between either of those and velar or lower pharyngeal place. In Chapter 6, I argue that the confusability between uvular and upper pharyngeal place has a phonological dimenstion, but that they are still distinguishable at the segmental level, whether this be by featural bifurcation or by a representational distinction between primary (uvular) and secondary (upper pharyngealization) tongue root retraction towards the juncture of the oral and pharyngeal cavities.

1.5 Summary

This chapter has outlined some of the general theoretical issues pertaining to the phenomena of marginal emphatic phonemes and post-velar place contrasts in Arabic. The core problem is that of the nature of phonological representations, which remains subject to scholarly disagreement after over a century of study despite general consensus that categories are constituted by contrast (§1.1). I adopt the view that phonetically grounded feature inventories are the fundamentals of phonological representation, and that distinctions based on place of articulation form an important subclass of these features. In §1.2, I move on to present examples of cases which lack categorial contrast corresponding to well-ordered phonological structure, and can be described as 'quasi-phonemic' or 'quasi-phonological.' These cases, I argue, are best accounted for by probabilistic models of structural emergence within language (§1.3). Finally, I survey theories of the organization of post-velar place (§1.4), concluding that, at least with respect to Arabic, systems which split upper pharyngeal from lower pharyngeal place and contrast uvularity with velarity are preferable to those which posit double specification of uvulars and conflate all kinds of pharyngeal articulation into a single feature. The following chapter will apply these concepts to the particular context of Moroccan Arabic emphatics and gutturals, providing historical and descriptive background along the way.

Chapter 2. The Post-Velar Phonology of Moroccan Arabic

This chapter provides historical and descriptive background on the role of post-velar speech sounds in Arabic, and delineates the phonological problem of uvulars and 'marginal emphatics' within the context of Colloquial Moroccan Arabic. I begin with historical background on post-velarization in Arabic (§2.1), followed by a summary of research on secondary post-velarization or 'emphasis' in the language (§2.2). I then discuss the phenomenon of 'marginal emphasis,' and the behavior of Arabic /r/ with respect to post-velarity (§2.3), and provide historical (§2.4) and phonological (§2.5) background on Moroccan Arabic. In conclusion, I summarize the relation of these phenomena to theoretical issues under investigation and describe the method of analysis to be pursued in the empirical part of the study (§2.6), which is presented in the following three chapters.

2.1 Arabic Gutturals and Emphatics in Historical Perspective

Arabic, a term which includes both Standard/Classical Arabic and a number of mutually unintelligible colloquial dialects, is a member of the Semitic branch of the larger Afro-Asiatic language family. These languages are characterized by the presence of a wide variety of guttural consonants, including the typologically unusual pharyngeals. The proto-Afro-Asiatic consonant inventory, outlined in Table 2.1, is generally agreed to have contained both a voiced and a voiceless pharyngeal fricative.

*m	*n								
*p	*t	*c /ts/	*č /tʃ/	*ĉ /tɬ/		*k	*q		*ʾ /ʔ/
*b	*d	*ʒ /dz/	*ǯ /dʒ/			*g			
	*ṭ /t’/	*ċ /ts’/	*č̣ /tʃ’/	*ĉ̣ /tɬ’/		*ḳ /k’/	*q̇ /q’/		
*f	*s			*ŝ /ɬ/		*ḫ/x∼χ/		*ḥ /ħ/	*h
						*ġ̇ /ɣ∼ʁ/		*ʿ/ʕ/	
	*r			*l	*y /j/		*w		

Table 2.1: The proto-Afro-Asiatic consonant system, adapted from Orel and Stolbova (1994) by Bacovcin and Wilson (2018).

In addition to primary pharyngeal consonants, Arabic and many other Semitic languages exhibit contrastive secondary pharyngealization, a feature which minimally distinguishes two classes of coronal obstruent phonemes, the pharyngealized ‘emphatics’ and the non-pharyngealized ‘plain’ consonants. The emphatic consonants correspond to the proto-Afro-Asiatic ejectives, with the exception of /k’/, which developed into a uvular stop in Arabic and most other languages of the Semitic subgroup, and /q’/, which merged together with /q/ and /x/ as a uvular fricative /χ/ before the proto-Semitic stage (Lipiński 2001, Wilson 2015).[12] Table 2.2 presents the resulting post-Classical[13] Standard Arabic consonant inventory, with pharyngealized coronal obstruents (‘emphatics’), uvular voiceless stop, and uvular voiced and voiceless fricatives in opposition to their pharyngeal counterparts, these last still preserved intact from proto-Afro-Asiatic.

[12] This is not typologically uncommon; in Georgian, for instance, the only uvular consonant is an ejective stop /q’/ which is observed to frequently shift in pronunciation to [χ].

[13] Classical Arabic had several minor differences from the modern *luɣat al-fuṣḥāʔ* in its inventory which are not pertinent to this discussion. Most notably, the modern /dˤ/ still inherited laterality from proto-Semitic, and was either /ɮˤ/ or /dɮˤ/ (Owens 2006).

/b/			/t/	/d/		/dʒ/	/k/		/q/				/ʔ/	
			/tˤ/	/dˤ/										
/f/	/θ/	/ð/	/s/	/z/	/ʃ/				/χ/	/ʁ/		/ħ/	/ʕ/	/h/
		/ðˤ/	/sˤ/											
/m/			/n/											
			/l/	/r/										
					/j/		/w/							

Table 2.2: The consonant inventory of Modern Standard Arabic.

There is considerable disagreement among scholars as to whether the emphatic consonants were glottalized or pharyngealized in proto-Semitic itself (Diakonoff 1965; Bomhard 1988; Lipiński 2001; Watson 2007). In favor of glottalization, it has been argued that the proto-Semitic emphatic inventory is restricted to voiceless obstruents and is subject to dissimilatory, rather than assimilatory, processes, while early vowel-coloring effects suggesting tongue-root retraction, the tendency of emphatic consonants to develop into dorsals or pharyngeals, and the existence of some assimilatory behavior against the claim of dissimilatoriality are cited as evidence for pharyngealization in the proto-language.

Regardless of when the shift happened, it is clear that at some point between proto-Afro-Asiatic and the earliest Arabic, glottalization was lost and replaced with a pharyngeal secondary articulation. As we shall see in the next section, however, the phonetics of emphasis in Arabic are not and probably never were quite as simple as it might appear from a cursory discussion. Glottalization does appear sporadically in descriptions of modern dialects, and there is little consensus about where the so-called ‘pharyngeal’ secondary articulation is actually articulated in the vocal tract.

2.2 Emphasis and Pharyngealization across Arabic

Moving on to contemporary Arabic varieties, there is a substantial body of research on the phonetic and phonological behavior of gutturals and emphatics. Some of this, such as John McCarthy's work motivating gutturals as a natural class, has already been discussed in Chapter 1 with reference to the theory of post-velar place. This section will focus on two particular aspects of post-velarity in Arabic, place of articulation and acoustic correlates of emphatic coarticulatiory spreaad, which exhibit considerable variability and have been the source of some scholarly disagreement. In the process, we will describe the general synchronic parameters of the Arabic post-velar sound system that are relevant to understanding uvularization and marginal emphasis as phonological problems.

2.2.1 The Articulatory Correlates of Emphasis

The complexity of Semitic pharyngealization drew some early attention from structural linguists such as Zellig Harris (1942), and Roman Jakobson even tackled the issue of Arabic emphatics in a 1957 article entitled 'Mufaxxama' after Sibwayh's term for the consonant class. Jakobson's discussion generally endorsed the notion of pharyngealization, with the caveat that 'whatever orifice is contracted, there appears a concomitant velarization' (quot. in Bakalla 2009:425). Modern phonetic work on the subject, however, begins with al-Ani's 1970 study of Iraqi speakers, which combined acoustic analysis with X-ray tracings of consonant articulations. Al-Ani found the emphatic consonants in Iraqi to involve clear pharyngeal retraction of the tongue root, and so the pharyngealization description was carried forward into future research.

Another foundational contribution to the literature was Salem Ghazeli's 1977 Ph.D. dissertation, which provided cinefluorographic imagery of 'back' and 'back-coarticulated' consonants among speakers of a variety of Arabic dialects. While Ghazeli concurs with al-Ani in labelling the emphatics 'pharyngealized,' his description indicates that unlike the pharyngeal fricatives which are articulated in the lower, epilaryngeal region of the pharynx, the pharyngealized coronals involve a secondary constriction of the back of the tongue towards the *upper* pharynx, close to to the uvula, at the 'level of the second cervical vertebra' (p. 72). This has led more recent researchers such as al-Masri and Jongman (2004:98) to see Ghazeli's study as supporting a categorical distinction between the upper pharyngealization or uvularization associated with emphasis and the lower pharyngeal or epiglottal articulation associated with the Arabic primary pharyngeal consonants.

In the decades that have passed since al-Ani and Ghazeli's work, a number of studies have challenged the earlier consensus that Arabic emphatic consonants are pharyngealized. Zawaydeh and de Jong (2003), for instance, argue from acoustic evidence that emphasis consititutes uvularization in the Jordanian dialect of Amman, and that this effect is quite similar to the coarticulatory effect of primary uvulars despite some systematic differences. The uvularization hypothesis is taken up for the same dialect by Jongman et al. (2011), who conclude that the acoustical properties of emphatics are most 'consistent with a narrowing near the uvula' (85). For Palestinian Arabic, on the other hand, researchers such as Herzallah (1990) have instead endorsed velarization as the articulatory correlate of emphasis, hearkening back to Jaokbson's earlier comments and the work of Obrecht (1968). Individual emphatic phonemes in particular dialects have been documented with even more exotic articulatory attributes, such as labialization for /d$^{\varsigma}$/ (Zeroual et al. 2011) and glottalization for /t$^{\varsigma}$/ (Schroepfer 2015).

No matter what articulatory label we choose for the description of emphasis, then, it is clear that the emphatic feature is more abstract and variable than any one label can entail. This justifies a terminological distinction between 'emphasis' – phonological (post-)velarization – and 'pharygnealization' – phonetic secondary articulation involving constriction towards the pharyngeal wall. I will continue to uphold this distinction in terms through the remainder of this dissertation, using 'emphasis' to refer to the phonological feature and notating emphatic segments in Arabist notation, with an underscore dot (e.g. /t̩/) rather than the articulatorily restrictive IPA pharyngealization diacritic (e.g. /tˤ/).

Another unambiguous conclusion of the phonetic literature is that the approach of Esling, Moisik, and Sylak-Glassman to pharyngeal place (see §1.4) is correct – upper and lower pharyngealization form completely separate classes in terms of place, and are only loosely connected with each other. Upper pharyngeals have much more structural and articulatory affinity with uvulars than with lower pharyngeals, and lower pharyngeals may be functionally indistinguishable from epiglottals. In terms of Arabic, the pharyngeal fricatives are lower pharyngeal/epiglottal in their phonetics and phonology, while the emphatic consonants, to the extent that they are pharyngeal at all, have *upper* pharyngealization.

2.2.2 Emphasis Spread and the Acoustic Correlates of Post-velarization

Although contrastive or primary emphasis is usually restricted to coronal obstruents in Arabic, the post-velarization associated with emphasis has a strong tendency to spread harmonically to adjacent segments, giving rise to back allophones of both vowels and other consonants. The specific constraints on emphasis spread vary among Arabic varieties. Sibilants, pharyngeals, and high vowels have all been observed to block emphasis spread (al-Masri and Jongman 2004),

while in other dialects spread of pharyngealization has been observed to be restricted to one syllable rightwards but may extend further to the left (Watson 2007), or to be generally restricted to adjacent vowels (Davis 1995). In Moroccan Arabic, studies have consistently indicated that emphasis spreads throughout the morphological word with only minimal blocking effects, except that it will not spread to certain affixed morphemes such as clitic pronouns and verbal inflections (Heath 1987).[14] This broad range of spread has led authors such as Dell and Elmedlaoui (2012) and Gouma (2013) to propose that Moroccan Arabic emphasis is a word-level suprasegmental feature, rather than a consonantal feature, an idea that was first floated by Harris in 1942. However, there is non-trivial evidence for the segmental localization of emphasis in Moroccan dialects, including productive stem-level emphasis dissimilation in some southern dialects and the lexical co-occurrence of plain and emphatic consonants even in northern- and central-type dialects without productive dissimilatory processes (see Heath 1987 for the details of this argument). Since the data presented here lend themselves to a consonant-centered analysis of post-velarization, we will continue to endorse the consensus view that words with emphatic consonants and vowels derive the feature from underlyingly emphatic consonant segments, while recognizing that defensible arguments for underlyingly autosegmental or vocalic emphasis can also be made.

Theoretical disputes aside, the existence of emphasis spread provides an invaluable tool for the phonetic analysis of Arabic post-velarization, since it ensures that the emphatic features

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[14] Heath (1987) does, in fact, claim a blocking effect of palatal segments /i/, /j/, /ʃ/, and /ʒ/. In my data I did not find that /i/ or /j/ blocked emphasis spread, but word-internal post-alveolar fricatives /ʃ/ /ʒ/ did seem to do so. For instance, *ṭajin* is pronounced [ṭɑʒin] and may not be pronounced as [ṭɑʒɨn] or [ṭɑʒen]. None of the wordlist data considered in Chapters 4 and 5, however, contains post-alveolars in a blocking environment.

of a post-velarized consonant will be reproduced on any adjacent vowels. The formant signatures arising from this coarticulatory aspect of emphasis spread are universally acknowledged to be the primary acoustic correlates of emphasis, and have been consistently described and corroborated by many researchers from Obrecht (1968) and al-Ani (1970) on (Ghazeli 1977, Alwan 1983, Norlin 1987, Yeou 1996, Shahin 2002, al-Masri and Jongman 2004, Bin-Muqbil 2006, Zawaydeh and de Jong 2011). Emphatic vowels are characterized by substantial lowering of the second formant and raising of the first formant, corresponding to the articulartory backing and lowering of the tongue involved in post-velarization (Alwan 1983). Figure 2.1, reproduced from al-Ani (1970:49), describes the acoustic regions of the vowel space involved in emphatic and non-emphatic articulations of the standard Arabic three-vowel system. Note that while the allophonic clusters are distinct, there is some overlap, with the most overlap for /u/ and the least for /i/, and that the F1 differences between the clusters are not as substantial for /a/ as for the high vowels.

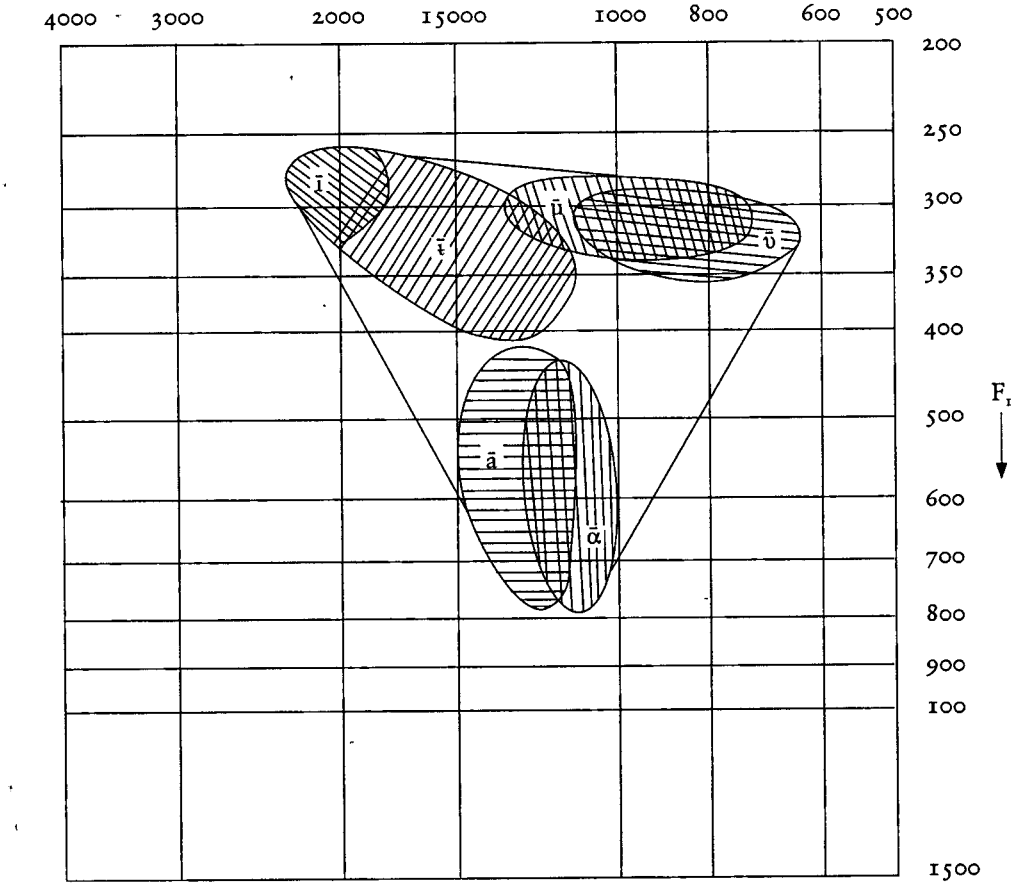

Figure 2.1: First and second formants of emphatic and non-emphatic vowel allophones in Arabic (reproduced from al-Ani 1970:49)

Phoneticians working on guttural consonants have found a similar, though not identical, pattern of formant modification associated with the uvular and pharyngeal consonants in Arabic. As predicted by acoustic models of the vocal tract (Alwan 1983, Stevens 2000), primary pharyngeals are associated with a raised first formant without concomitant lowering of the second formant (Ghazeli 1977, Alwan 1983, Zawaydeh 1999). Uvulars share this F1-raising feature with pharyngeals, but also cause lowering of the second formant similar to, but less

extreme than, that associated with emphatics (Ghazeli 1977:61). In the speech of a Tripolitanian Libyan speaker, for example, Ghazeli found that F2 of /a/ averaged 1450 Hz after a uvular but 1150 Hz after a pharyngealized coronal, while in both conditions F1 of /a/ was 600 Hz (as compared to 500 Hz in non-post-velarized environments). As the following chapters will show, Fessi/Central Moroccan may be added to the list of dialects that share this characteristic.

The phonetic affinity between uvulars and emphatics begs the question of whether these segments belong together as a phonological class. For the Ammani dialect, Zawaydeh (1999) certainly believes that they do, since she provides a description of 'uvularization spread from the emphatics and /q/' as if this were a single unitary phenomenon (p. 146 ff.). Other researchers who do not endorse the emphatic uvularization hypothesis so wholeheartedly have their doubts. Certainly, McCarthy (1994) admits that /q/ shares certain phonological characteristics with the emphatics, but ultimately opts to class it as a guttural; from the perspective of Moroccan Arabic, Heath (2002) speculates that the uvular consonants may exist in some kind of liminal space where 'a uvular counts as half a [+PH] value in its allophonic influence' (p. 306). We develop and qualify Heath's assessment in Chapter 6 below, suggesting that the intermediate behavior of uvulars should be taken as evidence of inherent featural indeterminacy, rather than determinate featural gradiency.

2.3 Marginal Phonemes and the Taxonomy of Emphasis

Because of the feature spreading associated with consonantal emphasis, Arabic has a larger number of emphatic segments at the phonetic level than it does at the level of underlying

phonological form.[15] We have already discussed the emphatic vowel allophones, which can be described for Moroccan Arabic roughly as [ɑ] for /a/, [ɨ] for /i/, and [o] for /u/ (Heath 1987). Consonants affected by emphasis spread are often referred to as 'secondary emphatics' (e.g. Watson 2007) and include a wide range of labial, coronal, and velar consonantal allophones whose membership may vary between dialects. In Moroccan Arabic, where emphasis spread is basically unrestrained, any oral consonant may have a secondary emphatic allophone (Harrell 1962, Heath 2002).

In addition to the secondary emphatics, there is a third category of consonants exhibiting emphatic-like characteristics in colloquial Arabic varieties. These consonants are neither derived from nor coarticulated with the four emphatic phonemes /ṭ ṣ ḍ ðˤ/ of Standard Arabic, and they only inconsistently exhibit post-velarization in specific lexical or phonological environments. We will follow Maamouri (1967) in calling them 'marginal emphatics,' as opposed to both the canonical coronal obstruent 'primary emphatics' and the 'secondary emphatics' arising from emphasis spread.

The marginal emphatic consonants include at least [ɾˤ] and [lˤ] in most Arabic varieties, and specific dialect descriptions sometimes include [bˤ] or [mˤ]. In Morocco, [bˤ] is mostly claimed as a marginal emphatic on the basis of [bˤa] 'my father' (Harrell 1962), though it is inconsistently claimed to occur in some other low-frequency words. Similarly, descriptive grammars such as Watson (2007) frequently grant the existence of a phonemic or quasi-phonemic /lˤ/ on the primary basis of the word [alˤaːh] 'God,' whose pronunciation with emphatic [lˤ] has been codified in the normative tradition following early descriptive accounts

[15] Without the assumption of some underlying phonological form, of course, this argument does not hold. In fact, the primacy of surface-generated phonological representations in recent theory may account for the increasing popularity of the suprasegmental approach to understanding emphasis.

by medieval grammarians (Card 1983). This account may be bolstered, depending on the dialect, by sporadic individual lexical items in which [l̩] cannot be attributed to emphasis spread, often including words such as [qaḷb] 'heart' which contain a uvular under the assumption that /q/ is not a source of emphasis spread. Heath, for example, writing on Moroccan Arabic (2002:157), cites *tħḷla* 'take care' in addition to *aḷḷah*, as well as a Marrakchi pronunciation *ltḷata* of the word for Tuesday and a number of words like *gaḷb* in which the /q/ has historically shifted to /g/.[16]

As this discussion of [l̩] shows, the case for the phonemic status of marginal emphatics is circumspect and based on limited evidence, as is any case that could be made for their allophonic character.[17] Accordingly, the majority approach has been to treat them as a side issue in the phonology of Arabic varieties, or to assert that they are 'marginal phonemes,' as Watson does (2007:21), if the problem of their status does arise. In this study, we will not entirely reject the concept of the marginal phoneme, but we will interrogate its basis and seek to clarify its meaning in both perceptual and structural terms. As discussed in the previous chapter, phonological ambiguity can take a number of distinct forms, from community-level differences in idiolect distributions that complicate acquisition to probabilistic or exemplar-based

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[16] The shift in pronunciation does not entail, however, that the /g/ < /q/ is not underlyingly emphatic/uvular. The issue of /g/ is not fully addressed here since it does not affect my results (I excluded /g/ tokens from the present analysis, partly because /g/ < /q/ is rare in northern Morocco), but the problem is an extension of the structural /k̩/~/q/ ambiguity discussed in §6.3.

[17] As an example of what this can look like, consider Harris' (1942) proposal that for the Moroccan (Casablancan) marginal emphatics, unlike other emphasis types, the *vowel* is underlyingly emphatic and conditions the emphaticization of the consonant. His analysis has not, to my knowledge, been taken up by contemporary researchers except in Youssef (2013), who proposes that the anomalous-emphatic-conditioning vowel in Baghdadi Arabic is a back /ɑ/ in accordance with his V-place [dorsal] analysis of emphasis.

uncertainty in the grammars of individual speakers. Where, if at all, does marginal emphasis fall along this spectrum?

Rather than attempting to answer this question for every marginal emphatic, or for every Arabic dialect, we will restrict our investigation to one 'quasi-phoneme' in particular: Moroccan [ɾˤ].

2.4 Rhotics in Arabic Phonology

The case of the marginal emphatic [ɾˤ] is particularly interesting because, unlike [bˤ] or [lˤ], the historical origins of its split with non-emphatic [r] are well-documented. The eighth-century Arab grammarian Sibawayh describes /r/ as participating in *tafxīm* (emphasis spread) when it is adjacent to /a/ or /u/, or when it is in the environment of a class of consonants combining emphatics and uvulars, which Sibawayh labels *mustaʕliya* 'raised' (al-Nassir 1993:49). Rhotic emphasis in the environment of emphatics is unremarkable and may be classed as secondary emphasis, the other two coniditioning environments describe a more complex allophonic system. If we take Zawaydeh's position that uvulars and emphatics share the basic phonological property of uvularization, then the conditioning of [ɾˤ] from uvulars – which, it should be noted, does *not* reliably occur in modern Arabic varieties – follows as an extension of secondary emphasis, while the conditioning of [ɾˤ] by back vowels seems to be a different phonological process particular to /r/.

In fact, this historical allophonic distinction, which could be formalized as

/r/ → [+RTR] % [+back]

in SPE notation, seems to underlie the synchronic marginal split between plain [r] and emphatic [ṛ]. Younes (1994), describing the patterning of [ṛ] in a Palestinian variety of Arabic, considers that the emphatic may be the underlying form, and that this /ṛ/ is regularly *de*-emphaticized in the neighborhood of high vowels (220).[18] Such a regular allophonic split does seem to be characteristic of at least Palestinian Arabic, since previous researchers such as Blanc (1953) found the same pattern, and in Baghdadi a similarly allophonic de-emphatization process with irregularity around the edges motivates Youssef's (2013) claim of phonemic emphatic /ɑ/ in that dialect. In other dialects, such as Cairene Egyptian, the situation is muddier, and while some scholars claim an inconsistently applied allophonic pattern of vowel conditioning (Harrell 1957, Watson 2002), others claim a complete phonemic split between /r/ and /ṛ/ (Broselow 1976, Youssef 2013).

In the literature on Moroccan Arabic, opinions on the nature of the [r]/[ṛ] distinction are divided. Caubet (2008), for example, presents the distinction as a straightforward phonemic contrast and does not even include /ṛ/ in her list of emphatic 'marginal phonemes,' while in an article immediately following in the same volume, Aguadé (2008) presents [ṛ] as merely an incidental variant of /r/, noting only that 'pharyngealization of plain consonants is a very common feature in Moroccan' (p. 290) by way of explanation. Harris (1942) splits the difference, grudgingly classing /r/ and /ṛ/ as separate phonemes even though 'they are largely

[18]This conclusion that the emphatic is underlying is informed by predictable structural similarities with the emphatics, including blocking of final /a/ raising (*ʔimāla*) and the association with /u/ as the theme vowel of the present stem in verbs. Researchers who find the fact that Semitic alveolar rhotics are often classed with gutturals and emphatics to be 'inexplicable' (Hedánek 2018:5) would do well to read Younes' work.

complementary' (p. 313) on the basis of a single minimal pair. The most thoroughly-considered treatment of the phenomenon is by Heath (2002), who ultimately reserves judgment on the phonological status of the distinction after describing a complex system of partial contrast and complementarity.

Heath describes a situation which is fundamentally transitional between allophony and phonemic contrast, and in which the degree of complmentarity between [r] and [ṛ] varies between regional varieties. In his 2002 dialectological study, following Colin (1986), he divides Moroccan dialects into three main types, northern (pre-Hilalian), central (koiné), and Saharan. In the central koiné, phonemicization of [ṛ] is quite advanced: 'either plain *r* or pharyngealized *ṛ* generalizes to most or all ablaut forms of a given stem' (p. 9). The northern sedentary dialects also exhibit a high degree of levelling, but in the southern, Saharan dialects 'a respectable number of *r* ~ *ṛ* alternations are preserved in ablaut derivation, even when the original vocalic basis for the allophony has become opaque' (p. 7). Even in the phonemicizing dialects, however, a small number of ablaut-conditioned rhotic emphasis alternations are preserved, such as *ħmaṛ* 'donkey' versus *ħmir* 'donkeys' and *kbir* 'big' with plural *kbaṛ*.

As these examples show, the vowel-conditioning rule by which plain [r] only occurs near a front vowel underlies the productive alternations that exist in Moroccan Arabic. An adjacent schwa may condition [r] if it is historically derived from short /i/, as in the Saharan example *šārəb* < *šārib* 'drinking' (Heath 2002:7). Echoing the *mustaʕliya* effect of Sibawayh, Heath notes a tendency for neighboring uvulars /q ʁ χ/ to favor [ṛ], 'but this factor is not always decisive' (p. 151). He cites *ṛqba* 'nape' and *qḍəṛ* 'be able to' as cases in which /q/ favors [ṛ], but a plain variant *qdər* is claimed to be dominant in the eastern part of Morocco. For stems with /χ/ favoring [ṛ], he cites *mnxəṛ* 'nostril' and *lxxəṛ* 'last,' both typical of northern Morocco with plain variants around Marrakech and in rural areas farther north (p. 153). The only example

with /ʁ/ is *ɣaṛ* 'cave,'[19] which often exhibits generalization of [ṛ] to the plural *ɣiṛan* despite the presence of a high vowel.

From the vantage point of this description, it is easy to appreciate the position of many researchers that /ṛ/ and /r/ are almost, but not quite, separate phonemes. Within the same variety, it is easy to find both allophonic alternations and overlapping distributions, creating a structural tension that has yet to be resolved. Determining the nature of this structural tension, and how it relates to the different axis of structural tension involving the relation of uvular place to the classes of emphatics and gutturals, is the basic goal of this dissertation. By isolating a particular community of Moroccan Arabic speakers and describing the phonetic and morphophonological details of their speech with respect to emphatics, uvulars, and rhotics, we can begin to evaluate these phenomena in Arabic with respect to specific theoretical proposals. The next section provides sociohistorical and descriptive background for the colloquial Arabic spoken in north-central Morocco, in order to contextualize and set the parameters of the linguistic community whose speech is described in the following chapters.

2.5 The Sociohistorical Context of Moroccan Arabic

The first Arabic speakers appeared in the northwestern corner of the African continent during the Arab conquests of the 7th century C.E.[20] At that time, North Africa was mostly populated by

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[19] Note that in non-phonetic Arabic transcriptions, I adopt the convention of using the letter *ɣ* for the Arabic letter غ, since this is easier to read and closer to most commonly-used transliteration systems than the appropriate IPA symbol ʁ. This should not be taken to imply that the consonant is velar in any way.

[20] Much of the historical information contained in this section is drawn from Jamal Abun-Nasir's *A History of the Maghrib in the Islamic Period* (1987).

Amazigh peoples who spoke languages ancestral to modern Tachlhit, Tamazight, Tarifit and Kabyle. The languages of this 'Berber' family share a common Afro-Asiatic ancestor with Arabic, but are only distantly related (Lipiński 2001). Over the centuries that followed, the Arab and Amazigh communities continued to co-exist, and much of the Islamic history of Morocco can be framed in terms of identitarian tension between these two ethnic groups (Benmamoun 2001). The original Arab communities in the region were basically urban in nature, being concentrated in fortified settlements. Starting in the 9th century, however, migrations of pastoral Bedouin tribes out of the Arabian peninsula began to spread west across North Africa, in an event known as the 'Hilalian migrations' after one of the tribes involved (Rosenhouse 2006). When this wave of pastoralists reached Morocco, most notably in a large confederation known as the Ma'qil, they brought with them a distinct dialect with characteristic 'Bedouin' features such as the shift of /q/ to /g/.

These migrations are the origin of the major split in North African dialects between 'Hilalian' and 'pre-Hilalian' varieties, with pre-Hilalian dialects concentrated in old urban areas or regions with rough terrain unsuited to grazing, and Hilalian dialects spread throughout the surrounding rural plains and deserts, as well as in urban centers founded after the medieval period. Jewish ethnic dialects in North Africa tend to be among the most prototypical examples of the pre-Hilalian type, and the most extreme exemplar of a 'pure' Hilalian dialect is the Hassaniyya Arabic of southernmost Morocco and Mauritania, which is sometimes labelled 'Sahraoui' in a Moroccan context (Heath 2002).

Though both pre-Hilalian and Hilalian dialects were exposed to Amazigh influence through language transfer, the Hilalian varieties of central Morocco developed particularly strong substrate effects as a result of several large Amazigh groups of that region undergoing language shift to Arabic after the Hilalian migrations (Colin 1986). The central Hilalian koiné

spoken today contains many Amazigh loanwords, and has borrowed both phonological features such as cluster-permissive phonotactics with reduction or deletion of short vowels (Aguadé 2008:293) and morphological features such as the derivational circumfix *ta- -it* to designate a profession (Harrell 1962, Heath 1987). It is intriguing from a substrate perspective to consider that Tamazight has a phonemic contrast between /r/ and /ṛ/ (Abdel-Massih 1971), but unfortunately the derivation and distribution of this distinction in Tamazight may be as poorly understood as it is in Arabic, and in any case the [r]~[ṛ] problem in Arabic predates contact with Amazigh speakers in North Africa.

In present-day Morocco, Amazigh languages are still primarily spoken in the northeastern mountains of the Rif, the central mountain belt of the Middle Atlas, and in a vast region of the south including the High Atlas, Sousse, Anti-Atlas, and parts of the Sahara. Arabic, on the other hand, is spoken natively throughout the northwest and center of the country, in a core area stretching from Tangier and Tétouan in the north to Marrakech in the south through the east-west axis of Casablanca, Rabat, Meknes, and Fes, which Heath terms the 'Central Urban Belt.'[21] The area north of this belt, including the rural *jbali* dialects of the mountains west of the Rif, speaks predominantly pre-Hilalian dialects, while the central urban belt itself and regions to the south are dominated by Hilalian dialects. The map in Figure 2.2 describes the localization of these dialect and language groups in greater detail.[22]

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[21] An anomalous Arabic-speaking area in the eastern part of the Sahara, which was once home to some unusual rural Jewish dialects (Heath and Bar-Asher 1982), is the Tafilalt region centered around Erfoud and Rissani.

[22] This map is a public-domain image drawn from Wikimedia Commons (https://upload.wikimedia.org/wikipedia/commons/6/64/Geographie_linguistique_au_Maroc.PNG), where it was compiled from a number of primary sources, including Colin (1986), Behnstedt (2004), and Hachimi (2007), by user Omar-Toons. Unfortunately, no Moroccan dialect maps in the published academic

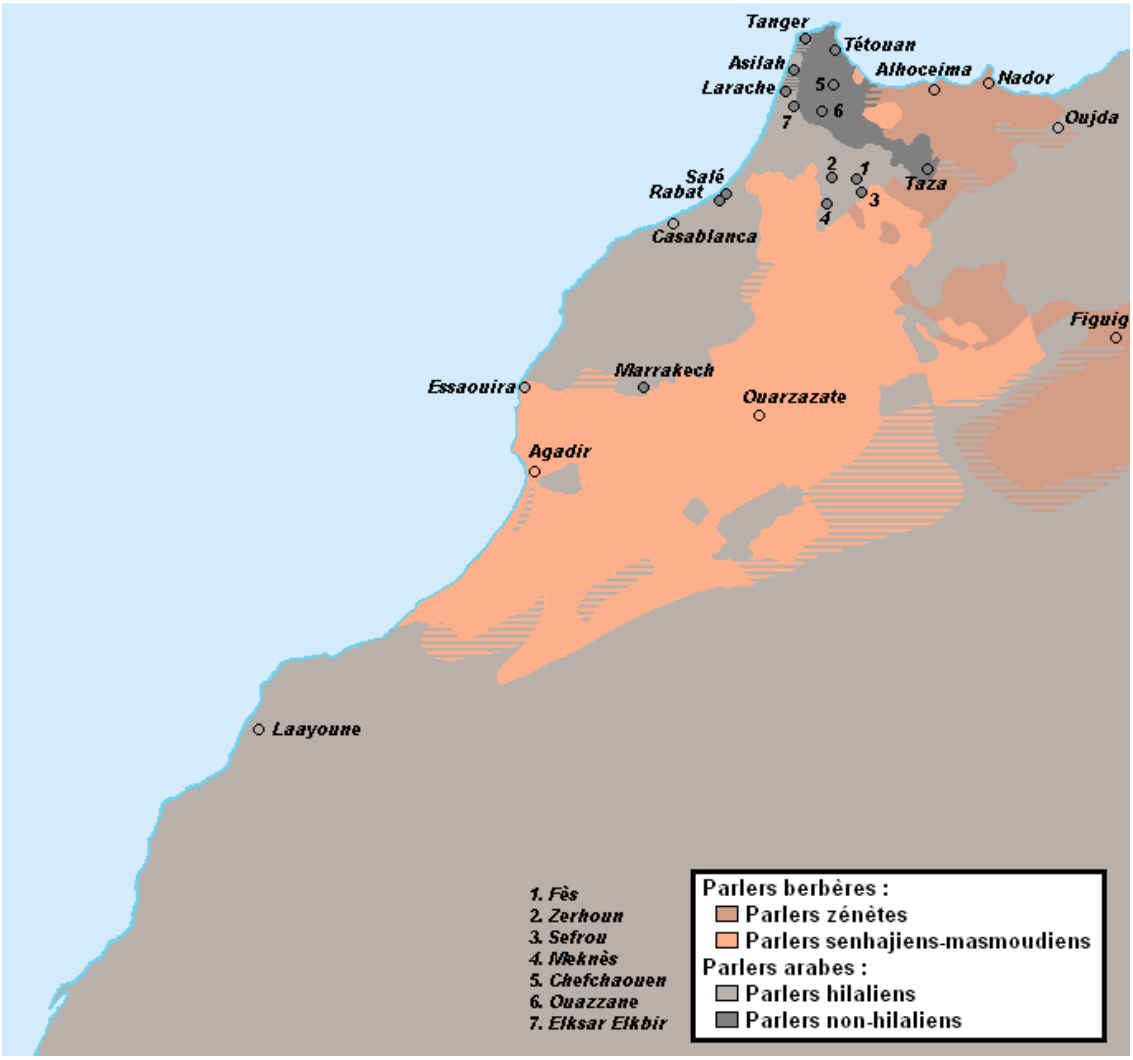

Figure 2.2: Language map of Morocco (source: Wikimedia Commons).

During the period of French and Spanish colonization in the early 20th century, Moroccan Colloquial Arabic was heavily influenced by both languages. Spanish influence was

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literature to date are both comprehensive and comprehensible, and this open-source effort is by far the best existing map for illustrative purposes.

strongest in Spain's protectorate on the Mediterranean coast while French predominated in the rest of the country, giving rise to doublets such as Tetouani *siyu* < Sp. *sello* as opposed to Fessi *timbr* < Fr. *timbre* 'postal stamp' that continue to this day. Another significant development during this period was the rapid rise of Casablanca as an urban center, from a small fishing village at the turn of the 20th century to a metropolis of over five million people today (Hachimi 2012). This conurbation drew together people from many different rural, Hilalian-speaking areas, giving rise to a new urban koiné (Hachimi 2007, Heath 2002). While the speech characteristic of today's Casablanca is identifiable to other Moroccans as 'Casaoui,' the koiné which developed over the course of the 20th century has become widespread as a national lingua franca (cf. its use in the media as described in Miller 2012), and has begun to erode traditional local varieties elsewhere in the country (Caubet 2008).

Fes, the site of the present study, is the second-largest city in Morocco and its largest pre-Hilalian urban center. Founded in the ninth century by the Idrisid dynasty, it was a major cultural and political center throughout the Middle Ages and attracted a large population of Andalusi refugees. Starting with the rise of Marrakech and the erection of nearby Meknès as a new capital in the 17th century, the city began to decline in importance, but when the French took over Morocco in 1912, Fes was still the country's first city and seat of government. The colonial government, however, moved to Rabat and oversaw the rapid growth of Casablanca, and in post-colonial Morocco the trend of migration has been away from Fes. However, as Atiqa Hachimi eloquently describes in her work on Fessi emigrés in Casablanca (2007), there is still considerable cultural prestige attached to the city, and being 'Fessi' is considered a badge of honor.

While the social upheavals of the past century may have enhanced the legend of Fes in the national consciousness, a very different set of dynamics has been at work in the city itself.

As they did throughout colonial North Africa, the French erected a 'ville nouvelle' or 'new city' on the outskirts of the medieval core of Fes. After decolonization in the 1950s, a considerable segment of the remaining urban elite left their properties in the old walled city and moved to modern apartments and villas in the suburban 'new city,' which has continued expanding to the south over the past half-century. As with the 'White flight' phenomenon in the United States, this created a space for poorer immigrant populations to move into the old core of the city from surrounding rural areas, many of them Berber speaking. Though this relocation was by no means universal, many of my participants endorsed a stereotype of the gritty Berber hustler living in the 'old city,' and the story I have just sketched is indeed derived from the anecdotal consensus of my contacts in Fes. The end result of this has been a shift of the Fessi speech community from both ends of the sociolinguistic spectrum, with the mobile and supraregionally connected upper class koinéizing their speech just as much as the largely immigrated working class, but for different reasons. Another side effect has been that residence in the 'new city' or 'old city' can be used to some extent as a proxy for social class, as I discuss in Chapter 3 below.

2.6 Aspects of Moroccan Arabic Phonology

It is not necessary to provide a complete sketch of Moroccan Arabic phonology here, since most relevant phenomena have been described in the preceding sections, including a detailed description of the Moroccan [r]~[r̝] contrast in §2.4. Nevertheless, a few points relevant to this study must be considered, most particularly the structure of the vowel system, some dialect-specific facts about gutturals, and the status of the so-called 'velarized labials.' After a brief

presentation of the colloquial Moroccan consonant system for reference, we will discuss each of these in turn.

2.6.1 The Consonants of Moroccan Arabic

Table 2.3 presents the consonant system of koiné Moroccan Arabic, as presented in standard sources such as Harrell (1962), Caubet (2008), and Heath (2002). Note that /ṛ/, /ḷ/, /ḅ/, and /ṃ/ are included despite their acknowledged quasi-phonemic status as 'marginal emphatics.'

		t	ṭ		k	q		ʔ
b	ḅ	d	ḍ		g			
	f	s	ṣ	ʃ		χ	ħ	h
		z	ẓ	ʒ		ʁ	ʕ	
m	ṃ		n					
		l	ḷ					
		r	ṛ					
				j	w			

Table 2.3: The consonants of Moroccan Arabic.

A few differences from the Standard Arabic consonant system of Table 2.2 should be pointed out. First, /dʒ/ has been deaffricated to /ʒ/, except in certain dissimilatory environments in which it surfaces as /d/ or /g/ (Harrell 1962) or is assibbilated to /z/ (Zellou 2010). Second, an independent /g/ phoneme has arisen from a combination of different sources, including dissimilated /dʒ/, 'Bedouin' [g] < /q/, and Amazigh or European loanwords (Heath 2002). In the koiné, and even more so in pre-Hilalian dialects, /g/ < /q/ is lexically restricted to specific borrowings from [g] < /q/ dialects such as *gal* <*qāla* 'said.' Third, as in all colloquial dialects,

/ð̣/ and /d̪/ have merged into a single phoneme, which happens to be /d̪/ in Morocco (it can also appear as /ð̣/ or /z̪/). The separate /z̪/ phoneme is a new development in Moroccan from original /z/, which is low-frequency and seems to have 'marginal emphatic' status similar to the /b̪ m̪ l̪ r̪/ class (Caubet 2008: 275).[23] Finally, as in many other dialects, the interdental fricatives have been lost, merging with /t/ and /d/ respectively.

2.6.2 The Vowels of Moroccan Arabic

The vowel system of Moroccan Arabic is the subject of some controversy. While most scholars (Harrell 1962; Heath 1987, 2002; Hilili 1979; Caubet 2008; Aguadé 2008) endorse a five-vowel system as the most generalizable inventory in the koiné, there is disagreement as to the composition of this system, and as to whether it includes a length contrast as in the six-vowel system of Standard Arabic (which has /a/, /i/, /u/, /aː/, /iː/, and /uː/, in addition to two diphthongs /aj/ and /aw/ which it is possible to analyse as clusters[24]). Some, such as Maamouri (2019[2015]), take a purely etymological approach to the representation of Moroccan words by adopting the Standard Arabic system intact, but if this approach is synchronically justifiable it is only in minority dialects of the extreme southern and northeastern parts of the country which

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[23] /z̪/ is less controversial since while there are not many minimal pairs, there is at least stable evidence for its exsitence (unlike /b̪/ and /m̪/), and it does not engage in the sort of phonetically conditioned alternation we have seen with /r̪/ (and which exists to a lesser degree for /l̪/). An example of a minimal pair involving /z̪/ is *z̪awya* 'broke' vs. *zawya* 'religious order' (Marjane 2001).

[24] While in many Arabic dialects, these diphthongs become phonemic mid vowels, in Moroccan Arabic the mid vowels have peripheralized to [i] and [u] respectively and merged with the high vowel phonemes. Moroccan Arabic mid vowels do exist, but primarily in French loanwords, and in many of these cases they have been reanalysed as emphatic allophones of the high vowels following an underlyingly emphatic consonant, as in [t̪obis] ← /t̪ubis/ < *autobus* 'local bus' (Heath 1989).

have not undergone the dramatic vowel reduction typical of the central koiné and related dialects.

In most Moroccan dialects, then, many short vowels inherited from earlier Arabic have either been reduced to schwa or deleted entirely, likely under influence from Amazigh languages which have notoriously consonant-heavy syllable structures (Dell and Elmedlaoui 2012). The general shape of the change is that **ă* and **ĭ* merged to /ə/ in non-final position, and remained distinct from each other but merged with **ā* and **ī* respectively in final position. In northern Hilalian-type dialects, some non-final **ĭ* vowels remain distinct from /ə/. Note that word-final /a/ is always backed, in an equal but opposite process to the *ʔimāla* of eastern Arabic – this makes it ineligible for analysis with respect to emphasis spread, a fact which had to be taken into consideration in my research.

Short **ŭ* also merged with its long counterpart word-finally, but was retained in non-final position as a sort of rounded schwa that causes difficulties for analysis. Heath (1987) considers that the Moroccan reflex of *ŭ* may in fact be some kind of labiovelar autosegment /^{w}/ that attaches to a (schwa) vowel when possible but may attach to a consonant when the vowel is deleted or absent. Of course, this behavior varies by dialect, leading researchers such as Caubet (2008:276) to propose that there are two systems, a five-vowel system with /ŭ/ and a less common 'Southern'/Marrakchi phonology with four vowels plus floating labialization.

The short vowel system is complicated further at the phonetic level by coarticulatory variability in the pronunciation of /ə/ (Caubet 2008:275-276) and by the existence of a somewhat unpredictable phonotactic- and prosody-based interaction of schwa deletion and epenthesis that affects both /ə/ and /ŭ/ (Dell and Elmedlaoui 2012; Louriz 2017). These processes make it difficult to determine the phonological status of any

particular reduced vowel token, and introduce floating labiovelarization as a vestige of deleted /ŭ/ even in dialects which are usually analysed as having a five-vowel system. While understanding the complexities of the Moroccan short vowel system is an important task, perhaps even of greater interest to phonology than the exercise in representational ontology I am engaged in here, it is not the goal of this dissertation. Accordingly, I have restricted my phonetic analysis to the 'full vowels' /a/, /i/, and /u/ whose phonological status can be trusted, though you will note some transcriptions indicating labiovelarization, such as *k^{w}bar*, that indicate a deleted **ŭ* elsewhere in the word.[25]

Before moving on from the vowel system, I should say a word about length contrast. Some scholars, such as Aguadé (2008), analyse the distinction between the two reduced vowels /ə/ and /ŭ/ and the three non-reduced vowels /a/, /i/, and /u/ as one of length, while others, including Caubet (2008) and Harrell (1987), analyse it as a qualitative distinction. Heath (2002) describes southern, Saharan dialects as preserving a length contrast without short vowel centralization, while the koiné and northern dialects have a five-way qualitative distinction. While at the phonetic level, there certainly is a difference in length – the reduced vowels rarely exceed 40 ms in length, while the 'full vowels' are almost always longer – the need to encode length as a structural contrast depends on the analysis of the place of /ŭ/ (is it identical to /u/ or underlyingly centralized?) and the weight the individual researcher gives to maintaining phonological continuity with Classical or Standard Arabic in their description. I will adopt the quality-based analysis and assume the following structure for the (non-Sahraoui) Moroccan vowel system:

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[25] In non-phonetic transcriptions, I also follow the French convention of writing schwa as *e* in Moroccan Arabic, so that *ṣɣer*, for instance, corresponds to the IPA transcription [sˁʁər].

/i/ /u/

/ʊ/

/ə/

/a/

Table 2.4: The Moroccan Arabic vowel system.

2.6.3 Post-Velar Phonetics in Morocco

In general, the behavior of emphatics and gutturals discussed for Arabic in general in §2.2 holds for Morocco as well. There, we mentioned that only certain morpheme boundaries block emphasis spread in koiné Moroccan Arabic, and that there is debate as to whether emphasis is best described in articulatory terms as uvularization, (upper) pharyngealization, or velarization. In Fes, pharyngealization spread is bidirectional and is only blocked by certain inflectional suffixes, possibly only by clitic boundaries and verbal agreement markers (Marjane 2001:52-59). As Heath (1987) notes, nominal suffixes seem to be involved in emphasis spread even when they are transparently inflectional.

As for the articulatory behavior of post-velar consonants, instrumental work on Moroccan Arabic speakers from Taza by Zeroual et al. (2011) concluded that emphasis could be characterized as upper pharyngealization in contrast to the velarization of the 'velarized labial' consonants discussed in the next section. Yeou and Maeda (2011) found that not only /ʕ/, but also /ħ/ and the uvulars /χ/ and /ʁ/, are best characterized as approximants rather than as fricatives. Finally, Embarki et al. (2011) found that Moroccan Arabic emphatic coarticulation

was stronger and extended further from the source consonant than in other regional colloquial dialects.

These recent findings do not preclude applying Zawaydeh's uvularization hypothesis to Moroccan Arabic, but they do entail the exclusion of velarization from the possible correlates of emphasis in Morocco. The next section discusses the phenomenon of (labio)velarized consonants in Moroccan Arabic, which Zeroual et al. investigated in relation to emphasis and which interrogates the boundaries of the post-velar consonant system in Moroccan Arabic.

2.6.4 'Special Labial Pronunciation'

Special Labial Pronunciation, or SLP, is a term coined by Heath (1987) to describe an idiosyncratic pronunciation of the labial conosnants /b f m/ in certain words with a secondary velarized articulation. These words typically exhibit surface gemination of the labials, and often contain underlying clusters with following /w/, as in [mːˠagən], the plural of [magana], which uses the morphological template /C_1waC_2əC_3/. In other cases it is much harder to make the case for an adjacent /w/, though some labiovelar feature is certainly influencing the pronunciation. A common example is [mːˠi], 'my mother,' derived from /ŭmm/ 'mother' and the first-person singular clitic pronoun /-i/. In addition, some clusters of labials with /w/ persist in Moroccan Arabic, so this is not a straightforward conditioned allophone. Heath (1987:225 ff.) attempts to associate these labial variants in his analysis with a process generating labialized velars in Moroccan Arabic from a floating labialization feature originally associated with /ŭ/, and a similar line of thought leads Harrell (1962) to call them 'labialized labials.' In most words exhibiting velarized labials, however, a geminate velarized labial can be traced back to either a cluster with following /w/, or a nearby historical /ŭ/. In almost all cases, there are productive

morphological alternations with forms exhibiting no velarization, as in [fmːʸək] ‘your mouth’ versus [fʊmm] ‘mouth.’

The velarized labials are tentatively labeled emphatic-like in most descriptions of Moroccan Arabic, including Harrell (1962) and Heath (1987). Vowel effects are found to be variable, with /a/ ranging from quite fronted to quite backed, /i/ ranging from lowered to a centralized diphthong with an effect ‘similar to that of Russian *y* in *ty*,’ and /u/ remaining unaffected (Heath 1987:226). As mentioned in the last section, Zeroual et al. (2011) investigated the articulatory phonetics of velarized labials in some detail for the eastern Moroccan city of Taza. Their EMA and ultrasound study determined that ‘MA labialised labials are produced with labial-velarisation,’ whereas ‘emphatics /ṭ, ḍ/ are pharyngealised and not velarised, and /ḍ/ has a slight degree of labialisation’ (p. 295), indicating that velarization is distinct from conosnantal emphasis in Moroccan Arabic.

2.7 Summary: Operationalizing Rhotic Emphasis and Uvularization as Research Problems

Putting this all together, we see that the marginal emphatic consonants in Moroccan Arabic raise several questions regarding the nature of phonological representations and organization of place in the lower vocal tract. First, the ambiguous distribution of [ɾ̪] raises the question of whether it is a phonemic or allophonic category with respect to plain [r], and if it is neither, how it is expected to behave and be represented as a so-called ‘marginal phoneme.’ Second, it is unclear whether emphasis is best characterized as pharyngealization or uvularization, and whether uvulars are in the same phonological class as coronal emphatics, as in Sibawayh’s *mustaʕliya* class.

Key to effectively answering these questions is moving beyond distributional data to consider the phonetic behavior of these ambiguous segments as compared to primary emphatics. The process of emphasis spread provides an ideal avenue for such an investigation, since it is a phonological process specifically targeting emphatics which lends itself well to acoustic phonetic measurement. As described above, formant structure of adjacent vowels is the key acoustic correlate of emphasis and of post-velar co-articulation, allowing us to observe differences in both the intensity and scope of vocalic emphasis spread directly. This in turn can help us distinguish between phonetic and phonological effects through analysis of coarticulatory gradiency, and to determine the alignment of ambiguous segments with different post-velar consonant classes by comparing coarticulatory formant signatures. This analysis can then be assessed with respect to distributional patterns for individual speakers in order to evaluate the phonological status of uvulars, uvularization, and the rhotic emphasis within the Fessi speech community.

The following chapter describes a research project addressing these issues by sampling and recording speakers in an clearly defined network within the Fessi speech community, and by conducting an acoustic analysis of their post-velar coarticulations to be evaluated according to phonological parameters. The acoustic results of the investigation are reported in Chapters 4 and 5, while the phonological assessment may be found in Chapter 6.

Chapter 3. Research Methodology

In order to build a dataset adequate to assess my research questions, I planned and conducted field interviews in Fes in early 2016. This fieldwork required development of an interview protocol combining wordlists and free speech, to be administered to a sample of participants having a range of demographic characteristics. After collection, the data required significant preparation and quality review before they could be used for analysis, beginning with manual transcription and segmentation. This chapter details the methods used for data collection and preparation. I begin by discussing fieldwork methods (§3.1) and interview/wordlist design (§3.2), before moving on to transcription and data preparation (§3.3).

3.1 Fieldwork and Recruitment

I conducted my interviews over the course of a five-month stay in Morocco from January to June of 2016. I arranged a partnership with the American Language Center-Fès, by which they provided me with lodging and access to their classrooms and other resources during my stay. The American Language Center (ALC) is a U.S.-sponsored organization with branches in a number of Moroccan cities, offering English instruction to Moroccan students and, in the case of the Fes location, Arabic instruction to foreign students studying abroad. They also offer a range of cultural programs which are attended by both Moroccan and foreign students associated with the Center. I made use of existing networks between students, teachers, and staff to recruit the majority of my participants, beginning with the recruitment and training of interview assistants from among local university students associated with the ALC.

Fes was chosen as the site of the study not only because I had previous experience there, but also because it fulfilled the dialectological characteristics I was seeking to investigate. The central urban koiné which has arisen over the past century as the cities of Casablanca, Rabat, Meknes and Fes have grown through migration from rural areas and other parts of the country presents an irregular and levelled mixture of features which exhibit different patterning in the country, and among these features is the [ṛ] ~ [r] alternation (Heath 2002; Aguadé 2003). As discussed in Chapter 2, rhotic emphasis exhibits a mix of allophonic and phonemic behavior, with specific patterns of paradigm levelling and alternation varying widely between dialect groups. In Fes, though the traditional urban dialect is of the 'pre-Hilalian' Northern type, ongoing demographic changes have initiated a shift towards the mixed 'Hilalian' central koiné. When these divergent systems come into contact, it creates a degree of phonological ambiguity.

Since phonological restructuring of /r/ emphasis is being considered here as a possible change in progress, it was also important to structure the sample of speakers to be as balanced as possible with respect to age and social factors. I collected information on age, gender, education, occupation, neighborhood of residence, place of birth, and history of residence. My recruitment method was largely word-of-mouth, guided by Niloofar Haeri's consideration that, in Arab countries, 'it is culturally more appropriate to contact people, not as a stranger, but as a friend or acquaintance of their own friends or relatives' (1997:23). Accordingly, I expanded from a handful of initial contacts to a broader network of speakers through personal introductions and referrals, some of whom only agreed to be interviewed after a long period of contact. I trained two native Moroccan interview assistants, both university students living and studying in Fes, who offered invaluable help in recruitment throughout my stay.

My final sample of speakers, then, was largely drawn from contacts established through the ALC. 8 of my 24 participants were Moroccan university students studying English at the

ALC, and another 8 worked as Arabic or English teachers at the school. 5 of the remaining 8 were employed by the center as administrative or maintenance staff, and the other 3 were referred by contacts within the center. As a result, my speaker sample cannot be said to be representative of Fessi society as a whole, but rather samples a certain social group among the more educated ranks of the Fessi population, which is overall more likely to have adopted supralocal linguistic norms than other groups.

Within this sample, though I was careful to control for social variables, certain asymmetries did emerge. I interviewed 15 men and 9 women ranging from 20 to 67 years old. 16 out of the 24 had at least some university-level education, while the remaining 8 had not completed secondary school, and 3 of these had only a fifth-grade education. 18 lived in the more middle-class 'New City' of French and post-colonial construction, while 6 resided in the more popular and traditional old medina.

The asymmetries in this distribution skew young, male, and well-educated, due to a combination of cultural and situational factors. First, as mentioned above, I was recruiting out of a foreign-run language school, drawing from students and teachers as my primary participant pool. This inevitably resulted in an abnormally large percentage of university-educated participants, since I was either dealing with individuals who were already highly educated (the teachers) or individuals who were taking supplemental classes to further their education (the students). Secondly, the younger, student population was better connected with my student interview assistants, and it was easier for me to make my own social connections with them than with the older generation. Third, gender norms in Morocco made it easier to recruit men than women, since men were more likely to agree to answer personal questions from a stranger and have them recorded, and also were considerably more likely to have received the sort of advanced education that placed them in my primary recruitment pool. I was only able to

interview one woman from a traditional social background, after several months of our acquaintance had built enough trust that she agreed to conduct an interview.

A more unexpected factor contributing to the age asymmetry was a persistent reticence of older Moroccans to consent to being recorded. I noticed this tendency especially among prospective participants over the age of 40, who would have come of age in an era of heightened government surveillance towards the end of the Cold War, known informally in Morocco as the 'years of lead.' The legacy of this period, combined with more traditional values among this generation, is likely responsible for their greater unwillingness to participate in the study. It was also difficult to communicate the purpose of the interviews to older individuals unfamiliar with the enterprise of academic research, enhancing the skew towards more highly educated Moroccans.

It was necessary for me to consider one final interspeaker variable: whether each participant had been born in Fes, and if not, how long they had resided there. Optimally, my data would have included only native-born Fessi speakers, but the search for a comprehensive demographic sample led me to broaden my criteria. As a rule, I admitted anyone who had moved to Fes as a child or adolescent into the study, but not individuals who had relocated to the city from another part of Morocco as an adult. I made an exception to this rule for two of my oldest speakers, Speaker 22 and Speaker 23, since their native towns were not far from Fes and they had been living in the city for over 20 years. Two other anomalous speakers were Speaker 8, a native of al-Hoceima who was studying at the university in Fes, and Speaker 5, who had moved to Fes as a child, and had learned to speak colloquial Arabic there, but was a native speaker of the Tarifit language and was also from al-Hoceima. These anomalies are most simply recorded in my dataset as a binary Fessi/Non-Fessi variable, with individuals who were born and raised in Fes exclusively counting as Fessi. 16 of my 24 speakers meet these criteria,

and the four ‘non-Fessis’ who I did not mention above all moved to Fes during childhood or adolescence from other Arabic-speaking communities.

Table 3.1 summarizes the distribution of my participants over these demographic variables. For the class variable presented here, a mixture of education and occupation was used; university-educated individuals, office workers, or individuals whose parents were universty-educated were considered upper-class, while individuals who worked as manual laborers or in service industries and had not attended university were considered working-class.

Gender	Age Group:	18-25 [8]	26-40 [11]	40+ [5]
Men [17]	Class:	UC: 4	UC: 3 WC: 3	UC: 4 WC: 1
	Background:	Fessi: 1 ‘Non-Fessi’: 3	Fessi: 5 ‘Non-Fessi’: 1	Fessi: 2 ‘Non-Fessi’: 3
Women [9]	Class:	UC: 4	UC: 3 WC: 2	
	Background:	Fessi: 3 ‘Non-Fessi’: 1	Fessi: 4 ‘Non-Fessi’: 1	

Table 3.1 Demographic Distribution of Speakers by Gender, Age, Class, and Place of Origin

Table 3.2 describes the backgrounds of the nine speakers who were not lifelong natives of Fes. They may broadly be divided into two categories, those with influence from northern Morocco (Speakers 5, 8, 17, 23, and 24) and those with influence from central or southern Morocco (Speakers 11, 14, 15, and 22).

Speaker	Gender	Age	Class	Background
05	M	26	W	Native Tarifit speaker from al-Hoceima (Rif), learned Arabic when he moved to Fes at the age of 14. Arabic is now his dominant language.
08	M	22	U	From al-Hoceima (Rif), has lived in Fes for two years while attending university.
11	M	20	U	From a military family, moved to Fes from a base in Dakhla (Wsestern Sahara) at the age of 12.
14	F	25	U	Moved to Fes from Marrakech at the age of 7.
15	M	22	U	Native of Marrakech, moved to Fes at the age of 16.
17	F	31	U	Moved to Fes from Nador (Rif) at the age of 11.
22	M	56	U	Childhood split between Fes and Beni Mellal (High Atlas), lived continuously in Fes since age 26.
23	M	62	U	Native of Sefrou (Middle Atlas city just south of Fes), lived in Fes for past 18 years.
24	M	49	U	Native of Sidi Kacem (north of Meknès), moved to Fes at age 15.

Table 3.2: Regional backgrounds of ‘non-Fessi’ research participants.

3.2 Interview Design and Wordlists

My field interviews combined word list elicitation with prompts eliciting free speech in the speaker’s dialect. Both datasets were processed and transcribed, but due to technical limitations only the wordlist data were comprehensively analysed and segmented, and the results of the wordlist portion of the interview form the core of this dissertation. The free-speech portion of the interview began with about twenty minutes of conversational speech, directed by two native Moroccan interivew assistants using questions inspired by interview protocols for the

Philadelphia Neighborhood Corpus (Labov 1984),[26] which was followed by elicitation of a story from a set picture prompts. The wordlist portion of the interview followed, and took about twenty minutes to complete.

Wordlists were designed to allow comparisons between all relevant consonantal groups, with minimal differences in phonological context. The *Georgetown Dictionary of Modern Moroccan Arabic* (Maamouri 2019[2015]) was used as a primary lexical resource for compiling word lists. The first wordlist consisted of 86 words designed to ensure elicitation of a comprehensive vowel tokens in all of phonetic contexts. The goal was to elicit /a/, /ə/, /i/, /u/, and /ʊ/ vowels in the neighborhood of uvular stops, uvular fricatives, emphatic coronal obstruents, plain coronal obstruents, labial obstruents, pharyngeal consonants, rhotics, laterals, and velar stops. When possible, these conditioning segment classes were elicited both preceding and following the target vowel in both adjacent and nonadjacent positions. Also, although this wordlist was checked for grammaticality in Moroccan Arabic by the interview assistants, participants did not always accept certain words as grammatical in their speech. In these cases, I encouraged them to produce the word anyway to the best of their ability, since my goal was to build a conprehensive phonetic dataset for reference.

There were some restrictions on the usability of the wordlist data arising from distributional and practical considerations. First, not all phonetic comparisons were able to be made due to lexical gaps in the language, particularly those involving non-adjacent syllables. The only vowel to occur in a near-complete set of environments relative to each relevant consonant class was /a/, while /i/, /u/, and /ə/ were successfully elicited from a majority of speakers only in the more restricted set of environments shown in Table 3.3, thus limiting the

[26] Topics were selected to be culturally appropriate for the Moroccan context, and included fighting, dreams, danger of death/fear, childhood games, neighbors, and family. In addition to the topics covered by the PNC modules, I included prompts on (1) cooking and (2) Ramadan customs.

possibilities of analysis. /i/ can still be considered with respect to all consonant classes in some adjacent environments, but comparisons involving /u/ are necessarily more limited. An additional problem was that for /ə/ and the rarer /ʊ/, vowel tokens were found to be too variable, reduced, and subject to elision to provide reliable acoustic data for assessing feature spread. The principles governing the insertion and deletion of schwas in Moroccan Arabic are complex and prosody-dependent (Louriz 2017), and it was judged prudent to avoid making structural proposals based on highly coarticulated vocoids with uncertain phonological status. Finally, some tokens could not be effectively elicited during interviews or were later excluded due to poor sound quality, so only words with a number of tokens distributed across multiple speakers could be used in analysis.

Conditioning Consonant	CV Context			VC Context		
	/i/	/u/	/ə/	/i/	/u/	/ə/
[ṭ], [ṣ]	*ṭisan, bṣiṭ*	*ṭub*		*bṣiṭ, biḍ*		
[q]	*baqi*					*tšaneq*
[ħ]	*ħit, kħib*	*ħut*	*lħem, kħel, ħebb*	*šiħ, dbiħ*	*šluħ, luħ*	
[k]	*kisan*		*nkes*			
[t]	*ti(ye)s*	*ktub, tuma, tut*		*bit, šnit*	*mut, tabut, tut*	

Table 3.3: Wordlist tokens appropriate for analysis of post-velar harmony in non-low vowels.

The second list of 60 words targeted specific vocabulary items reported to exhibit marginal emphatics, also including control words having minimal phonetic differences from the targets. This wordlist ensured the elicitation of a number of morphological vowel alternations involving *r*, to determine the extent of emphasis leveling across paradigms. Table 3.4 lists the

noun and adjective paradigms that were successfully elicited from a majority of speakers, including variant forms provided by participants.[27] The singular/plural pairs *ħmir*/*ħmar* 'donkey' and *kbir*/*kbar* 'large' were included, since they are reported to exhibit alternations in *ṛ* emphasis in all Moroccan dialects, and they may be susceptible to leveling. Many other singular/plural pairs were elicited, including *kar/kiran* 'bus,' *ɣar/ɣiran* 'cave,' *bir/byar* 'well,' *far/firan* 'mouse,' *tur/tiran* 'bull,' *bar*/*biran* 'bar,' and *xruf/xrfan* 'sheep.' Particular care was made to include words reported to exhibit differences in *r* patterning in the presence of uvulars were be elicited, such as *xrif* (pl. *xerraf*) 'autumn,' *ɣrib* (pl. *ɣrab*) 'strange,' and *qrd* (pl. *qrud*) 'monkey.' A number of diminutives were also elicited, among them *dar/*dim. *dwira* 'house,' *ṣɣir/*dim. *ṣɣiwer* 'small,' and *ṣfar*/dim. *ṣayfer* 'yellow.'

[27] I also elicited several past-tense verb paradigms to target syllable and morpheme boundaries, but due to the aforementioned difficulties in analyzing schwa, these did not ultimately prove useful to the study.

	Contrast involving /i/	Only /a/ or /u/ vowels
No post-velars	/bar/~/biran/ 'bar' /kar/~/kiran/ ‘intercity bus’ /bir/~(/biran/~/bjur(a)/~/bjar/) ‘well’ /far/~/firan/ ‘mouse’ /tur/~(/tiran/~/twar/) ‘bull’ /rkba/~(/rkabi/~/rkbat/) ‘knee’ /kbir/~/k^{w}bar(in)/ ‘big’	/dar/~/djur/ 'house' + *dim.* /dwira/ /ʒrana/~/ʒran(at)/ ‘frog’ /taʒər/~/t^{w}ʒːar/ ‘trader’ /fkrun/~/fkarən/ ‘turtle’ /ras/~/rjus(a)/ ‘head’
	/sərbis/ ‘queue’ /rusi/ ‘Russian’ /brika/ ‘lighter’	/rqba/ ‘nape’
/ʕ/ or /ħ/	/ħmar/~/ħmir/ 'donkey’	
	/ʕaris/ ‘bridegroom’ /ħrt/ ‘plow (v.)’ /zrəʕ/ ‘farm (v.)’	/ʕarus(a)/ ‘bride(groom)’
/q/, /χ/, or /ʁ/	/ʁar/~/ʁiran/ 'cave' /ʁrib/~/ʁ^{w}rab(in)/ ‘strange’	/mnχar/~/mnaχər/ ‘nostril’ /χruf/~(/χrfan/~/χrajf/) ‘sheep’ /qrd/~/qrud(a)/ ‘monkey’
/ṣ/ or /ṭ/	/ṣʁir/ ‘small’ + *dim.* /ṣʁiwər(a)/	
	/rχiṣ/ ‘cheap’ /rṭəb/ ‘soften’	/fṭur/ ‘breakfast’ /ṣdər/ ‘chest’

Table 3.4: Noun paradigms and some isolated words with /r/ (shaded cells).

The second wordlist also included the lexical items given in Table 3.5, which are all mentioned by Heath (2002) as exhibiting lexically idiosyncratic dialect variation with respect to *r* emphasis.

/ʃrəb/ ‘drink’	/drrəg/ ‘to hide’
/ʒrana/ ‘frog’	/rqba/ ‘nape’
/gzzar/ ‘butcher’	/qdər/ ‘to be able to’
/rʒəʕ/ ‘to go back’	/mnχər/ ‘nostril’
/fkrun/ ‘tortoise’	/lχχri/ ‘the last one’
/rkba/ ‘knee’	/ħrət/ ‘to plow’
/ṣdər/ ‘chest’	/rħa/ ‘handmill’
/bərd/ ‘coldness’	/rijəħ/ ‘to sit’

Table 3.5: Lexical items reported to exhibit dialect variation in *r*-emphasis.

These two wordlists were followed by a short reading passage that included some low-frequency emphatic *r* alternations, as well as a phrase which forced code-switching into Standard Arabic through use of formal language.[28] The forced code-switch provided a reference point for assessing the influence of Standard Arabic on the participant’s linguistic production in other portions of the interview. This reading passage was presented in both Arabic and Latin script for ease of interpretation, and I found that participants unanimously preferred to read from the prompt in Arabic script.

Finally, I elicited a list of several homophone pairs contextualized in sentence frames, reported to exhibit a minimal contrast between /ṛ/ and /r/ by Hilili (1979) in his analysis of the Fessi dialect. I found that most of these words were considered archaic or marginal by my participants, and they included a taboo vocabulary item which was difficult or impossible to

[28] This morbidly conceived and awkward passage reads as follows: *l-gezzar r-rusi riyeħ ʕal el-ʔarḍ u šaf fkrun waħed qddamu. xda l-fkrun mn er-ras u qtelh b-muṣ ṣɣir. le-mmwaṣ ṣ-ṣɣiwera hiya ʔadawat mufiḍa bzzaf f-qtila l-fkaren u j-jran.* ‘The Russian butcher was resting on the ground and saw a single tortoise in front of him. He took the tortoise by the head and killed him with a little knife. Itty-bitty little knives are really serviceable implements for the killing of tortoises and frogs.’

elicit. These pairs, and the difficulties encountered in their elicitation and analysis, are listed in Table 3.6.

Reportedly [ɾ]	Reportedly [r]	Elicitation Notes
/brəd/ 'become cold'	/brəd/ 'cold' (n/adj)	Noun/adj form was found to be ungrammatical. 4 speakers also altered the verbal form to a causative.
/rib/ 'become dilapidated'	/rib/ 'curdle (intr.)'	Much variation. Speakers favored altering both to transitive or participial forms, which have a surface vowel contrast.
/ʒra/ 'occur'	/ʒra/ 'run'	Both were universally attested and accepted. Some speakers, however, doubled the /r/ in 'occur' to make a causative and one strongly preferred the word /sbəg/ for 'run.' Neutralization of word-final /a/ variants prevents reliable phonetic comparison.
/mərra/ 'instance'	/mərra/ 'to hand over (to)'	Fairly well attested, but may be homophonous. Several speakers also produced an [a] in the first syllable, suggesting that they were interpreting these as Standard Arabic. Neutralization of word-final /a/ variants prevents reliable phonetic comparison.
/t-tərma/ 'the arse'	/ttərma/ 'to cast oneself down'	Well accepted, but complicated by the taboo nature of the first member of the pair. Certain speakers refused to utter the word. This pair is also complicated by its morphological complexity. Neutralization of word-final /a/ variants also prevents reliable phonetic comparison.
/dar/ 'house'	/dar/ 'do'	*Not from Hilili.* Excellent pair, but added towards the end of data collection so only attested for 6 speakers. Also, it is not out of the question that 'house' may have /dˤ/ rather than /d/, which would make it useless for the analysis of /r/ emphaticization.

Table 3.6: Minimal pairs, most reported for 'ancien fessi' by Hilili (1979).

3.3 Transcription, Segmentation, and Data Preparation

After completing my recordings, I contracted a native speaker to provide impressionistic transcriptions of anonymized versions of the free speech section of each interview. I instructed

the transcriber to use informal latin-script transcriptions of the spoken Arabic, such as is commonly used for SMS and online messaging. This writing system has been referred to as 'Arabizi' in other parts of the Arab world and its use has been well documented in recent academic literature (Yaghan 2008, Guellil et al. 2017, Allehaiby 2013). As used in Morocco, phonetic equivalencies are loosely based on French, with some idiosyncratic alphanumeric substitutions suggested by the shapes of Arabic letters. Table 3.7 illustrates some peculiarities of the orthography.

IPA symbol	Romanization
/ʕ/	3
/ħ/	7
/χ/	5, kh
/q/	9, q
/ʃ/	ch, sh
/u/	ou, u
/ʁ/	gh
/ʊ/	o, u
/ə/	e
/ʔ/	2 (or for /ṭ/)

Table 3.7: The 'Arabic chat language' romanization system.

For the portion of each recording containing wordlist, reading passage, and minimal pair tasks, which I will refer to as the 'wordlist section' of the interview, I conducted transcriptions myself in the ELAN program (Wittenburg et al. 2006) using a standardized phonetic orthography based on the Arabic chat language system. Wordlist responses were indexed to indicate which prompt they were elicited in response to, and noisy or otherwise difficult regions of the recording were noted and removed. I created separate ELAN files for the formal half of each interview, which were then imported into a PRAAT textgrid file for segmentation.

Complete segmentations of the wordlist section of the interview were prepared by hand in PRAAT (Boersma and Weenink 2015), using the spectrogram of the recording as a guide to aligning segment boundaries.[29] My segmentation method marked clear boundaries where possible, and, where boundaries were gradient, bisected transitions in such a way as to center stable portions of sonorant nuclei within the relevant segment.

Boundaries between obstruents and sonorants were placed at the time that periodic phonation with defined formant structure became visible or ceased; this was almost always a discrete point, except for a small number of tokens of [z] and [ʒ] in which high frequency aperiodic noise continued above the periodic signal for a short duration. In these cases, I placed the boundary at the point at which the periodic signal extended to 3000 Hz. The voiced pharyngeal fricative /ʕ/ behaved acoustically as an approximant with well-defined formant structure, rather than an obstruent.

Boundaries between sonorant segments were placed at the midpoint of formant transitions between the segments. This principle was sufficient except for cases in which a sonorant consonant and a vowel were indistinguishable from each other either by timing or formant structure, having a perceptually and acoustically indistinct transition. This was quite common in the case of [ʕ], and heavily pharyngealized portions of vowels adjacent to [ʕ] which were not perceptually distinguishable from the consonant itself were included in the [ʕ] segment. For a few such vowels having short duration, no portion of the vowel was distinct from the pharyngeal consonant, and in these cases the vowel and consonant were segmented together as a single compound segment, which was excluded from formant analysis but counted as a vowel plus a consonant when calculating adjecency scores.

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[29] To my knowledge, no automated forced-alignment software trained to segment Moroccan Arabic data yet exists, and the unusual phonotactics of the language makes it difficult to bootstrap algorithms designed for other languages onto Moroccan data.

Rhotic segments, which form the focal point of the analysis, offered some further dimensions of acoustic complexity. Generally, /r/ was an apical trill [r] or tap [ɾ], identifiable by a single or repeated break in the continuity of the periodic signal, with an accompanying dip in formant frequencies. However, in some cases there was no occlusion, and [ɹ] appeared as a rhotic approximant. In yet other tokens, the 'burred r' was accompanied by low-amplitude, high-frequency frication, indicating a closed pronunciation as [ɹ̝]. Either the trill or the fricated rhotic could also exhibited devoiced variants word-finally or before voiceless obstruents. To complicate matters further, trilled [r] often included periods of sonorance with unrhoticized schwa-like formant structure either before, during, or after the trill itself, lasting up to 50ms in duration. These periods were tagged separately as 'er' where they were ambiguous with a preceding or following schwa, but were tagged as part of the [r] when internal to the larger trill gesture.

The heterogeneity of /r/ articulation presents some interesting phonetic questions, but was judged to be tangential to the issue of pharyngeal secondary articulation, since any of these articulations of /r/ could be either pharyngealized, uvularized, or neither, and this feature could spread to adjacent vowels regardless of whether the consonant itself was produced as a trill, a tap, or an approximant, with or without frication, voiced or devoiced. Therefore, all rhotics were considered as a single segment [r] for the purposes of the phonological analysis, and note was made only of which speakers consistently exhibited some pronunciation as [ɹ], since this is a potential diagnostic feature for traditional Fessi speech.[30]

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[30] As I discuss in more detail elsewhere, the traditional Fessi dialect is reported to have a 'uvular r.' My impression from anecdotal evidence is that native speakers consider some version of [ɹ] to typify this pronunciation, since I did not encounter any tokens of uvular fricative or approximant /r/ in the course of my research.

Vowels were coded according to the five-vowel system discussed in §2.6.2 above. Schwas which could be identified as epenthetic were coded separately, as were vowel tokens having unusual phonation or other acoustic properties which would interfere with formant extraction.

Following segmentation, formant measurements were extracted from the data, taking measurements at the midpoint of each vowel or sonorant segment, and then at intervals 20 ms before and after the midpoint if the segment was at least 40 ms in length.[31] All formant values were Lobanov normalized (Adank et al. 2004) and rescaled to control for vocal tract length as a source of interspeaker variation. The dataset was then preprocessed using a Python script that encoded information about each token's phonetic context in terms of a number of binary variables. All classes of consonants pesent in each word were noted, as well as whether tokens of each consonant class occurred preceding, following, or adjacent to the target segment and how many tokens of each consonant class were present in the word.

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[31] Formant extraction used Praat's built-in LPC formant tracker. First-pass measurements were taken using default settings, identifying 5 formants below 5000 Hz for male speakers and 5500 Hz for female speakers with a 25 ms window. Following the first-pass, outlying measurements were adjusted to correct for errors in the automated formant extraction. First, any non-low vowels with F1 values greater than 1000 Hz were re-evaluated to identify 6 formants within the specified frequency range, and then 7 formants if this still resulted in an unreasonably high F1. For low vowels with F1 greater than 1000 Hz, a 6-formant adjustment was performed only if the resulting F2-F3 distance was greater than 500 Hz, as a small F2-F3 distance is atypical for low vowels and would indicate that the LPC algorithm was being forced to find too many formants. Next, back vowels with F2 measures greater than 2000 Hz were corrected in the same way, by adding formants until F2 was lowered below 2000 Hz, and then removing formants if the resulting values exhibited a small F2-F3 distance that would indicate a measurement error for these vowels.

Chapter 4. Uvulars and the Differentiability of Post-velar Spreading Effects

This chapter considers the question of how different kinds of post-velar coarticulation and feature spread are organized in Moroccan Arabic. There is considerable variation in reported articulatory correlates of emphasis, ranging from true pharyngealization through uvularization to velarization. The data presented here point towards a three-way distinction between uvular, secondary/upper pharyngeal, and primary/lower pharyngeal coarticulatory effects, with the secondary pharyngeal effect exhibiting the greatest phonologization and the primary pharyngeal effect being the most purely local and phonetic.

When rhotic coarticulation is considered relative to these three categories, it is found that rhotic coarticulation has an acoustic signature most similar to uvularization, rather than pharyngealization, but with a degree of variability that points to significant interspeaker and lexical variation. The implications of this variation for the phonological organization of Moroccan Arabic rhotics are investigated in the following chapter, but the more general data in this chapter are sufficient to advance the proposal that the acoustically intermediate properties of Arabic uvularization spread as compared to pharyngealization spread are the source of the claim that rhotics exhibit 'partial' or 'attenuated' emphasis, when in fact this phenomenon reflects a qualitative phonetic and phonological difference in place.

I begin by establishing general trends across consonant classes (§4.1), and then conduct detailed vowel comparisons of wordsets which constrast consonant classes in the same phonetic environment (§4.2), before proposing a typology of Moroccan Arabic post-velar spreading effects that can be used to evaluate the patterning of individual speakers and words (§4.3). Throughout this chapter, I consider rhotic tokens as members of a single category /r/ for the purpose of general comparison with other consonant classes, while understanding that this /r/

subsumes important phonological distinctions between emphatic and non-emphatic variants that will be examined in Chapter 5.

4.1 General Patterns of Post-Velar Spreading

My first analysis considers formant levels across all vowel measures grouped by preceding or following consonant, using only words having plain oral consonants in addition to a token of the target consonant class in the specified position. This grouping of the data, while too imbalanced for rigorous statistical analysis, allows us to identify general patterns of coarticulation in the data.

The consonant classes for comparison were defined as follows: Emphatics (EMPH): /ṭ ṣ ḍ/; Plain coronal obstruents (COR): /t s d z/; Uvular stop (Q): /q/ ; Rhotics (R): /r/ (includes [ɾ̣] variant); Pharyngeals (PHAR): /ħ ʕ/. The formant frequency distributions for /a/ and /i/ folowing each of these consonant classes is shown in Figure 4.1 below.

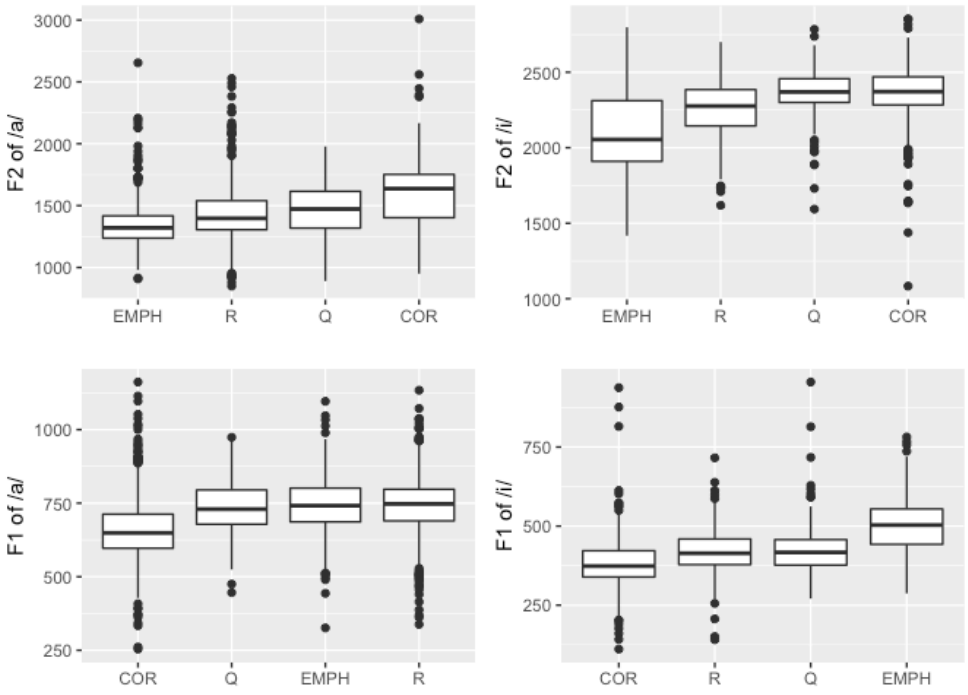

Figure 4.1: Formant frequencies organized by class of preceding consonant.

The values in Figure 4.1 show that, compared to vowels following plain coronals, vowels following emphatic coronals had consistently lower F2 and higher F1 values. In the plain coronal condition, /a/ had a mean F1 of 658 Hz and F2 of 1584 Hz, compared to 741 Hz and 1341 Hz in the emphatic condition; for /i/, the frequencies were 382 Hz and 2362 Hz in the plain condition as opposed to 499 Hz and 2106 Hz in the emphatic condition. All of these differences were found to be statistically significant.[32]

Vowels following both /q/ and /r/ are characterized by intermediate formant values between the emphatic and plain coronal distributions, with the single exception of F1 of /a/ after /r/, which is higher than F1 of /a/ after an emphatic coronal. The alignment of these

[32] $F1_{/a/}$: ***$t = 22.4(1863)$, $p < 0.0001$; $F2_{/a/}$: ***$t = 30.9(2368)$, $p < 0.0001$; $F1_{/i/}$: ***$t = 19.0(408)$, $p < 0.0001$; $F2_{/i/}$: ***$t = 15.0(357)$, $p < 0.0001$

intermediate /q/ and /r/ distributions varies, being closer to the plain coronal distribution for /i/, and closer to the emphatic coronal distribution for /a/. In the case of F1 of /a/, for which the rhotic distribution has higher mean frequency than the emphatic distribution, there is in fact no significant difference between the two samples ($t = 0.50(1961)$, $p = 0.62$) or even between the /q/, emphatic, and /r/ samples taken together ($F_2 = 2.23$, $p = 0.11$). In all other measures, however, /q/ and /r/ environments differed significantly from both plain and emphatic coronals.[33]

The observed difference between vowels near plain and emphatic coronal obstruents simply confirms the existence of discrete allophones associated with emphatic and plain consonantal contexts. The results for /r/ and /q/ are more ambiguous in interpretation, since there may either be a uniformly intermediate frequency distribution, or a mixture of tokens belonging to plain and emphatic distribution inside each class. The more refined analyses that follow indicate that there is, in fact, an intermediate frequency range associated with uvular coarticulation, and that these frequencies are typical of many post-rhotic vowels as well. As we will demonstrate in Chapter 5, however, lexical and dialectal variation between plain and emphatic rhotics are also crucial factors in determining patterns of post-velar spreading.

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[33] $F1_{/a/}$, /r/~/q/~COR: $***F_2 = 372.2$, $p < 0.0001$; $F2_{/a/}$, /r/~/q/~EMPH: $***F_2 = 97.7$, $p < 0.0001$; $F2_{/a/}$, /r/~/q/~COR: $***F_2 = 190.2$, $p < 0.0001$; $F1_{/i/}$, /r/~/q/~EMPH: $***F_2 = 110.6$, $p < 0.0001$; $F1_{/i/}$, /r/~/q/~COR: $***F_2 = 57.3$, $p < 0.0001$; $F2_{/i/}$, /r/~/q/~EMPH: $***F_2 = 110.5$, $p < 0.0001$; $F2_{/i/}$, /r/~/q/~COR: $***F_2 = 97.7$, $p < 0.0001$; $F2_{/i/}$, /r/~/q/~EMPH: $***F_2 = 66.9$, $p < 0.0001$.

4.2 Analysis of Specific Consonant Class Effects

In order to provide a more nuanced analysis, we will proceed to consider balanced or nearly-balanced phonetic sets comparing a full complement of consonant types with post-velar articulation – uvular fricatives /χ ʁ/ and pharyngeal consonants /ħ ʕ/ in addition to the four categories presented above, and with the addition of plain velar /k/ as a plain oral control condition in contrast to /q/. Separate comparisons are provided for consonants in each testable configuration relative to the vowel – immediately preceding, immediately following, and distantly following. Due to dataset limitations, these contexts could only be fully investigated for the /a/ vowel, and adjacent /i/ is also considered in the adjacent following context.[34]

4.2.1 /a/ Immediately Following a Post-velar Consonant

Table 4.1 gives cross-speaker F1 and F2 averages and standard deviations for /a/ following [ħ], [q], [ţ], [k], and [t] respectively in syllables ending in [b]. For uvular [χ], there were no words in the data with [b] following the vowel, so the syllable [χat] in *xatem* 'ring' was used instead. The six speakers with no tokens of *rkabi* produced a variant plural form *rekbat* of *rkba* 'knee.'

[34] Chapter 5 includes a more limited consideration of following adjacent /u/ that allows comparison of /r/, but not of uvulars or gutturals, to emphatic/plain coronal effects.

C:	[ħ] [sħab] (21 speakers)	[χatəm] (22 speakers)	[q] [qabla] (22 speakers)	[ṭ] [ṭab] (21 speakers)	[k] [rkabi] (17 speakers)	[t] [ktab] (22 speakers)
F1init	741.6 (48.1)	727.8 (55.5)	787.0 (48.0)	790.1 (64.5)	595.3 (50.2)	621.3 (50.0)
F2init	1697.7 (92.2)	1609.3 (124.8)	1481.2 (105.2)	1270.5 (85.3)	1951.4 (114)	1745.3 (88.5)
F1mid	734.1 (52.1)	712.5 (48.2)	758.1 (50.2)	780.1 (55.5)	605.2 (47.2)	637.9 (48.1)
F2mid	1685.4 (92.2)	1627.8 (113.8)	1495.1 (130.5)	1262.2 (71.4)	1915.4 (115.7)	1713 (86.8)
F1end	715.6 (55.1)	678.2 (48.8)	717.9 (61.5)	770.3 (63.1)	601.6 (47.5)	637.4 (44.5)
F2end	1662.9 (87.6)	1653.4 (101.3)	1513 (131.9)	1260.7 (64.9)	1878.2 (121.9)	1692.3 (90.1)

Table 4.1: Mean formant values of [a] when immediately following consonants of different classes (standard deviations in parentheses)

Some notable patterns emerge from these data. First, the mean F1 of [a] in midpoint measurements, which is correlated with primary pharyngealization, is only slightly above 600 Hz after [k] and [t] but is well above 700 Hz after [ħ], [q], [χ] and [ṭ]. F2 of /a/, on the other hand, is lowest following [ṭ], somewhat higher when following [q], and highest when following [ħ], [t], [χ] or [k]. The distinction between the [q] and [ṭ] conditions is statistically significant (***$t = 4.89$ (61), $p < 0.001$). Over the course of the vowel, the frequency of F1 lowers significantly after pharyngeals and uvulars, but not after plain or emphatic oral consonants. Uvular fricatives and stops differ in that [q] is associated with F2 lowering, but [χ] is not.

ANOVAs comparing *xatem* to the vowels in *sħab* and *qabla* support a significant phonetic distinction between all three groups of consonants at midpoint, since despite the similarities with [ħ] the magnitude of F1 raising is lower for [χ], and unlike [ħ] there is a significant (though also low-magnitude and gradient) F2 lowering effect.[35] This F2 lowering is a weaker, more coarticulatory version of the high-magnitude, stable F2 lowering associated with

[35] F1: ***$F_5 = 31.7$ ($p < 0.0001$); F2: ***$F_5 = 34.9$ ($p < 0.0001$). Post-hoc t-tests confirm that all three distributions are significantly different.

[q] (approx. 1650 Hz instead of 1500 Hz), and suggests that the fricative may trigger a more purely phonetic version of the same uvular effect.

So, on the F1 dimension (associated with gutturality), uvulars, pharyngeals, and emphatics pattern together in exhibiting raising, while on the F2 dimension (associated with emphasis), pharyngeals pattern with non-emphatics and uvulars have their own distribution between the emphatic and non-emphatic distributions. This distribution of effects can be schematized in terms of featural organization across places of articulation in Figure 4.2, with brackets surrounding regions with distinctive phonetic effects on neighboring vowels.

F1:	[Lower Pharyngeal	Upper Pharyngeal	Uvular]	Oral
F2:	Lower Pharyngeal	[Upper Pharyngeal]	[Uvular]	Oral

Figure 4.2: Schematic organization of post-velar spreading effects on following /a/.

Adding /r/ into this framework, we consider the behavior of the first /a/ in *jranat*, one of the plural variants for *jrana* 'frog,' which was attested by 13 out of 23 speakers. Figure 4.3 plots all first-syllable vowel tokens for *jranat*, *ṭab*, *tab*, and *qabla* in F1-F2 space at beginning (upper left), middle (upper right), and end (lower left) measurement points, and then gives a boxplot of midpoint F2 distributions (lower right). Note that the formant clusters after [ṭ] and [t] are consistently distinct and non-overlapping, while [a] after [q] exhibits considerable variability in the space between plain and emphatic coronal clusters, and the post-[r] tokens cluster towards the center of the [q] space.

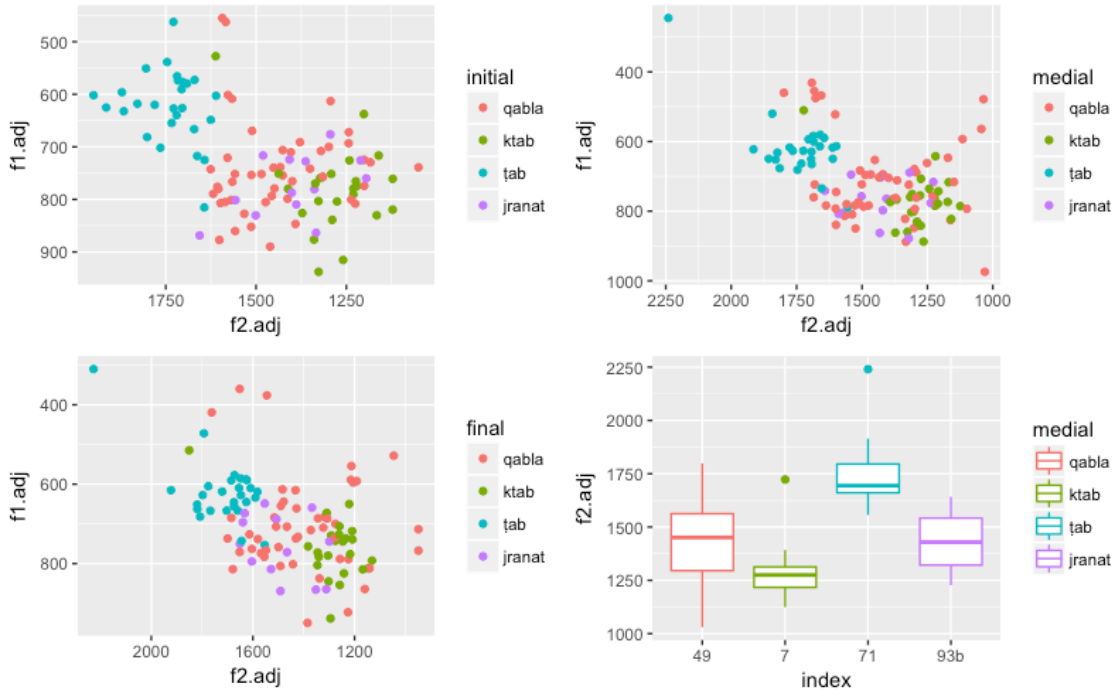

Figure 4.3: Formant profile of [a] after [q], [ṭ], [r], [t].

The difference between midpoint F2 of *q*[a]*bla* and *jr*[a]*nat* is not statistically significant ($t = 0.32(27)$, $p = .075$), while both the differences between *jranat* and both *ktab* ($t = 6.95(18)$, $p < 0.0001$) and *ṭab* ($t = 3.48(22)$, $p = 0.002$) are. Similar results hold for F1. Table 4.2 provides mean formant data for *jranat,* which indicate that [a] indeed has a similar pronunciation after [q] and [r] that is distinct from the pronunciation after pharyngeals, coronal emphatics, or plain oral consonants, and [r] and [q] may be interpreted as belonging to a unique post-velar consonant class.

	[jr̲anat]
F1init	774.7 (59.4)
F2init	1394.3 (130.8)
F1mid	768.8 (60.6)
F2mid	1434.1 (132.8)
F1end	756.8 (80.5)
F2end	1492.7 (126.0)

Table 4.2: Mean F1 and F2 of [a] following /r/ in *jranat* 'frogs' (standard deviations in parentheses).

4.2.2 /a/ Immediately Preceding a Post-velar Consonant

Table 4.3 reports frequencies for [a] preceding the target consonant classes, contrasting [ħ], [q], [ṭ], and [t], and using voiced [ʁ] in the uvular fricative condition.[36]

C:	[ħ] [baħ] (missing 3)	[dmaʁ] (missing 1)	[q] [baqi] (missing 2)	[ṭ] [baṭ] (missing 3)	[t] [bat] (missing 3)
F1init	696.3 (57.8)	782.2 (72.4)	735.3 (54.9)	752.9 (51.7)	653.2 (43.3)
F2init	1706.2 (116.8)	1344.3 (123.1)	1308.4 (106.9)	1229.5 (95.7)	1754.3 (99.9)
F1mid	725 (55.6)	786.8 (65.1)	764.8 (52.5)	768.0 (49.0)	663.8 (41.4)
F2mid	1694.1 (126.7)	1340.7 (118.8)	1310.1 (97.1)	1240.1 (95.9)	1757.2 (96.6)
F1end	747.2 (52.1)	772.4 (57.5)	773.2 (47.6)	766.0 (54.1)	658.1 (41.4)
F2end	1702 (102.9)	1321.9 (129.3)	1290.5 (88.5)	1263.1 (85.6)	1760 (93.5)

Table 4.3: Mean formant values of [a] when preceding consonants of different classes (standard deviations in parentheses)

[36] The data contained no appropriate words for comparison containing the sequences [ak] or [aχ].

These data indicate that leftward emphasis spread operates similarly to rightward spread. For F1, [ħ], [q], and [ṭ] trigger the guttural raising effect, which weakens with distance from the triggering consonant, and for F2, [q] and [ṭ] are characterized by two distinct lowering effects that persist throughout the vowel.[37] For *dmaɣ*, we see a pattern of stable raised F1 and lowered F2 that is almost identical to the effect observed in [q], but which differs from the gradient F1 raising and high F2 before [ħ].[38] The similarity in spreading effects between preceding and following vowels is supported by two-way ANOVAs combining the midpoint data in Tables 4.3 and 4.1, grouping by adjacent consonant and direction of spreading, which find that consonant type, but not direction, is a significant source of variance.[39]

Again extending this analysis to include /r/, we now consider the behavior of the words *far* 'mouse' and *bar* 'bar,' both attested by 22 out of 23 speakers. *bar* is a borrowing from French, while *far* is a native Arabic word. Table 6.4 provides mean formant values for [a] in these two words.

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[37]The distinction between F2 in the [q] and [tˤ] conditions is statsitically significant: $t = 2.35$ (40), $p = 0.024$.

[38] [dmaʁ]/[baqi]: (*F1init:2.43(41),p = 0.020; F1mid:1.24(41),p = 0.22; F1end:0.0481(42),p = 0.96; F2init:1. 03(42),p = 0.31; F2mid:0.939(42),p = 0.35; F2end:0.948(39), p = 0.35); [dmaʁ]/[baħ]; (***F1init:4.36(41),p < 0.0001; *F1mid:3.39(42),p = 0.0015; F1end:1.52(42),p = 0.13; ***F2init:10.0(42),p < 0.0001; ***F2mid:9.52(41),p < 0.0001; ***F2end:10.8(41),p < 0.0001). Unusually compared to other uvular fricative data, *dmaɣ* does not have a noticeable formant transition across the vowel; I suggest that this may be due to rightward coarticulation from the preceding labial consonant.

[39] For F1, consonant class was a highly significant source of variation (F3 = 47.5, p < 0.001), while direction of spread did not approach significance (F2 = 0.191, p = 0.663). For F2, direction of spread was significant at the .05 level only if [q] was included in the analysis (F2 = 4.255, p = 0.041); if [q] was excluded and only [ħ], [tˤ], and [t] were compared, direction of spread was found to have no significant effect on variance in F2 (F2 = 0.295, p = .588).

	[bar]	[far]
F1init	749.4 (57.3)	774.5 (51.6)
F2init	1230.8 (126)	1251.6 (95.2)
F1mid	752.5 (52.8)	778.3 (46.5)
F2mid	1250.3 (110.9)	1265 (108.7)
F1end	759.4 (54.5)	777.8 (38.7)
F2end	1287.4 (97.9)	1280.1 (103.6)

Table 4.4: Mean formant values of [a] when followed by /r/ (standard deviations in parentheses)

An obvious property of these data is how acoustically similar the two words are; at midpoint there is no significant difference between them in either F2 ($t = 0.471(46)$, $p = .63$) or F1 ($t = 1.84(47)$, $p = .07$). The formant tracks are also very flat in both words; initial measures are not significantly different from final measures in either F2 (*bar*: $t = 1.88(51)$, $p = .07$; *far*: $t = 0.947(42)$, $p = .34$) or F1 (*bar*: $t = 0.676(54)$, $p = .50$; *far*: $t = 0.241(39)$, $p = .81$). Both words, then, have the same [a] variant, with F1 raised above 700 Hz and F2 lowered below 1300 Hz – in other words, the emphatic allophone of /a/.

The situation with following [r] is, however, ambiguous from a strictly statistical perspective, since the midpoint F2 of [a] in *bar* is not significantly different from either *baqi* ($t = 2.00(46)$, $p = .05$) or *baṭ* ($t = 0.345(46)$, $p = .73$). The same is true of *far*, though in both words the [a] pronunciation trends closer to the [ṭ] distribution than to the [q] distribution. This pattern is illustrated in Figure 4.4, which compares F2 distributions between the [ʁ], [q], [r], and [ṭ] conditions. While [r] affects preceding [a] in these words more like a coronal emphatic than like a uvular, the tokens are distributed in such a way that it is not purely identifiable with either distribution.

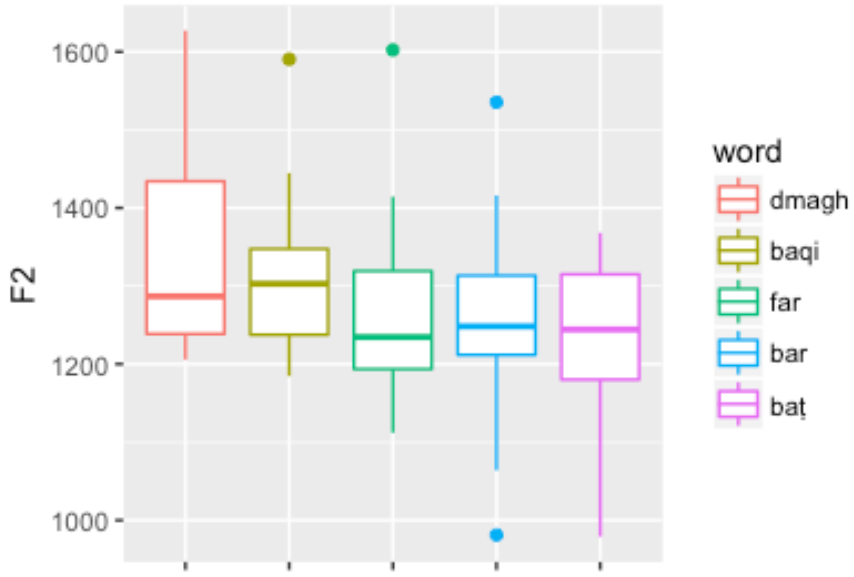

Figure 4.4: Midpoint F2 distributions for preceding /a/.

This result complicates the proposed grouping of /r/ with uvulars, by showing that at least for some words in some phonetic contexts, rhotics can behave more like coronal emphatics in their effect on nearby vowels. Such an observation points us towards endorsement of a phonological distinction between different rhotic types, as discussed later on in Chapter 5. For the other (non-rhotic) consonant types, however, the four-way distinction between uvulars, pharyngeals, emphatic coronals, and plain oral consonants holds for leftward spreading as it does for rightward spreading, with similar effects.

4.2.3 /i/ Immediately Following a Post-velar Consonant

Table 4.5 reports the formant frequencies of [i] tokens immediately following the consonant types tested above for /a/. Note that there are no uvular fricative data in this context, and that

only 60% of speakers had tokens of [ṭisan] (as for *kas*, the remainder provided a different plural form).

C:	[ħ] [kħib] (22 speakers)	[q] [baqi] (21 speakers)	[ṭ] [ṭisan] (14 speakers)	[k] [kisan] (22 speakers)	[t] [tis] (20 speakers)
F1init	422.6 (54.4)	457.7 (59.6)	551.2 (57.8)	337.8 (39.0)	336.4 (56.2)
F2init	2409.3 (94.9)	2301.2 (156.6)	1891.0 (180.2)	2388.9 (86.4)	2382.7 (110.6)
F1mid	412.3 (60.4)	442.3 (53.4)	512.4 (48.7)	334.0 (38.2)	341.5 (51.9)
F2mid	2411.9 (118.6)	2378.4 (99.7)	1994.8 (180.2)	2306.9 (286.4)	2379.3 (139.9)
F1end	403.1 (62.1)	449.1 (102.9)	478.4 (60.6)	331.0 (41.1)	341.0 (60.0)
F2end	2359.1 (119.8)	2391.7 (138.5)	1990.7 (179.1)	2263.6 (228.6)	2373.4 (140.2)

Table 4.5: Mean formant values of [i] when immediately following consonants of different classes (standard deviations in parentheses)

These data illustrate a similar F1 pattern to that observed for /a/: raised F1 associated with emphatics, uvulars, and pharyngeals, and a much lower F1 following plain oral consonants. Note that here, however, F1 is raised considerably more after [ṭ] than it is after [ħ] or [q]. For F2, [i] is only lowered after [ṭ], and not after pharyngeals or uvulars. For [i], then, the featural schematic is as illustrated in Figure 4.5: only the emphasis feature associated with [ṭ] affects F2, there is no distinctively uvular effect, and the guttural feature raises F1 as in /a/. The extremely high F1 associated with [ṭ] may be explained as the emphasis feature affecting F1, either replacing or adding to the F1 raising associated with the guttural feature.

F1:	[Lower Pharyngeal	[Upper Pharyngeal]	Uvular]	Oral
F2:	Lower Pharyngeal	[Upper Pharyngeal]	Uvular	Oral

Figure 4.5: Schematic organization of post-velar spreading effects on following /i/.

Once again turning to the behavior of /r/, we consider the word *rib* 'curdled.'[40] Table 4.6 gives formant means and standard deviations for tokens of this word.

	[rib]
F1init	416.8 (47.7)
F2init	2153.9 (206.3)
F1mid	396.3 (60.6)
F2mid	2288.1 (149.1)
F1end	375.3 (63.5)
F2end	2325.7 (129.4)

Table 4.6: Mean formant values of [i] when followed by /r/ in *rib* 'curdle' (standard deviations in parentheses)

Figure 4.6 compares midpoint measures of *rib* to measures of [i] following [q], [ṭ], and [k]. The results indicate that in this context, as for following [a], [r] has a spreading effect more similar to the effect of [q] than to the effect of [ṭ].

[40] This word was elicited as a member of a reported historical *r/ṛ* minimal pair for which the other member of the pair was found to be ungrammatical for many speakers, and not to be indicative of a plain/emphatic contrast for any.

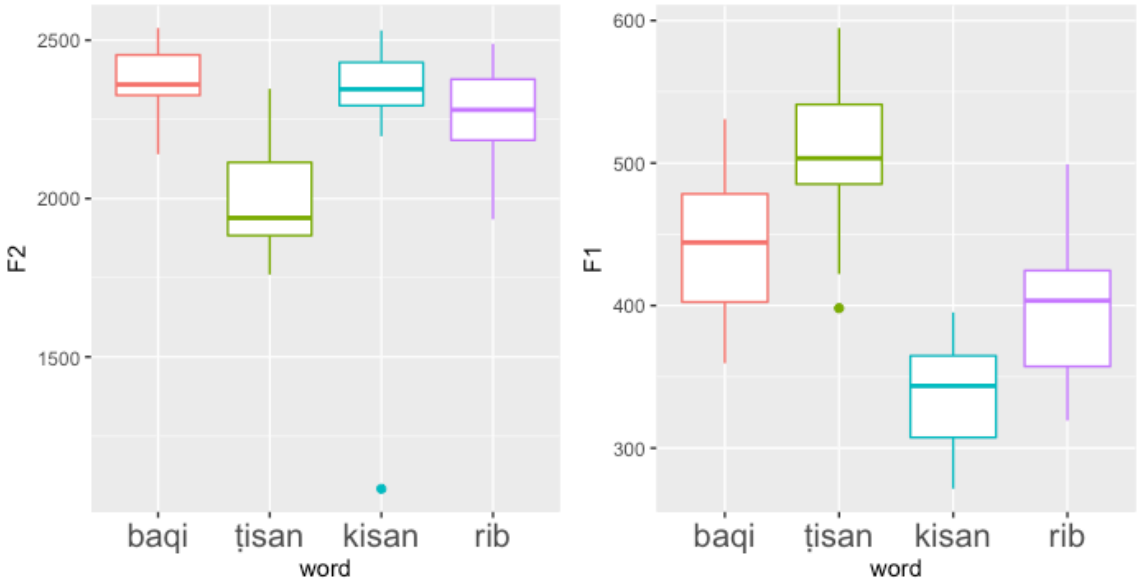

Figure 4.6: Formant distributions for following [i] at midpoint, including after /r/.

4.2.4 Non-adjacent /a/ Following a Post-velar Consonant

Comparison of following non-adjacent vowels allows for assessment of long-distance feature spreading. A full comparison of non-adjacent vowels is possible for following /a/ in the syllable following initial [ṭ], [q], [ʕ], [k], and [χ],[41] with results as shown in Table 4.7.

[41] The only word with a plain coronal in this conditioning environment is *ʔadewat* 'implements,' which is problematic for a number of reasons : first, because it is a Standard Arabic word that primed code-switching, second, because the target vowel is in an inflectional suffix, and third, because the [w] adjacent to the target vowel may cause labiovelar coarticulation. *kisan*, on the other hand, is perfectly suited as a plain control to contrast with emphatic *ṭisan*, since the syllable containing the target vowel is identical in both and there is no reason to hypothesize long-distance spreading from [k].

C:	[ʕ] [ʕəssas] (23 speakers)	[q] [qəddam] (22 speakers)	[ṭ] [ṭisan] (14 speakers)	[k] [kisan] (22 speakers)	[χəbbaz] (22 speakers)
F1init	635.5 (53.7)	662.2 (57.2)	739.0 (74.3)	675.9 (61.8)	630.1 (55.1)
F2init	1743.4 (80.2)	1737.3 (106.1)	1495.8 (121.2)	1734.8 (102.4)	1699.7 (126.3)
F1mid	644.0 (53.0)	678.6 (60.6)	736.0 (72.2)	686.9 (61.7)	626.6 (53.1)
F2mid	1727.1 (86.4)	1705.8 (110)	1523.6 (127.7)	1720 (104.0)	1691.5 (124.7)
F1end	633.2 (54.1)	685.3 (56.7)	708.4 (123.3)	669.5 (73.8)	613 (46.7)
F2end	1701.7 (87.2)	1684.1 (117.9)	1540.1 (98.6)	1707.7 (115.6)	1683 (119.5)

Table 4.7: Mean formant values of /a/ when distantly preceded by consonants of different classes (standard deviations in parentheses)

The results in Table 4.7 confirm that long-distance post-velar harmony is only operative in the case of emphatic coronals, and not for gutturals or uvulars. The [ṭ] in *ṭisan* triggers lowering of F2 and raising of F1, with a transition to lower F1 over the course of the vowel, but unlike for adjacent [a], neither the primary pharyngeal [ʕ] nor the uvulars [q] and [χ] raise F1 in non-adjacent [a], nor is [q] or [χ] associated with a lowering of F2. This difference suggests that guttural F1 raising is a local coarticulatory effect, and that the uvular feature triggering lowered F2, though stronger and less gradient in the case of /q/, may belong to a similar class of phenomena. One the other hand, the analogous upper-pharyngeal feature associated with [ṭ] has a broader, more categorical range of spreading effects. Figure 4.7 illustrates this much reduced set of post-velar spreading effects with the same schematic used in Figures 4.2 and 4.5.

F1:	Lower Pharyngeal	[Upper Pharyngeal]	Uvular	Oral
F2:	Lower Pharyngeal	[Upper Pharyngeal]	Uvular	Oral

Figure 4.7: Schematic organization of long-distance post-velar spreading effects to /a/.

Since this phonetic environment provides a categorical distinction between coronal emphasis and other kinds of post-velar spreading, it can serve as a useful test case for evaluating the underlying behavior of /r/. Here we will consider /r/ in the word *jranat* 'frogs,' which we found to be characterized by uvular-like local spreading patterns in section 4.2.1. Table 4.8 gives mean formant values for the second [a] in this word, and Figure 4.8 graphs midpoint formant values for each token as compared to *ṭisan* and *kisan* tokens.

	[jran̲at]
F1init	699.7 (69.8)
F2init	1701.6 (104.7)
F1mid	696.2 (64.1)
F2mid	1685.6 (100.5)
F1end	677.1 (73.6)
F2end	1678.8 (89.5)

Table 4.8: Mean formant values of /a/ when distantly preceded by /r/ in *jranat* (standard deviations in parentheses)

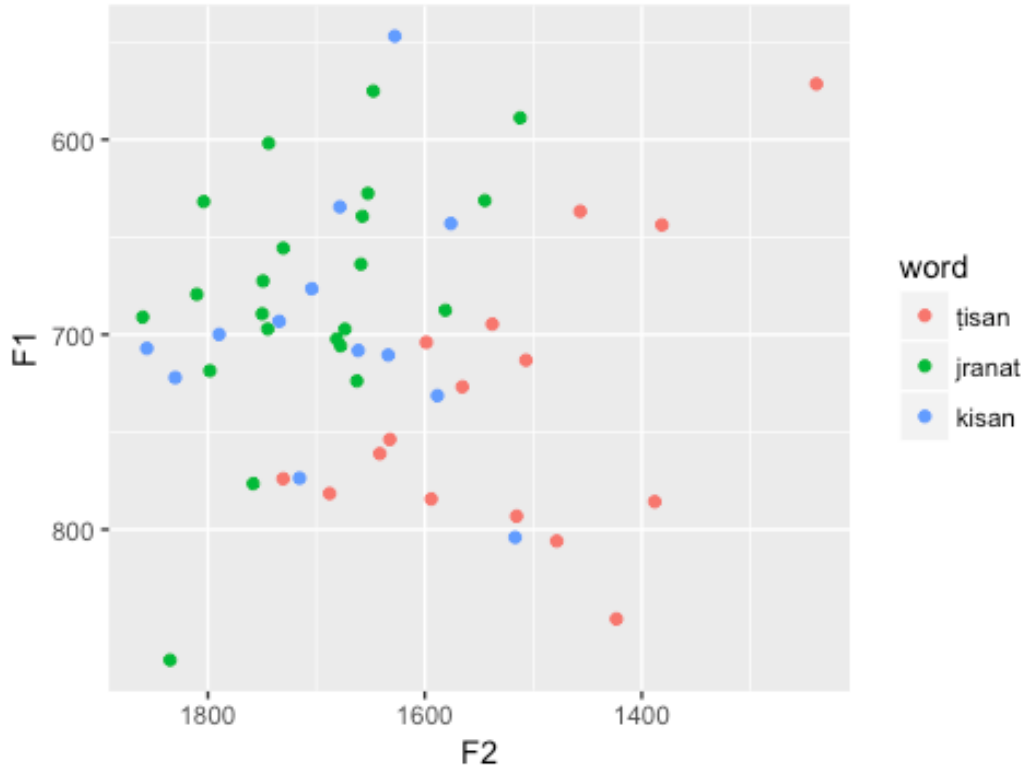

Figure 4.8: Scatterplot of midpoint tokens comparing the final [a] in *jranat* with that in *ṭisan* and *kisan*.

These data clearly indicate that in general, *jranat* patterns with *kisan* and is distinct from *ṭisan*. Statistical tests confirm this conclusion: there is not a significant difference between the distribution of midpoint F2 of the second /a/ between *jranat* and the corresponding distribution in *kisan* ($t = 0.604(23), p = .55$), but there is a highly significant difference between *jranat* and *ṭisan* ($t = 3.82(27), **p = .0007$). At least in this word,[42] the uvular-like coarticulation associated with /r/ does *not* engage in the long-range harmony processes associated with coronal emphasis.

[42] And in the word *rkbat*, which was found to have an almost identical distribution of [a] tokens over 13 speakers.

4.3 Analysis of Acoustic Coarticulatory Patterns

The preceding pages have systematically described differences in spreading behavior between different consonant classes defined with respect to postvelar features. With the exception of [r], the results indicate that three separate and consistently applied spreading features operate in the Moroccan Arabic of Fes, which we may describe as follows:

[GUT]: The guttural effect causes local raising of F1, spreading in both directions but only to adjacent vowels. This effect is usually gradient, suggesting that it is a coarticulatory phonetic effect, and it is triggered by [r q ħ χ ʁ ʕ] (though the effect seems to be weaker for the uvular fricatives).

[UVU]: The uvular effect causes bidirectional local lowering of F2 in the /a/ vowel, but perhaps not in the /i/ vowel. This effect is triggered by [r q χ ʁ]. The uvular lowering effects the entire vowel for [q] and [r], but again seems to be weaker for [χ ʁ] which cause F2 lowering only in the nearer part of the vowel.

[EMPH]: The emphasis effect lowers F2 in vowels across the entire word in either direction,[43] and raises the F1 of /i/. This applies to [t̪] in our dataset, and we know it also applies to [s̪ d̪ z̪]. Based on the data seen so far, [r] triggers an effect indistiguishable from [EMPH] in some contexts (left-spreading to [a]), but not in others (any right-spreading context).

[43] Though we have no direct evidence for long-distance left-spreading, this is uncontroversially established in previous literature on Moroccan Arabic (e.g. Gouma 2013).

As we shall see in the next chapter, the difficulty in categorizing [r] is due to lexical and dialectal differences between different rhotic classes, rather than due to its participation in a different type of post-velar spreading from those described here. The typology presented here, however, provides a reference framework according to which the spreading characteristics of various [r] tokens can be evaluated.

Note that, while I am discussing all three post-velar features in terms of their phonetic realizations, [EMPH] spreading is truly a phonological process, while [UVU] and [GUT] may be interpreted in the context of vowel data as phonetic features causing coarticulation. There is, however, reason to believe that both the guttural and uvular features also have a phonological basis – for gutturality, this has been well documented by researchers from McCarthy onwards, and for uvularity, evidence will be presented in the next chapter that it independently corresponds to a structural opposition in Moroccan Arabic.

Finally, then, on the basis on the frequency data described in the preceding sections, the acoustic properties in Table 4.9 are proposed as diagnostic of vowels affected by each type of post-velar spreading effect, with the disclaimer that the outer limits of each frequency range are approximate and that F1 and F2 values should be considered more reliable than the impressionistic ΔF1 and ΔF2 criteria. According to this analysis, only vowels adjacent to the conditioning segment should exhibit the [UVU] and [GUT] pronunciation, but any vowel in the same morpheme as a conditioning [EMPH] segment will have the [EMPH] pronunciation.

[EMPH]	$F1_{/a/}$: 700-850 Hz	$F2_{/a/}$: 1200-1350 Hz	Small ΔF1, Small ΔF2
	$F1_{/i/}$: 400-550 Hz	$F2_{/i/}$: 1800-2100 Hz	Small ΔF1, Small ΔF2
[UVU]	$F1_{/a/}$: 700-850 Hz	$F2_{/a/}$: 1350-1550 Hz	Large ΔF1, Small/Variable ΔF2
	$F1_{/i/}$: 400-550 Hz	$F2_{/i/}$: 2100-2500 Hz	Large ΔF1, Small ΔF2
[GUT]	$F1_{/a/}$: 700-850 Hz	$F2_{/a/}$: 1550-1750 Hz	Large ΔF1, Small ΔF2
	$F1_{/i/}$: 400-550 Hz	$F2_{/i/}$: 2100-2500 Hz	Large ΔF1, Small ΔF2
PLAIN	$F1_{/a/}$: 550-700 Hz	$F2_{/a/}$: 1550-1750 Hz	Small ΔF1, Small ΔF2
	$F1_{/i/}$: 300-400 Hz	$F2_{/i/}$: 2100-2500 Hz	Small ΔF1, Small ΔF2

Table 4.9: Acoustic properties of /a/ and /i/ by post-velar coarticulatory class.

Chapter 5. Distributional Patterns of Rhotic Emphasis

The last chapter described and categorized the differing acoustic effects of distinct post-velar consonant classes on nearby vowels. This chapter makes use of that information to empirically analyse the distinction between and variable distribution of emphatic and non-emphatic rhotic variants in the production of Moroccan Arabic speakers. Intraspeaker variation is found to be primarily lexical in nature, with some predictable but not categorical effects of phonetic environment in determining the choice of rhotic variant. This suggests that for this dialect of Moroccan Arabic, rhotic pharyngealization/uvularization approaches phonemically distinctive status, but nevertheless preserves traces of a historically allophonic relationship. To the degree that interspeaker variation in the distribution of emphatic rhotics is predictable, it is found to be correlated with external regional influences on an individual's speech rather than with demographic characteristics such as age, sex, or class.

The relationship between rhotic uvularization and pharyngealization, as indicated by the acoustics of adjacent vowels, exhibits some unanticipated complexities. While the majority of emphatic /ṛ/ tokens are found to be indistinguishable in their adjacent vowel effects from pharyngealized coronal obstruents, a number of speakers have /ṛ/ tokens that trigger the attentuated F2 lowering associated with uvularization only in the allophonic plain environment, and only in paradigms which are typically levelled to /ṛ/. Another set of speakers exhibits the uvularization effect after a subset of plain /r/ tokens, in words which typically preserve an allomorphic/allophonic alternation between /r/ and /ṛ/.

5.1 Rhotic Alternations in Lexical Paradigms

This chapter will focus on the comparison of a set of singular/plural paradigms having the form $C_1VC_2 \sim C_1iC_2an$, which is a productive template for plural formation of biconsonantal nouns in Moroccan Arabic. As indicated in Table 3.4, I elicited a number of singular/plural paradigms having this form, several of which had a rhotic consonant as C_2, others of which had only plain coronal consonants, and some of which contained an emphatic conronal consonant triggering pharyngealization harmony throughout the word.[44] These paradigms have the advantage of containing C_2 adjacent to /a/ in both the historical [r]-conditioning environment of adjacent /i/ (C_1iC_2an) and the historical [ṛ]-conditioning environment of adjacent /a/ or /u/ (the singular is typically C_1aC_2 or C_1uC_2), allowing for easy assessment of paradigm levelling.

In addition to the words with C_1iC_2an plurals, we consider the singular/plural pairs *ħmar ~ ħmir* 'donkey' and *kbir ~ k$^{(w)}$bar* 'large,' which have been reported to preserve an [r]~[ṛ] alternation associated with adjacent vowel type by several previous researchers, including both Hilili (1979) and Heath (2002). While these words offer some complicating phonetic factors for analysis in the form of primary pharyngeals and variably realized labiovelar features, we shall see that they generally do conform to the rhotic emphasis alternation predicted by the historical allophonic rule, unlike other lexical paradigms.

Table 5.1 gives the raw formant and formant transition values averaged across all speakers for each vowel in each of these paradigms.

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[44] Even though *-an* can be analysed as a suffix combined with ablaut in the C_1iC_2an plural, its affixation does not constitute the kind of word-level morphological boundary that blocks emphasis spread in CMA.

Type	Word		Vowel	$F1_{mid}$	$F2_{mid}$	ΔF1	ΔF2
$C_1VC_2 \sim C_1iC_2an$ with rhotic	*bar*	Sg	*b*[a]*r*	752.5 (52.8)	1250.3 (110.9)	10.0 (44.6)	56.6 (72.4)
		Pl	*b*[i]*ran*	519.6 (57.0)	1990.3 (132.9)	60.4 (40.9)	-110.7 (90.0)
			bir[a]*n*	777.4 (81.8)	1419.9 (196.6)	-43.5 (100.0)	67.3 (156.0)
	well	Sg	*b*[i]*r*	387.0 (61.5)	2301.8 (123.1)	40.5 (42.8)	-78.7 (61.7)
		Pl	*b*[i]*ran*	459.0 (66.2)	2128.2 (208.9)	54.0 (32.7)	-83.6 (42.8)
			bir[a]*n*	717.1 (112.1)	1604.9 (153.1)	-9.1 (65.4)	-38.5 (229.7)
	mou-se	Sg	*f*[a]*r*	778.3 (46.5)	1265.0 (108.7)	3.3 (29.2)	28.4 (37.6)
		Pl	*f*[i]*ran*	421.3 (47.6)	2209.5 (130.3)	54.7 (37.8)	-126.5 (95.7)
			fir[a]*n*	691.9 (76.2)	1712.6 (144.2)	0.9 (37.2)	-41.4 (53.5)
	bus	Sg	*k*[a]*r*	795.3 (65.1)	1312.4 (94.0)	6.0 (42.2)	-16.2 (45.8)
		Pl	*k*[i]*ran*	540.8 (53.4)	2007.8 (138.2)	90.0 (44.1)	-250.2 (107.4)
			kir[a]*n*	805.6 (68.1)	1384.2 (119.8)	-22.4 (62.7)	59.2 (81.3)
	cave	Sg	*ɣ*[a]*r*	778.1 (47.4)	1265.2 (72.9)	1.7 (24.5)	28.3 (81.7)
		Pl	*ɣ*[i]*ran*	587.1 (70.5)	1893.8 (147.7)	37.0 (26.6)	-57.8 (87.6)
			ɣir[a]*n*	781.2 (96.1)	1413.7 (98.7)	-18.9 (46.6)	42.3 (77.5)
	bull	Sg	*t*[u]*r*	574.9 (110.4)	941.4 (179.8)	31.4 (126.0)	31.3 (220.0)
		Pl	*t*[i]*ran*	433.8 (61.5)	2167.6 (170.7)	57.4 (46.0)	-186.2 (108.5)
			tir[a]*n*	699.3 (73.9)	1630.0 (149.3)	19.8 (135.9)	31.9 (141.6)
$C_1VC_2 \sim C_1iC_2an$ without rhotic	*wash basin*	Sg	*ṭ*[a]*s*	779.8 (75.3)	1334.9 (99.0)	-28.0 (32.4)	35.4 (66.1)
		Pl	*ṭ*[i]*san*	512.4 (48.7)	1994.8 (180.2)	-72.8 (50.3)	99.7 (133.7)
			ṭis[a]*n*	736.0 (72.2)	1523.6 (127.7)	-30.6 (89.6)	44.2 (77.3)
	cup	Sg	*k*[a]*s*	640.4 (45.9)	1756.4 (83.8)	3.9 (35.1)	-37.4 (80.8)
		Pl	*k*[i]*san*	336.7 (37.9)	2305.8 (286.3)	-8.2 (22.8)	-127.4 (224.0)
			kis[a]*n*	682.0 (64.7)	1716.8 (102.7)	-4.9 (36.2)	-26.3 (55.5)
ablaut plural with rhotic	*big*	Sg	*kb*[i]*r*	403.2 (48.0)	2260.6 (124.0)	45.7 (26.6)	-114.4 (61.6)
		Pl	*kb*[a]*r*	712.2 (112.0)	1356.7 (370.4)	12.8 (47.0)	57.8 (72.1)
	don-key	Sg	*ħm*[a]*r*	810.8 (82.1)	1294.5 (137.9)	0.2 (87.7)	-3.6 (253.4)
		Pl	*ħm*[i]*r*	469.3 (52.8)	2335.4 (198.3)	33.2 (51.2)	-107.0 (181.3)

Table 5.1: Average midpoint formant measures and formant transition measures for individual word forms across all speakers. Shading indicates a vowel other than /a/ (blue = /i/, purple = /u/).

Table 5.1 indicates that even when all speakers' data is averaged together, certain words contain unambiguously emphatic vowel allophones while others exhibit unambiguously plain

allophones. The /a/ in /far/, for example, is an [ɑ] with an average F2 of 1265 Hz and F1 near 780 Hz, while the /a/ in /firan/ is an [æ] with average F2 of 1712 Hz and F1 under 700 Hz. Even when standard deviations are taken into account, these two vowels are far from overlapping.

For many words, however, the results are cloudier. When we see that both /kar/ and /kiran/ have an /a/ with high F1 and with F2 between 1300 and 1400 Hz, does this mean that these vowel tokens fall within the uvular distribution or that there is variation between speakers having an emphatic [ɑ] and others having a plain [a] with high F2? What about the guttural F1 effect applying across both conditions here, while it does not in *far~firan*? We might hope that standard deviation size could offer a clue to the answer, but in fact the standard deviations for F2 of /a/ in *kar~kiran* are smaller than those for *far~firan*, offering no indication that there is greater variance within the data for this paradigm. The speaker-specific analyses in the following section help to shed light on this problem, and indicate that a complex interaction of split distributions and phonetically intermediate uvularization is at work.

Finally, there is the complicating issue of the /u/ vowel in *tur*, which cannot be evaluated with respect to the /i/ and /a/ data presented in the previous chapter. To fill this gap, we can compare it to the formant patterns in *ṭub* 'clay' and *tut* 'mulberry,' as representative of emphatic-adjacent and plain-adjacent /u/ respectively. Table 5.2 presents data for these words.

Form	$F1_{mid}$	$F2_{mid}$	ΔF1	ΔF2
ṭ[u]*b*	560.6 (102.0)	835.5 (109.9)	-7.1 (79.2)	-29.8 (87.2)
t[u]*t*	449.2 (71.8)	1195.8 (250.7)	-14.5 (107.9)	-9.5 (286.2)

Table 5.2: Average formant measures for /u/ vowels in plain and emphatic environments.

Like both /a/ and /i/, /u/ exhibits raised F1 and lowered F2 when adjacent to a coronal emphatic obstruent. F1 is raised from approximately 450 Hz in the plain condition to approximately 560 Hz in the emphatic condition, and F2 lowers from near 1200 Hz to below 850 Hz. While ΔF1 and ΔF2 have no directional trend, they exhibit a wide degree of variance among tokens.

Compared to this baseline, *tur* has raised F1 and lowered but intermediate F2, a pattern which is familiar in the context of /a/ as the uvular effect. However, we must be cautious about such a generalization, since the average F2 of /u/ in *tur* is closer to the /u/ in *ṭub* than to the /u/ in *tut* and we have no uvular or left-spreading baseline for /u/ comparison. It could well be that 940 Hz is a reasonable F2 for /u/ preceding an emphatic consonant. What we know for sure is that the /u/ in *tur* is not 'plain,' and does exhibit a post-velar spreading effect.

Keeping all this in mind, Table 5.3 indicates the best interpretation of the speaker-aggregated lexical data with respect to the post-velar spreading patterns derived in section 4.3. Vowels characterized by high F1 and low F2 (dark shading) are labelled EMPH, while vowels characterized by high F1 and mid-range F2 (light shading) are labelled UVU with the exception of the non-adjacent lowered /a/ in *ṭisan.*[45] Note that despite our conjectures

[45] Recall that uvularization spreading does not extend to non-adjacent vowels.

about vowel stability in the previous chapter, ΔF1 and ΔF2 levels are not predictive of any post-velar spreading type within this data.

Paradigm Type		Form	$F1_{mid}$	$F2_{mid}$	PATTERN	ΔF1	ΔF2
C_1VC_2 ~ C_1iC_2an with rhotic	‘bar’	*b*[a]*r*	High	Low	EMPH	Small	Small
		b[i]*ran*	High	Low	EMPH	Mid	Large
		bir[a]*n*	High	Mid	UVU	Small	Small
	‘well’	*b*[i]*r*	Low	High	PLAIN	Mid	Small
		b[i]*ran*	High	Mid	UVU	Mid	Mid
		bir[a]*n*	Mid	High	PLAIN/GUT	Small	Small
	‘mouse’	*f*[a]*r*	High	Low	EMPH	Small	Small
		f[i]*ran*	High	High	PLAIN/GUT	Mid	Large
		fir[a]*n*	Mid	High	PLAIN(/GUT)	Small	Small
	‘bus’	*k*[a]*r*	High	Low	EMPH	Small	Small
		k[i]*ran*	High	Low	EMPH	Large	Large
		kir[a]*n*	High	Mid	UVU	Small	Mid
	‘cave’	*ɣ*[a]*r*	High	Low	EMPH	Small	Large
		ɣ[i]*ran*	High	Low	EMPH	Small	Mid
		ɣir[a]*n*	High	Mid	UVU	Small	Small
	‘bull’	*t*[u]*r*	High	Mid	UVU/EMPH	Small	Small
		t[i]*ran*	Mid	High	PLAIN/GUT	Mid	Large
		tir[a]*n*	Mid	High	PLAIN/GUT	Small	Small
C_1VC_2 ~ C_1iC_2an without rhotic	‘washbasin’	*ṭ*[a]*s*	High	Mid	(EMPH)	Small	Small
		ṭ[i]*san*	High	Low	(EMPH)	Large	Large
		ṭis[a]*n*	High	Mid	(EMPH)	Small	Small
	‘cup’	*k*[a]*s*	Low	High	(PLAIN)	Small	Small
		k[i]*san*	Low	High	(PLAIN)	Small	Large
		kis[a]*n*	Low	High	(PLAIN)	Small	Large
ablaut plural with alternating rhotic	‘big’	*kb*[i]*r*	Mid	High	PLAIN/GUT	Small	Large
		kb[a]*r*	High	Mid	UVU/EMPH	Small	Mid
	‘donkey’	*ħm*[a]*r*	High	Low	EMPH	Small	Small
		ħm[i]*r*	High	High	GUT	Small	Mid

Table 5.3: Analysis of speaker-aggregated lexical paradigm data.

More clearly than Table 5.1, this table highlights the division between paradigms having *r~ṛ* alternation – *faṛ~firan*, *tuṛ~tiran* – and paradigms having an emphatic/uvular *ṛ* variant in the /i/-adjacent context – *baṛ~biṛan*, *kaṛ~kiṛan*, *ɣaṛ~ɣiṛan. bir~biran* stands out as having little evidence of post-velar vowel coloring in the C_1iC_2an plural, indicating either that this paradigm is either unlerlyingly levelled to plain /r/ or that it shares an alternating underlying /r/ with *faṛ~firan* and *tuṛ~tiran*, in opposition to the other words with /ṛ/. As predicted, vowel-conditioned alternation is preserved in the *kbir~kbaṛ* and *ħmaṛ~ħmir* paradigms, although the post-velar effect may be of the uvular variety in *kbaṛ*.

We may address the question of the underlying form of *r* in *bir* by considering the alternate plural forms attested by many speakers, *byar* and *byur(a).* In these forms, the *r* is in an emphatic-favoring phonetic environment, and so would be expected to surface as [ṛ] if it were underlyingly allophonic. However, as shown in Table 5.4, this is not the case; the vowels in these words have unmistakably low F1 and high F2, indicating no post-velar effects and thus an adjacent plain [r].[46]

Form	$F1_{mid}$	$F2_{mid}$
by[a]*r*	647.5 (56.8)	1827.8 (110.7)
by[u]*r(a)*	495.3 (82.7)	1167.0 (140.0)

Table 5.4: Average formant measures for /a/ and /u/ in variant plural forms of *bir* 'well.'

[46] I have not reported vowel trajectories for these forms, since not all vowels were long enough for 50ms trajectories to be calculated and, as discussed above, the trajectories were not found to reliably differentiate post-velar spreading types.

5.2 Interspeaker Variability in Rhotic Emphasis

While the combined analysis in the last section can tell us that rhotic emphasis is lexically conditioned, it cannot tell us if there is any variation between speakers in its distribution. This section addresses this fine-grained level of analysis of individual speaker pronunciations of individual words. Since there never more than a dozen tokens per word per speaker, and often considerably fewer, these data are presented in terms of individual token values rather than averages and standard deviations. Only when speakers are grouped according to some variable, as in §5.2.3, is sample size large enough to support any statistical tests. §5.2.1 presents demographic and phonetic profiles of each of the 23 research participants contributing to the dataset, while §5.2.2 considers the interpretation of variability in individual patterns, and §5.2.3 demonstrates that social variables cannot be used as predictors of interspeaker rhotic variation.

5.2.1 Speaker-by-speaker Vowel Patterns

In the following pages, I describe the demographic background and *r*-adjacent vowel system of each speaker in turn. The vowel analysis is based on F1-F2 scatterplots of individual tokens for the words dicussed in the previous section, which are used to derive categorizations of words into plain, emphatic, and in some cases intermediate/uvular (notated as *ṙ*) distributions. Since some tokens were either missing or excluded to preserve data quality, there are paradigm gaps for some speakers. Occasional outlier tokens resulting from formant tracker problems will also be noted. These mostly occur in recordings with low-amplitude speech or high-amplitude background noise, which could not always be avoided or excluded due to constraints on recording conditions (see discussion in Chapter 3).

a) Speaker 02

Speaker 02 is a 21-year-old woman native to Fes. She studies at the university, and lives in the New City.

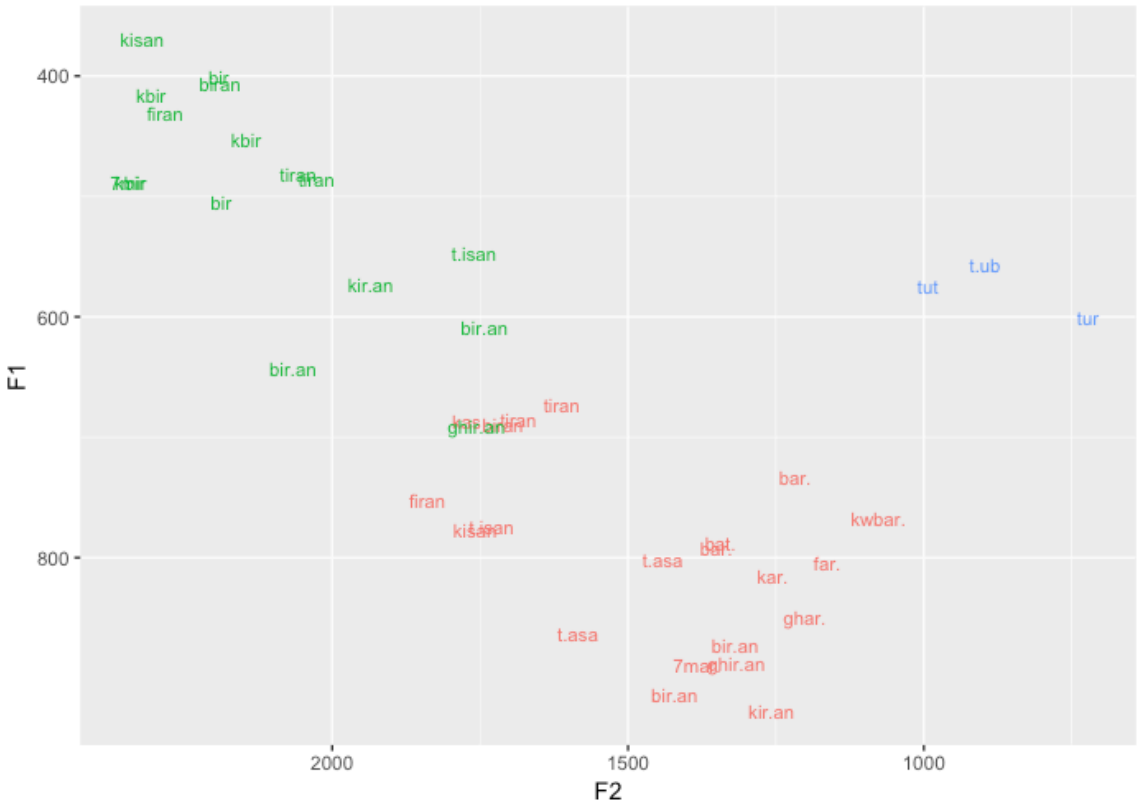

Figure 5.1: Distribution of midpoint vowel formants for Speaker 02. Colors indicate vowel type (/i/, /a/, or /u/).

Speaker 02 has a clear distinction between plain and emphatic distributions of /a/ and /i/. For /i/, *biṛan* 'bars,' *ɣiṛan* 'caves,' and *kiṛan* 'buses' are emphatic, while the rest are plain; for /a/, *tiran* 'bulls' and *ṭiran* 'mice' are plain, while the rest are emphatic. For /u/, *ṭub* is nearer to *tut* in F2 than it is to *tur*, but both *ṭub* and *tur* have a lower F2 than *tut* and so can be classed as emphatic. This establishes the following *r~ṛ* distribution across paradigms for this speaker :

SPK 02:	Only [r]:	*bir~biran*
	Alternating:	*faṛ~firan*
		tuṛ~tiran
		kbir~kbaṛ
		ħmaṛ~ħmir
	Only [ɾ]:	*baṛ~biɾan*
		kaṛ~kiɾan
		ɣaṛ~ɣiɾan

b) Speaker 03

Speaker 03 is a 23-year-old man native to Fes. He studies at the university, and lives in the New City.

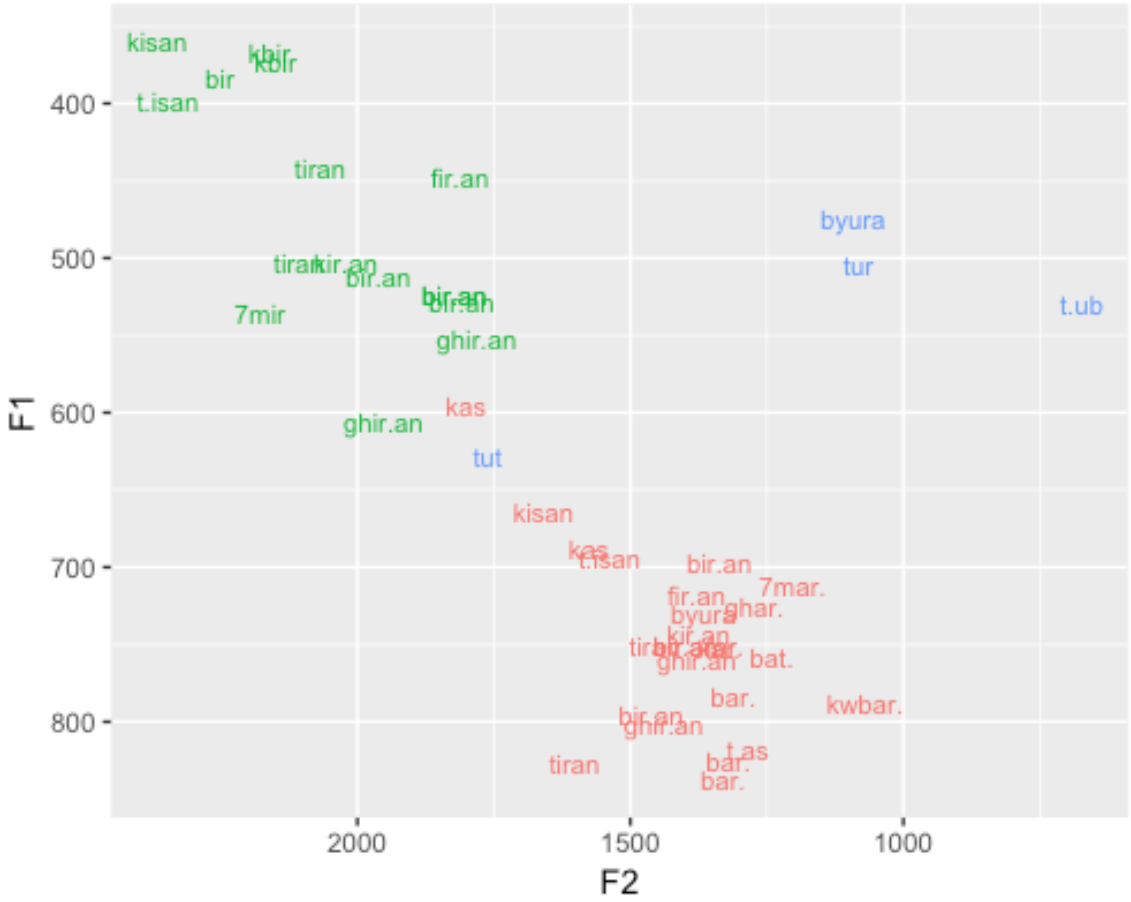

Figure 5.2: Distribution of midpoint vowel formants for Speaker 03. Colors indicate vowel type (/i/, /a/, or /u/).

Speaker 03 has less distinct emphatic/plain distributions for /a/, and has an apparently centralized /u/ outlier in *tut*, which is likely a measurement error. In any case, the /u/ tokens in *byura* and *tur* have F2 values within the 'plain' range established in §5.1, while the /u/ in *ṭub*

has an F2 value within the emphatic range, so I judge *tur* and *byura* to have plain /r/ for this speaker. /i/ tokens are more visibly separated into two clusters, with plain /i/ in *bir* and *kbir* and emphatic /i/ in all other /r/ words. *ɣiṛan* and *biṛan* have consistently lower and backer pronunciations than other words in the emphatic /i/ cluster, but are not distinct in terms of their /a/ distribution. In /a/, no /r/ words are plain ; only *kas*, *kisan*, and *tisan* (this is almost certainly a plain-/t/ elicitation error when prompted with *ṭisan*). This gives Speaker 03 the following paradigm distribution :

SPK 03:	Only [r] :	*bir~byura*
	Alternating :	*kbir~kbaṛ*
		ħmaṛ~ħmir
		(?) *tur~tiṛan*
	Only [ɾ] :	*faṛ~fiṛan*
		baṛ~biṛan
		kaṛ~kiṛan
		ɣaṛ~ɣiṛan

Note that the proposed *tur~tiṛan* alternation, if true, would not be phonetically conditioned by vocalic environment. In fact, due to the small sample size and lack of a reliable reference point, the plain status of *tur* is questionable, and the two *tiran* tokens have higher F1 for /i/ and lower F2 for both /a/ and /i/ than other tokens in the emphatic cluster, suggesting a uvularized *ṙ* instead of an emphatic *ṛ*. The evidence is too scant, however, to make a clear determination.

c) Speaker 04

Speaker 04 is a 34-year-old man native to Fes. He runs a cybercafé in the Old City, where he also lives, and is pursuing a post-graduate degree remotely.

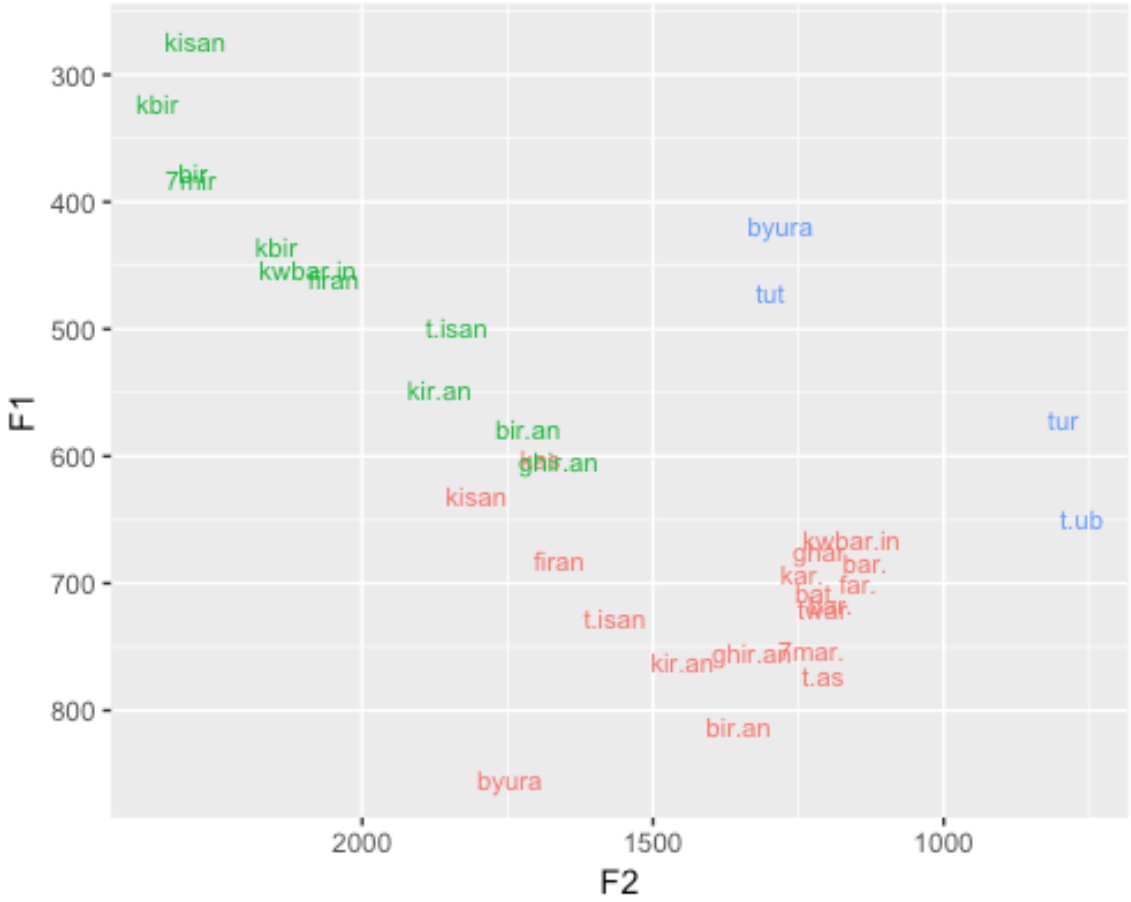

Figure 5.3: Distribution of midpoint vowel formants for Speaker 04. Colors indicate vowel type (/i/, /a/, or /u/).

This speaker has a tripartite clustering of /i/ tokens, with *kbir, bir, byura*, and *ħmir* falling into the tense 'plain' cluster, *kiṛan*, *biṛan,* and *ɣiṛan* falling into the centralized 'emphatic' cluster, and *kbiṛ*, *kʷbaṛin*, and *fiṛan* falling into an intermediate cluster which may be characterized as

uvularized. *fiṙan* also has an F2 range of /a/ intermediate between plain and emphatic, justifying its analysis as uvularized, but the /a/ in *kʷbaṛin* has one of the lowest F2 values of any /a/ token, suggesting that it is better analysed with *ṛ*. For /u/, *tuṛ* clearly belongs to the emphatic cluster as opposed to plain *byura*.

SPK 04 :	Only [r] :	*bir~byura*
	Alternating with [ṙ] :	*faṛ~fiṙan*
		kbiṙ~kbaṛin
	Alternating with [r] :	*ħmaṛ~ħmir*
	Only [r̥] :	*baṛ~biṛan*
		kaṛ~kiṛan
		ɣaṛ~ɣiṛan
		tuṛ~twaṛ

d) Speaker 05

Speaker 05 is a 26-year-old man native to al-Hoceima, a town in the Rif region of northern Morocco. He is a native speaker of Tarifit, but has used Moroccan Arabic as his primary language since relocating to Fes at the age of 14. He has some high school education, works in food service, and lives in the Old City.

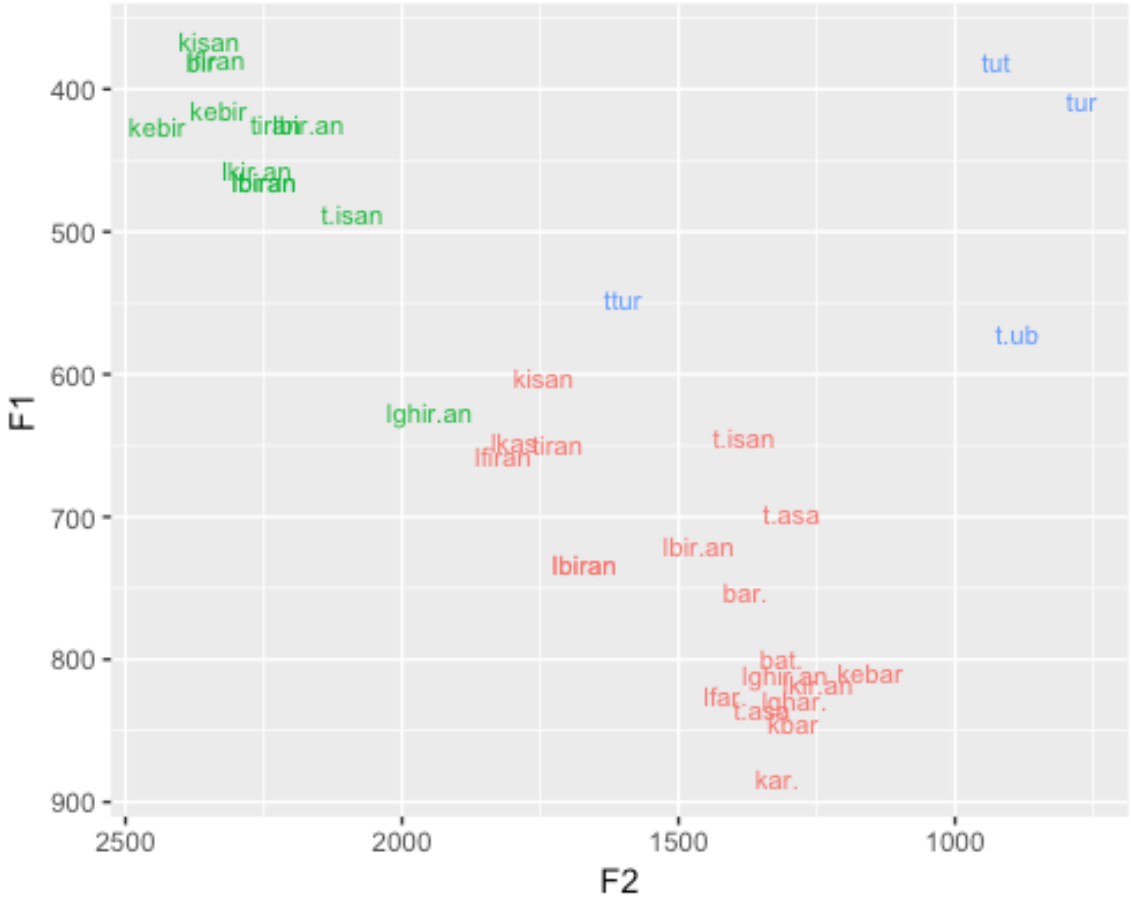

Figure 5.4: Distribution of midpoint vowel formants for Speaker 05. Colors indicate vowel type (/i/, /a/, or /u/).

While clustering of /i/ and /a/ tokens along a diagonal plain/emphatic axis is undeniable for this speaker, there is a considerable range of intermediate values among his vowels, such that *biṙan* 'wells' in particular could be in either the plain or emphatic clusters. *kiṛan* would appear to be the same on the basis of /i/ alone, but the /a/ value for this token is centered in the back and low emphatic cluster. *biṛan* is also intermediate, though it has lower F2 than *biṙan* in both vowels and so remains distinct. *firan* and *tiran* are plainly plain. There is a centralized /u/ outlier in one *tur* token, probably another measurement error, but the other is close to *tut*.

SPK 05 : [r]/Alternating with [ṙ]: (?) *bir~biṙan*

Alternating with [ṛ] : *faṛ~firan*
kəbir~kbaṛ
(?) *tuṛ-tiran*

Only [ṛ] : *baṛ~biṛan*
ɣaṛ~ɣiṛan

Note that the *bir~biṙan* alternation is difficult to motivate, and since there is a possibility that *biṙan* is simply a high-F1 outlier of the plain distribution, it may be preferable to propose a levelled-to-[r] analysis of this plural as *biran*. In any case, this individual's background as a native Tarifit speaker makes any unusual aspects of his phonology subject to interpretation as cross-linguistic interference.

e) Speaker 06

Speaker 06 is a 33-year-old man native to Fes. He has some highschool education and works as a security guard. He lives in the Old City.

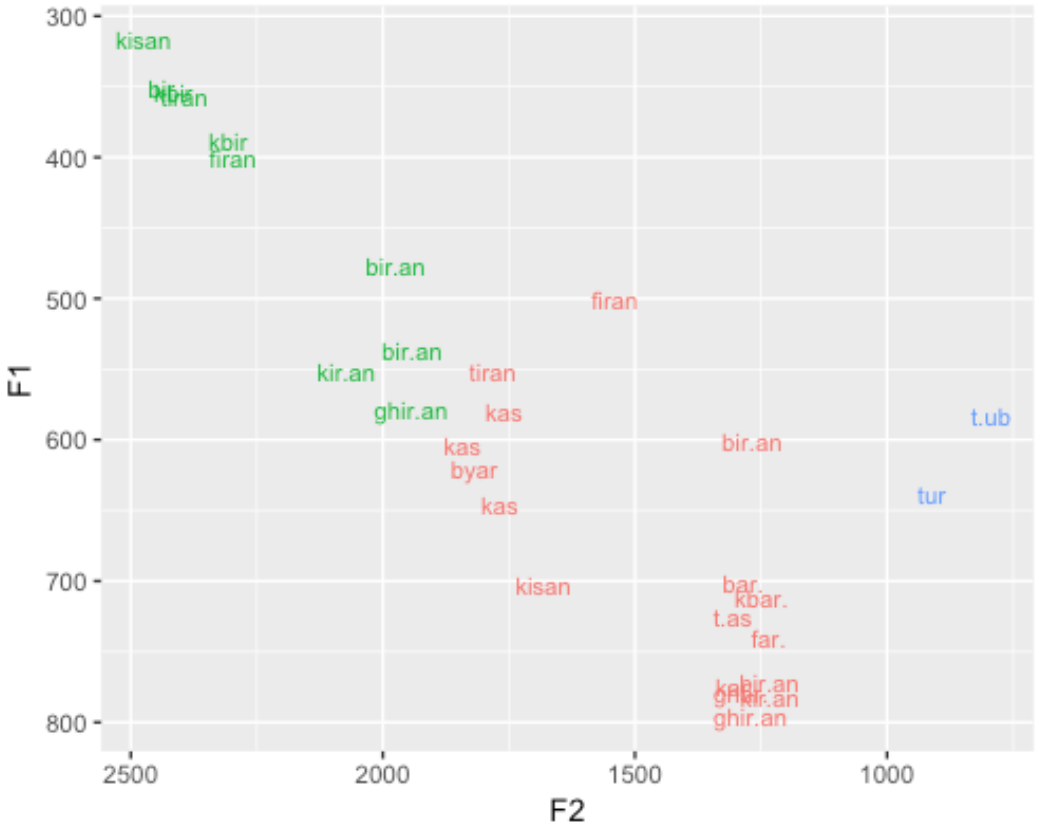

Figure 5.5: Distribution of midpoint vowel formants for Speaker 06. Colors indicate vowel type (/i/, /a/, or /u/).

This speaker, like speaker 02, has very distinct plain/emphatic clusters for /a/ and /i/ vowels. The only word which is discernibly intermediate between the two is *fiṙan*, on the basis of its F2 of /a/. *kbiṙ* has the same [i] formant values as the [i] in *fiṙan* and so may be classed with it has having uvular *ṙ*. There is no plain reference point for /u/, but the /u/ in *tuṛ* is close to that in *ṭub* and is well within the emphatic fomant ranges established in §5.1.

SPK 06 :	Only [r] :	*bir~byar*
	Alternating with [ṙ] :	*faṛ~fiṙan*
		kbiṙ~kbaṛ
	Alternating with [r] :	*tuṛ~tiran*
	Only [ṛ] :	*baṛ~biṛan*
		kaṛ~kiṛan
		ɣaṛ~ɣiṛan

f) Speaker 07

Speaker 07 is a 28-year-old man native to Fes. He works in art and cultural tourism, lives in the Old City, and has a college education. He identifies strongly with the traditional Fessi artisan class.

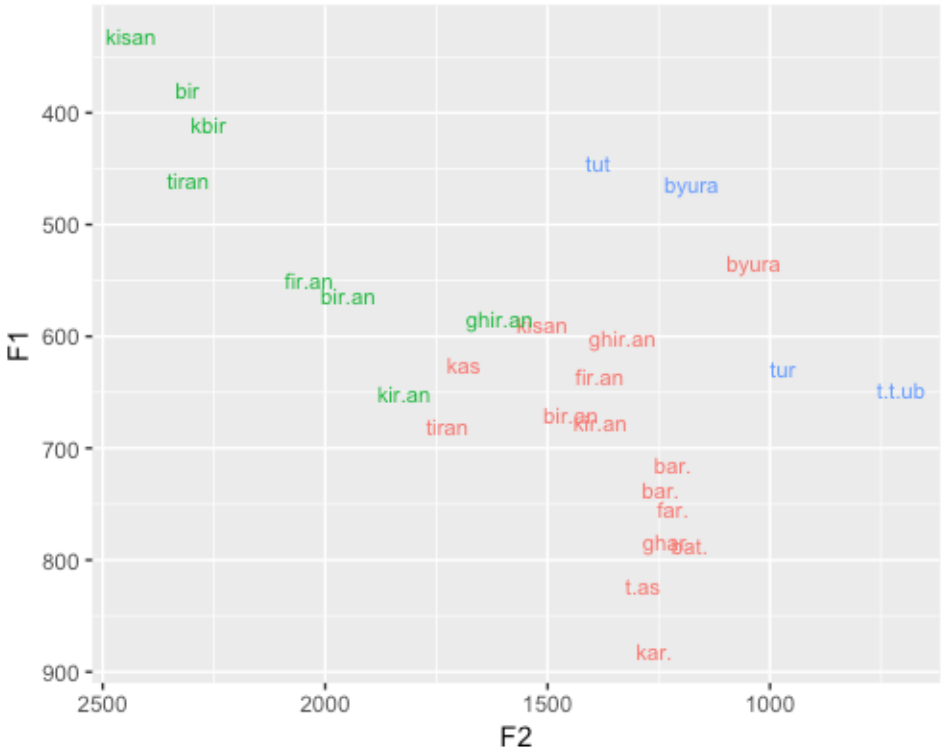

Figure 5.6: Distribution of midpoint vowel formants for Speaker 07. Colors indicate vowel type (/i/, /a/, or /u/).

This speaker has a tripartite clustering pattern in both /a/ and /i/, in which *ṙ* is distinguished from *ṛ* by a combination of F1 and F2. We see that his word-final [a] in *byura* is backed but not lowered unlike his EMPH [a]. *bir*, *kbir*, and *tiran* are plain, *fiṙan* and *biṙan* 'bars' are uvular, and the rest are EMPH (though *kiṛan* and *ɣiṛan* are admittedly close to *fiṙan* and *biṙan* in F1 of /a/).

SPK 07:	Only [r] :	*bir~byura*
	Alternating with [ṙ] :	*baṛ~biṙan*
		faṛ~fiṙan
	Alternating with [r] :	*tuṛ~tiran*
		kbir~ ?
	Only [ṛ] :	*kaṛ~kiṛan*
		ɣaṛ~ɣiṛan

g) Speaker 08

Speaker 08 is a 22-year-old man native to al-Hoceima in the Rif. He is a native Arabic speaker, and has lived in the New City of Fes for two years while attending university.

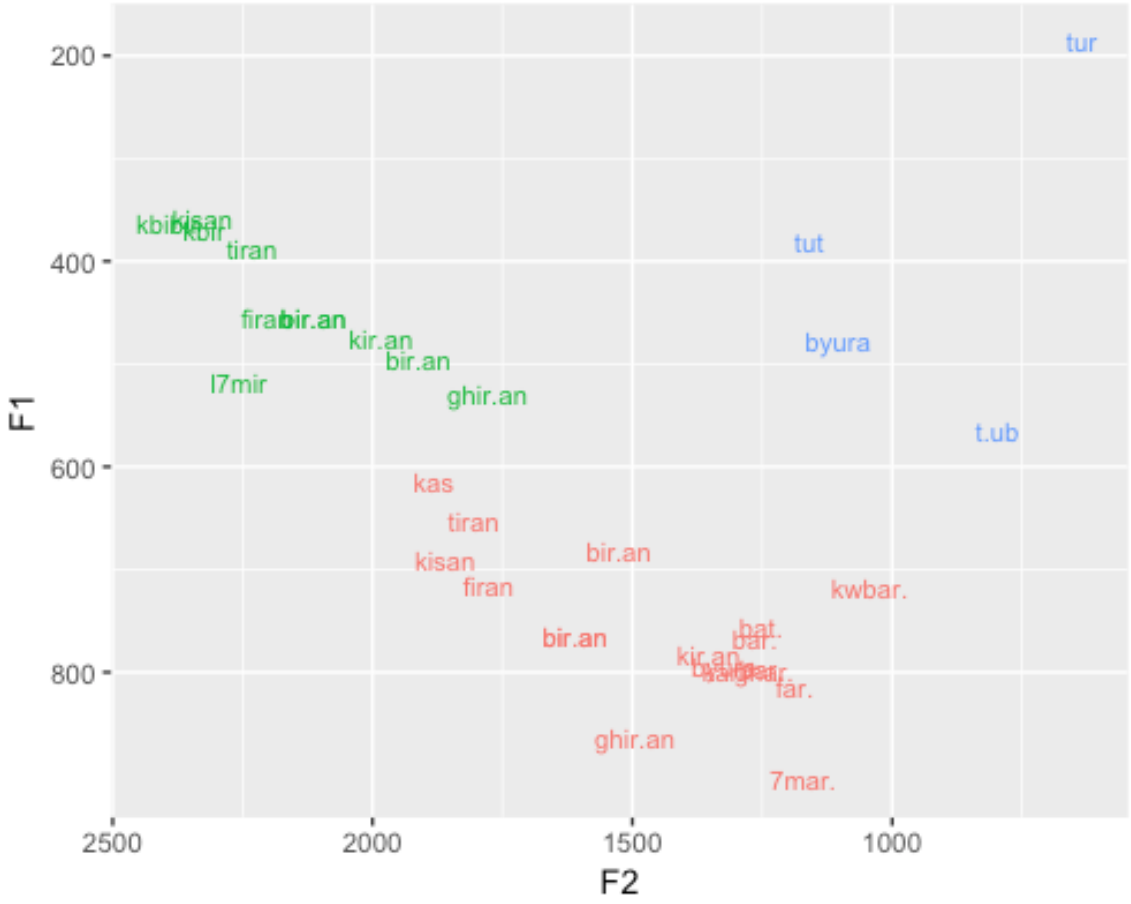

Figure 5.7: Distribution of midpoint vowel formants for Speaker 08. Colors indicate vowel type (/i/, /a/, or /u/).

Like Speaker 05, who is also from the Rif, this speaker has a very front /i/ with high F2. This speaker has a clearly different dialect in other domains as well, with features such as non-reduced short /i/ and a fricated pronunciation of /ʕ/, so his speech may be considered atypical

with respect to the Fessi speech community. His /r/ distributions exhibit levelling to [ṛ] only in *kiṛan*, and instead have *ṙ* with intermediate F2 of /a/ adjacent to /i/ in *biṙan* and *ɣiṙan*. The measurement for *tur* is an unreliable outlier.

SPK 08 :	Only [r] :	*bir~byura*
	Alternating with [r] :	*faṛ~firan*
		ʔ~tiran
		kbir~k^{w}baṛ
	Alternating with [ṙ] :	*baṛ~biṙan*
		ɣaṛ~ɣiṙan
		ħmaṛ~ħmiṙ
	Only [ṛ] :	*kaṛ~kiṛan*

h) Speaker 09

Speaker 09 is a 37-year-old man native to Fes. He has a primary education and works as a property manager, living in the Old City.

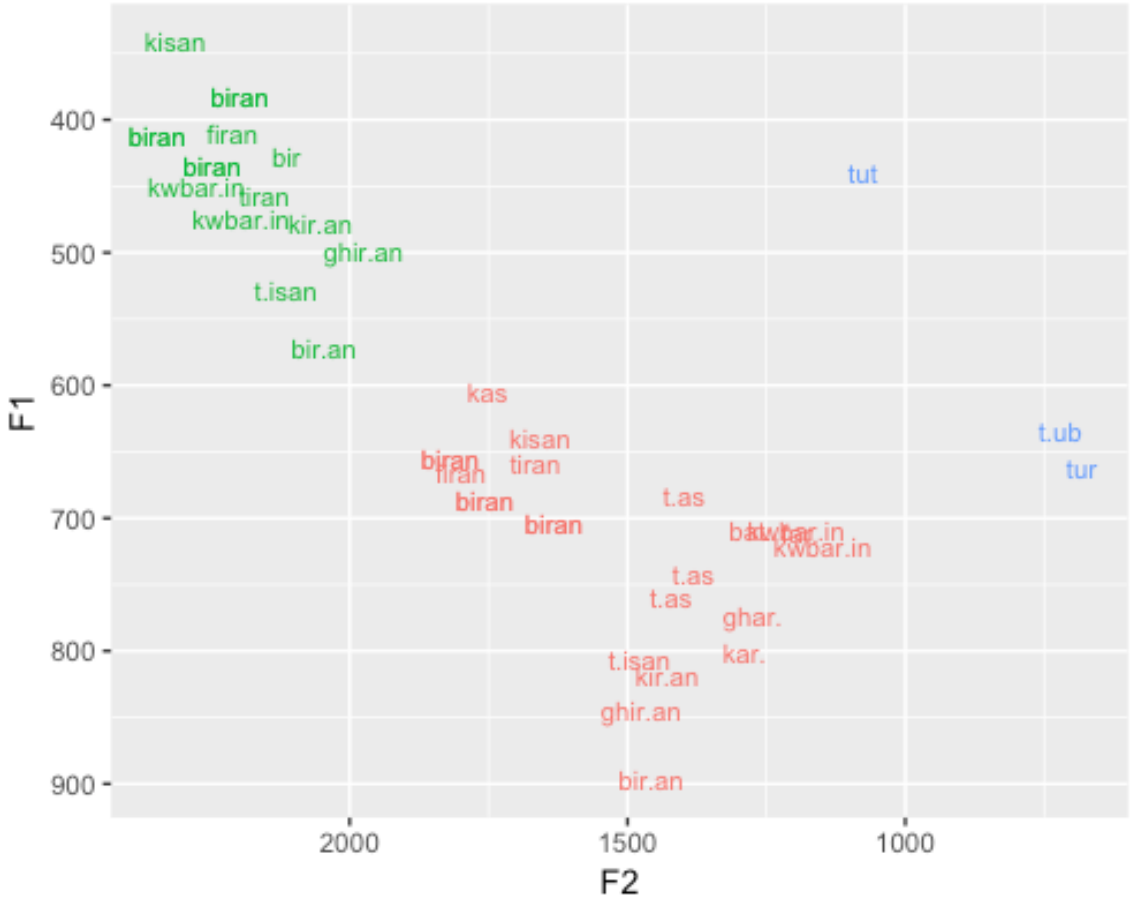

Figure 5.8: Distribution of midpoint vowel formants for Speaker 09. Colors indicate vowel type (/i/, /a/, or /u/).

For this speaker, /a/ and /u/ have a bimodal distribution, but the /i/ tokens grade from plain to emphatic without discrete clustering. Based on a combination of /i/ F1 intermediacy and low F1/low F2 in /a/, I suggest [ɨ] in *kʷbaɨin* but not for any other tokens.

SPK 09:	Only [r] :	*bir~biran*
	Alternating with [r] :	*faṛ~firan*
		tuṛ~tiran
	Alternating with [ṙ] :	*?~ kʷbaṙin*
	Only [ṛ] :	*baṛ~biṛan*
		kaṛ~kiṛan
		ɣaṛ~ɣiṛan

i) Speaker 10

Speaker 10 is a 39-year-old man native to Fes. He is college-educated and works as an English teacher, living in the New City.

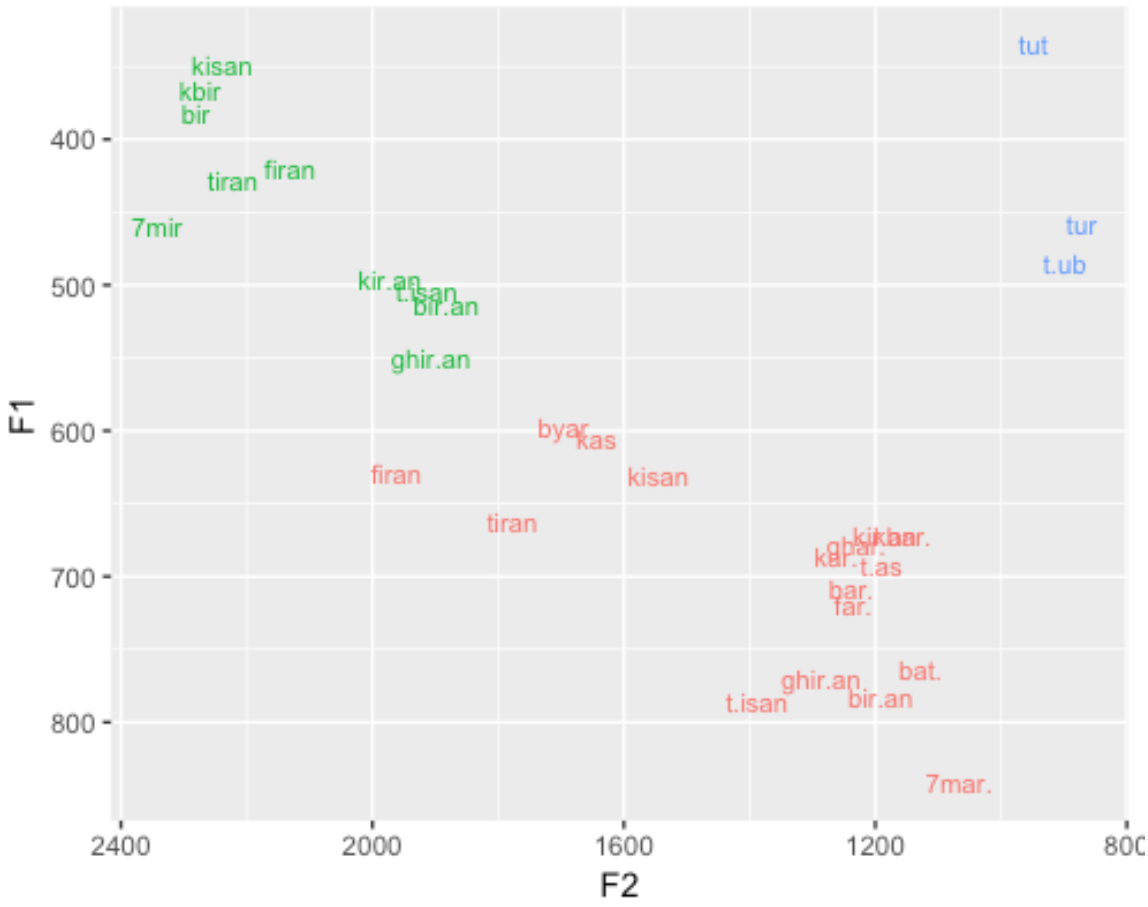

Figure 5.9: Distribution of midpoint vowel formants for Speaker 10. Colors indicate vowel type (/i/, /a/, or /u/).

Based on F2 values, there is no evidence for a discrete [ṙ] cluster for Speaker 10. The vowels in *ħmir*, *kbir*, *tiran*, *firan*, *bir*, and *byar* belong to 'plain' clusters, while all other vowels in *r* paradigms are emphatic.

SPK 10 :	Only [r] :	*bir~byar*
	Alternating :	*faṛ~firan*
		tuṛ~tiran
		kbir~kbaṛ
		ħmaṛ~ħmir
	Only [ɾ] :	*baṛ~biɾan*
		kaṛ~kiɾan
		ɣaṛ~ɣiɾan

j) Speaker 11

Speaker 11 is a 20-year-old man raised primarily in Dakhla (Western Sahara) until age 12, when he moved to Fes. Due to a military background, he acquired a koiné-type dialect rather than the regional Sahraoui/Hassaniya dialect. He has some secondary education, and is currently a student, living with his family in the New City.

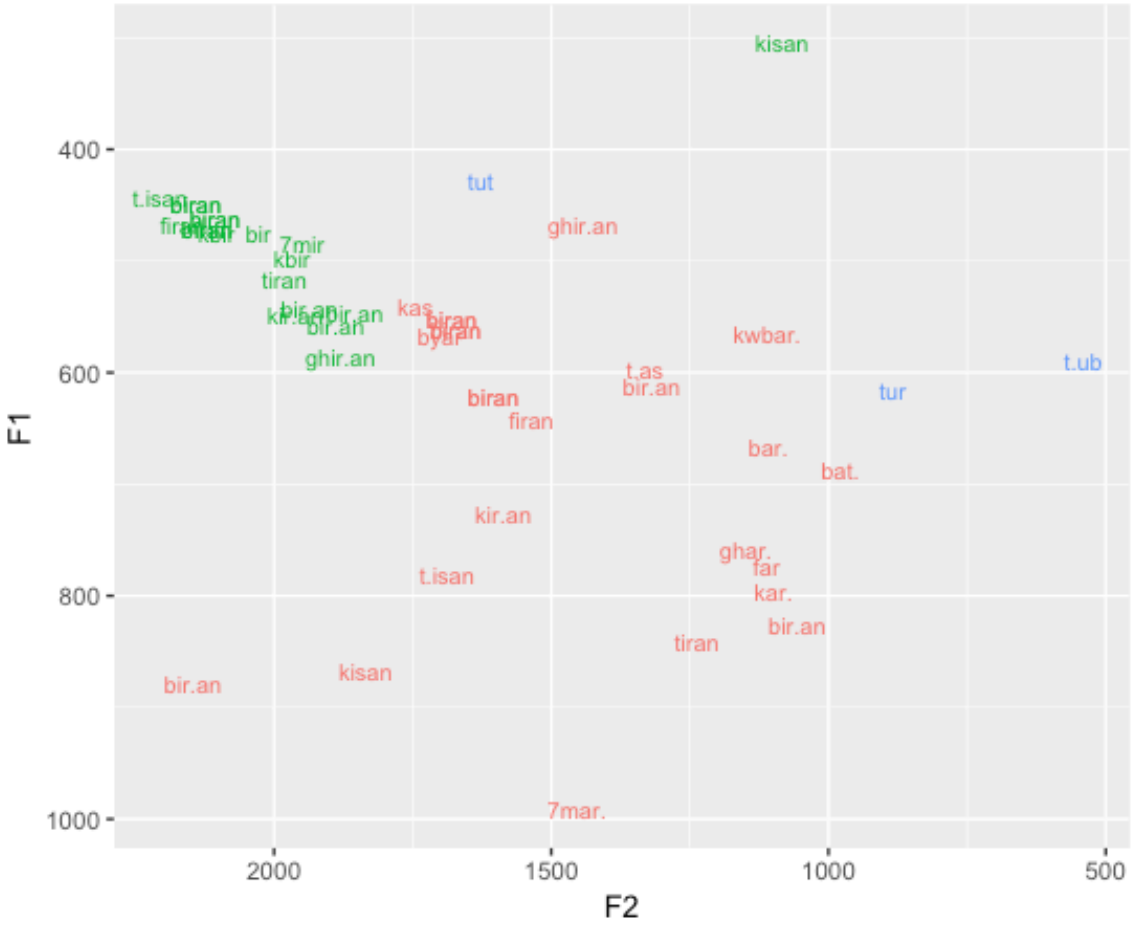

Figure 5.10: Distribution of midpoint vowel formants for Speaker 11. Colors indicate vowel type (/i/, /a/, or /u/).

This speaker's vowel chart has a number of unreasonable outlier measurements, including all five /a/ tokens with high F1 and high F2, yet bimodal clustering conforming to the patterns of other speakers is still discernable in his speech. The reason for these measurement problems is that this individual spoke very quietly during his interview, resulting in indistinct formant bands which could not always be reliably identified by the Praat formant tracker. Nevertheless, all /i/ tokens but one are in a reasonable formant range, and there are two clusters of /a/ tokens in the expected range for plain and emphatic allophones. The /i/ distribution has an intermediate cluster comprising *ħmiṙ, kbiṙ,* and *tiṙan*, with lower F2 than the plain cluster but lower F1 than the emphatic cluster.

SPK 11:	Only [r] :	*bir~byar*
	Alternating with [ṙ] :	*tuṛ~tiṙan*
		kbiṙ~kbaṛ
		ħmaṛ~ħmiṙ
	Alternating with [r] :	*faṛ~firan*
	Only [ɽ] :	*baṛ~biɽan*
		kaṛ~kiɽan
		ɣaṛ~ɣiɽan

k) Speaker 12

Speaker 12 is a 21-year-old woman native to Fes. She spent 8 years of her childhood living elsewhere in the country. She studies at the university and lives in the New City.

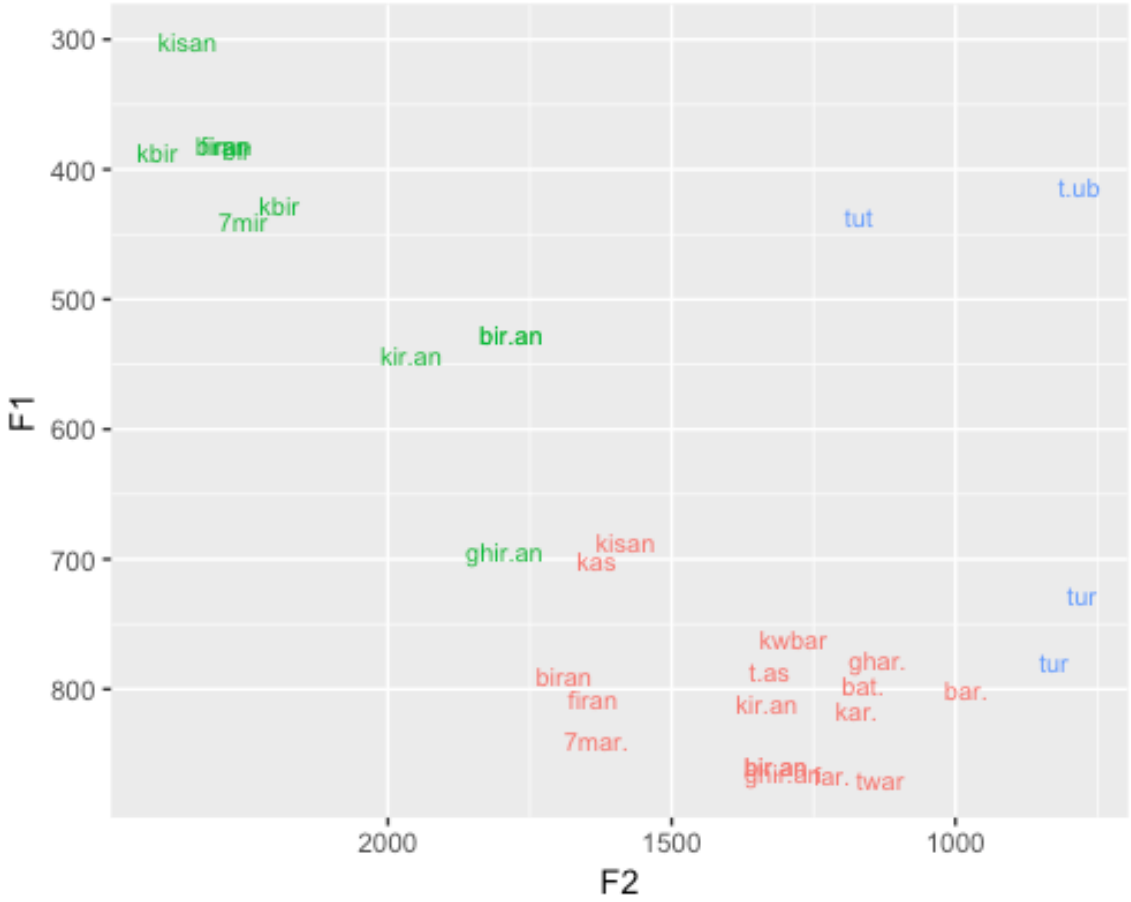

Figure 5.11. Distribution of midpoint vowel formants for Speaker 12. Colors indicate vowel type (/i/, /a/, or /u/).

Speaker 12 has a bipartite distribution. Despite the appearance of a difference in /i/ between *ɣiṛan* and *kiṛan/biṛan*, this is only a (guttural-driven) F1 difference, not an F2 difference, and neither *kiṛan* nor *biṛan* has a high F2 of /a/ that would distinguish them from other members of

the emphatic /a/ cluster. The most unusual feature in this speaker's pattern is that *ħmar* is plain rather than emphatic. In general, her speech exhibits an exceptional amount of paradigmatic levelling.

SPK 12:	Only [r] :	*ħmar~ħmir*
		bir~biran
	Alternating :	*faṛ~firan*
		kbir~k^{w}baṛ
	Only [ṛ] :	*baṛ~biṛan*
		kaṛ~kiṛan
		ɣaṛ~ɣiṛan
		tuṛ~twaṛ

1) Speaker 13

Speaker 13 is a 43-year-old man native to Fes. He has a college education and works as a teacher, living in the New City.

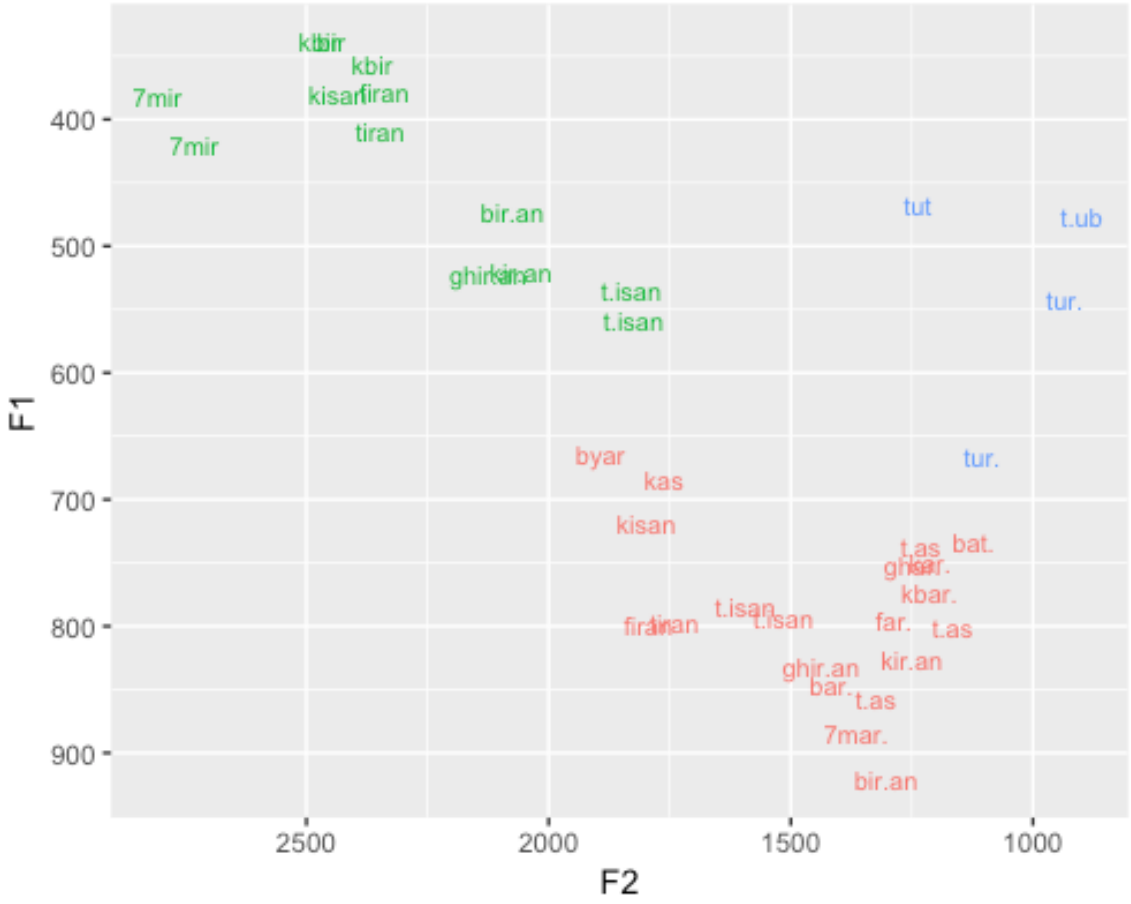

Figure 5.12: Distribution of midpoint vowel formants for Speaker 13. Colors indicate vowel type (/i/, /a/, or /u/).

Speaker 13 reproduces the same bipartite clustering pattern we saw for Speaker 10.

SPK 13 :	Only [r] :	*bir~byar*
	Alternating :	*faṛ~firan*
		tuṛ~tiran
		kbir~kbaṛ
		ħmaṛ~ħmir
	Only [ṛ] :	*baṛ~biṛan*
		kaṛ~kiṛan
		ɣaṛ~ɣiṛan

m) Speaker 14

Speaker 14 is a 25-year-old woman native to Marrakech, who has been living in the New City of Fes since the age of 7. She has some high school education and works as a teacher.

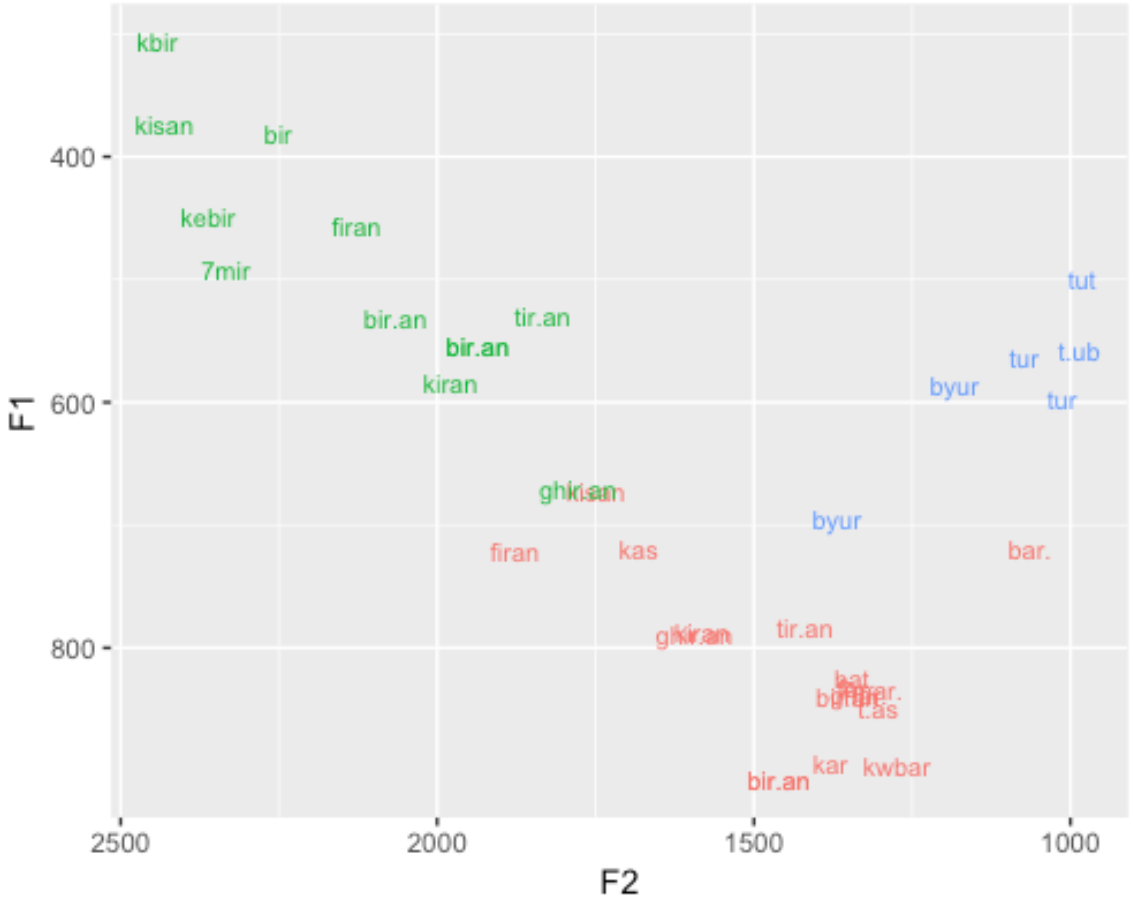

Figure 5.13: Distribution of midpoint vowel formants for Speaker 14. Colors indicate vowel type (/i/, /a/, or /u/).

For Speaker 14, I judge *firan* to belong to the plain distribution based on /a/ though it is ambiguous for /i/, together wth *kbir*, *bir*, *ħmir*, and *byur*. The other tokens are emphatic. Speaker 14 is the first to exhibit unambiguously emphatic *tiṛan*.

SPK 14:	Only [r] :	*bir~byur*
	Alternating :	*faṛ~firan*
		kbir~k^{w}baṛ
		ħmaṛ~ħmir
	Only [ɽ] :	*baṛ~biɽan*
		kaṛ~kiɽan
		ɣaṛ~ɣiɽan
		tuṛ~tiɽan

n) Speaker 15

Speaker 15 is a 22-year-old man native to Casablanca. He moved to Fes at the age of 16 and lives in the New City. He studies at the university and works as a waiter.

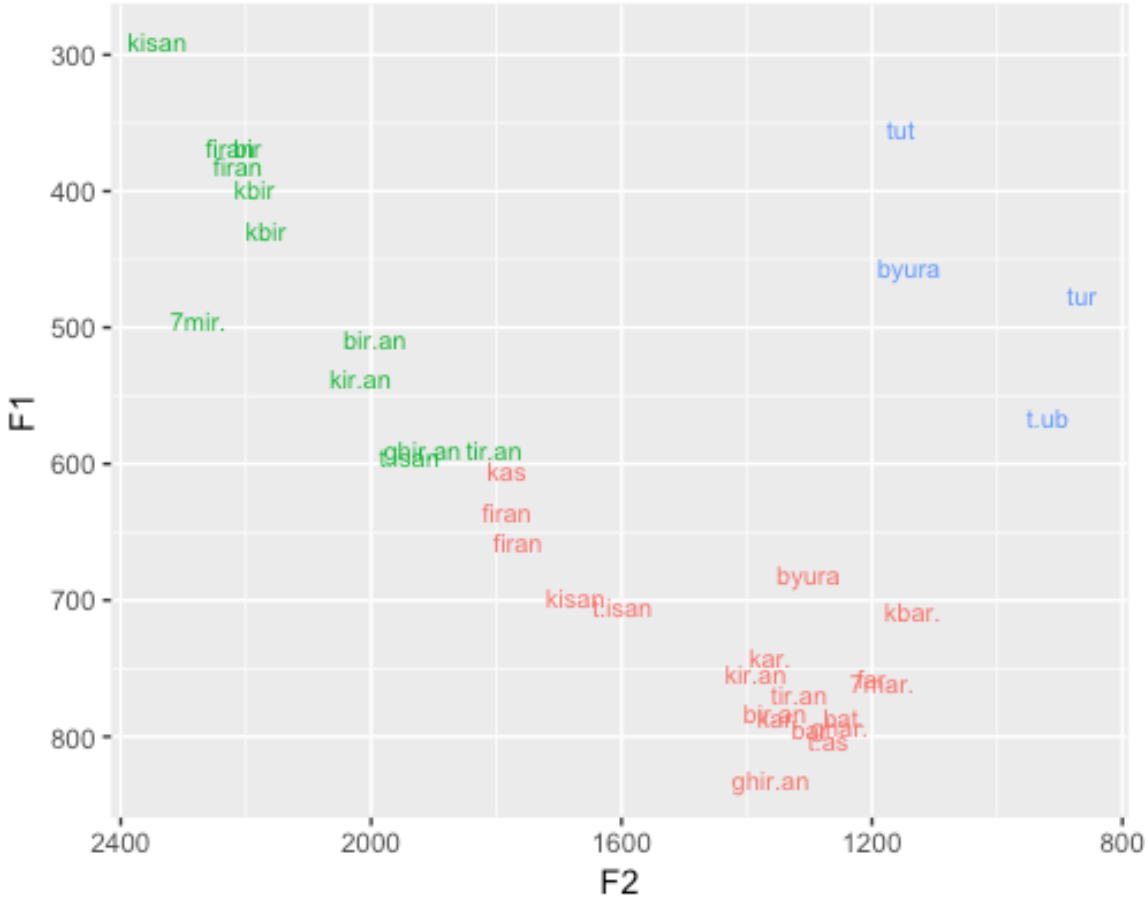

Figure 5.14: Distribution of midpoint vowel formants for Speaker 15. Colors indicate vowel type (/i/, /a/, or /u/).

Speaker 15, who like the last speaker is from a south-central city defined by the koiné, also has a bipartite ditribution with levelled *tuṛ~tiṛan*.

SPK 15:	Only [r] :	*bir~byura*
	Alternating :	*faṛ~firan*
		kbir~kbaṛ
		ħmaṛ~ħmir
	Only [ṛ] :	*baṛ~biṛan*
		kaṛ~kiṛan
		ɣaṛ~ɣiṛan
		tuṛ~tiṛan

o) Speaker 16

Speaker 16 is a 30-year-old woman native to Fes. She has a primary education and works as a housekeeper, living in the Old City.

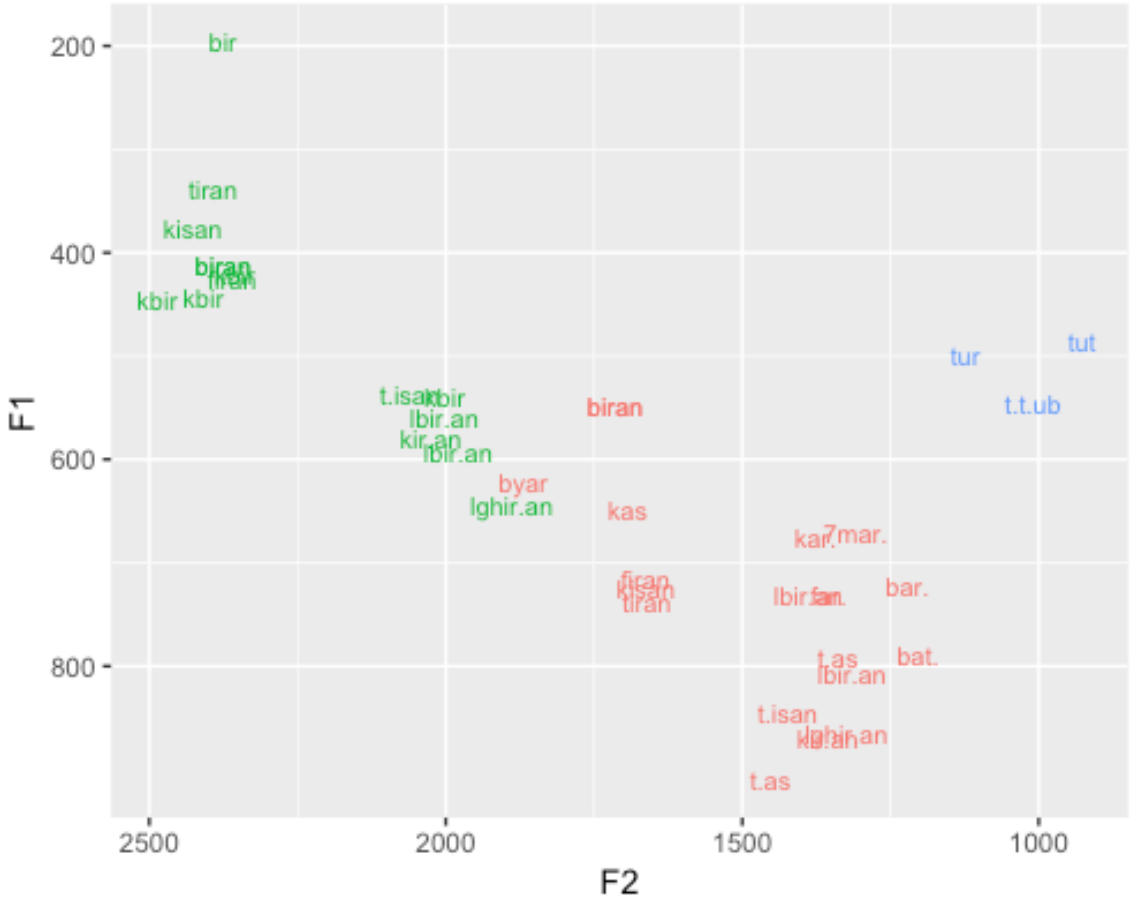

Figure 5.15: Distribution of midpoint vowel formants for Speaker 16. Colors indicate vowel type (/i/, /a/, or /u/).

This Fessi speaker has a rigorously distinct two-way plain/emphatic split for /i/ and /a/. *tiran, firan, byar, biran, kbir, ħmir*, and *bir* are plain; *kaṛ, ħmaṛ, baṛ, biṛan, ɣaṛ, ɣiṛan*, and *kiṛan* are

emphatic. The /u/ data, as we have seen before, are messy and possibly unreliable, so I will exclude *tur* as indeterminate for this speaker.

SPK 16 :	Only [r] :	*bir~byar/biran*
	Alternating :	*faṛ~firan*
		?*~tiran*
		ħmaṛ~ħmir
		kbir~ ?
	Only [ṛ] :	*baṛ~biṛan*
		kaṛ~kiṛan
		ɣaṛ~ɣiṛan

p) Speaker 17

Speaker 17 is a 31-year-old woman who is native to Nador, a city in the Rif, but moved to Fès at the age of 11. She works as a teacher and has a college education, living in the New City.

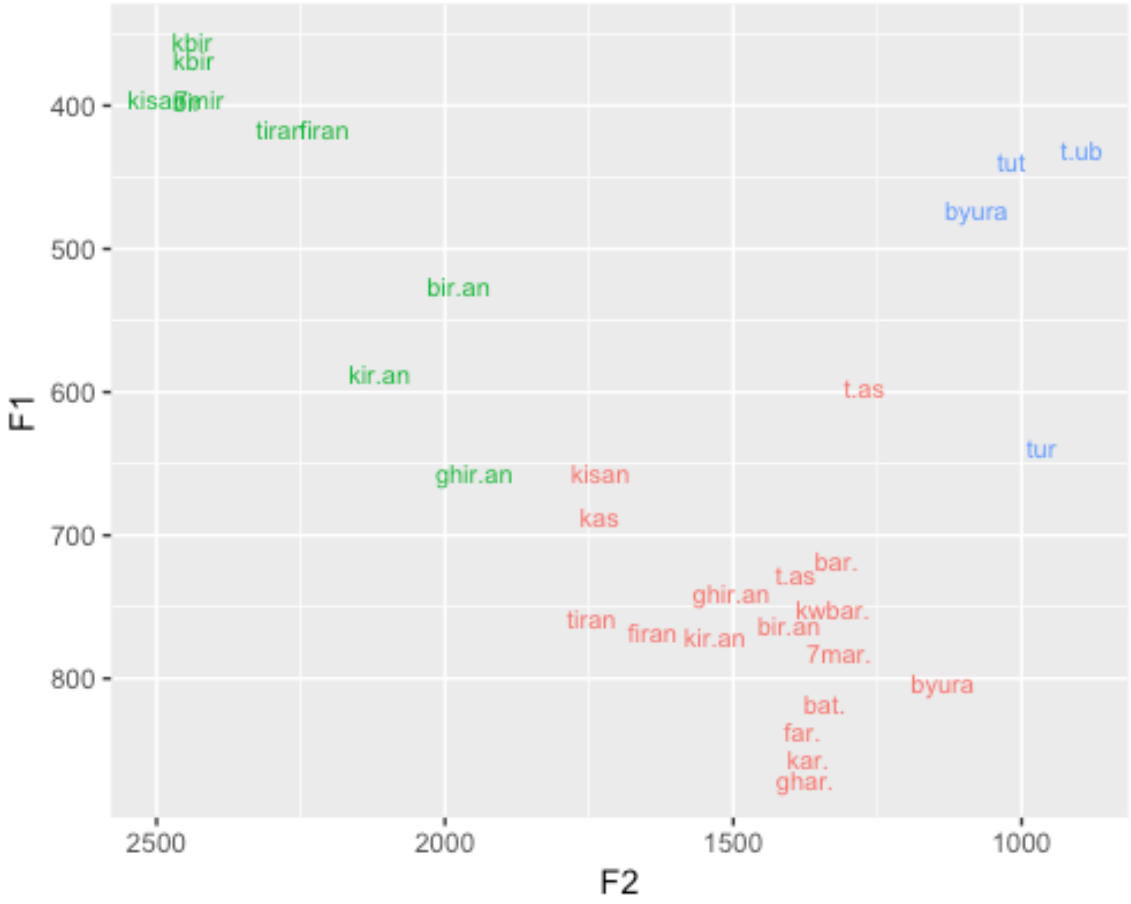

Figure 5.16: Distribution of midpoint vowel formants for Speaker 17. Colors indicate vowel type (/i/, /a/, or /u/).

This speaker, like others we have seen, has a range of tokens grading from plain to emphatic which cannot be easily categorized into clusters. The intermediate tokens are *tiran*, *firan*, *ɣiṛan*, and *kiṛan*, which I categorize as indicated because *tiran* and *firan* are at the edge of the plain

cluster for /i/ on both dimensions and belong to plain /a/ on the F2 dimension, and because *ɣiṛan* and *kiṛan* have the most emphatic /i/ tokens despite being at the leftward (higher F2) edge of the emphatic cluster for /a/.

SPK 17 :	Only [r] :	*bir~byura*
	Alternating :	*faṛ~firan*
		tuṛ~tiran
		kbir~k^{w}baṛ
		ħmaṛ~ħmir
	Only [ɽ] :	*baṛ~biṛan*
		kaṛ~kiṛan
		ɣaṛ~ɣiṛan

q) Speaker 18

Speaker 18 is a 30-year-old woman native to Fes. She is college-educated and works in sales, living in the New City.

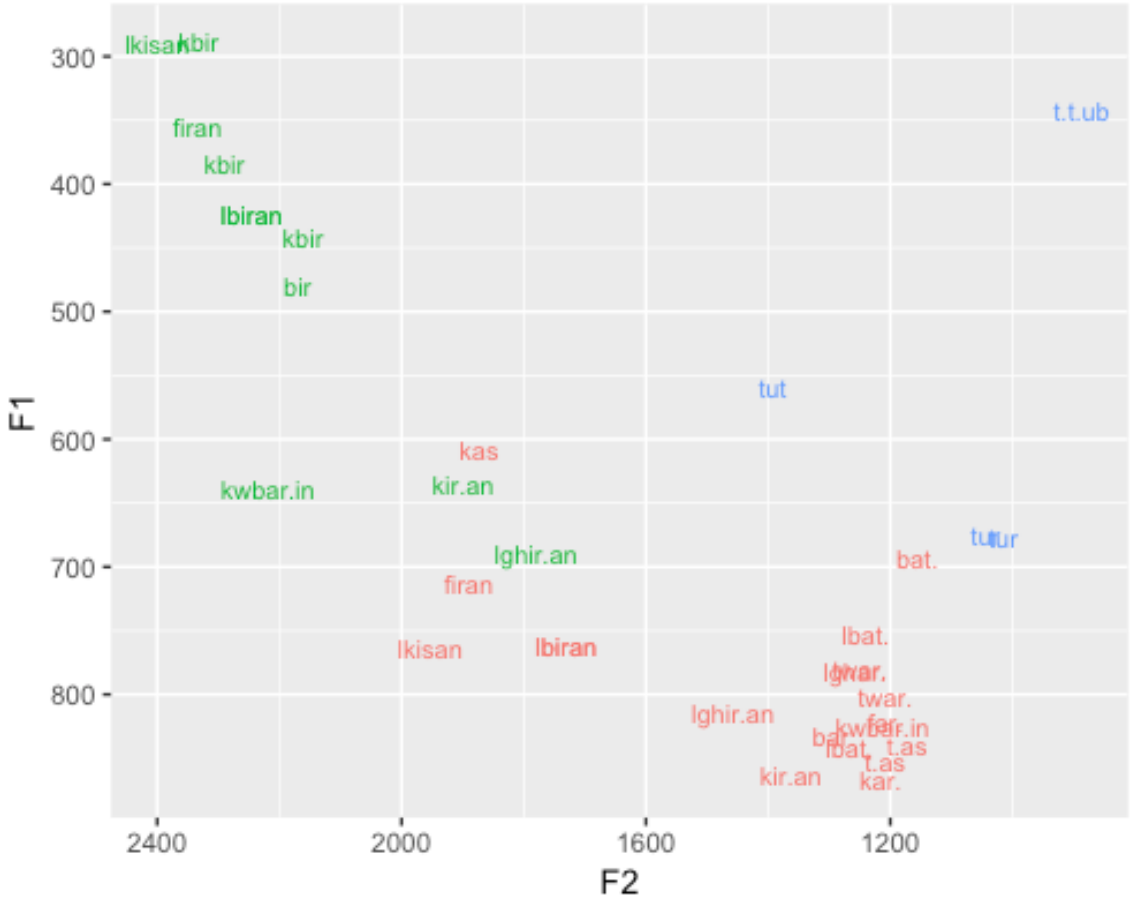

Figure 5.17: Distribution of midpoint vowel formants for Speaker 18. Colors indicate vowel type (/i/, /a/, or /u/).

Based on their separation from the emphatic distribution on F2 of /a/, this speaker has uvular *ṙ* in *kiṙan* and *ɣiṙan*. All other words fall into emphatic or plain clusters respectively.

SPK 18 :	Only [r] :	*bir~biran*
	Alternating with [ɽ] :	*faɽ~firan* *tuɽ~tiran* *kbir~k^{w}baɽin*
	Alternating with [ṙ] :	*kaɽ~kiṙan* *ɣaɽ~ɣiṙan*
	Only [ɽ] :	*baɽ~*?

r) Speaker 19

Speaker 19 is a 67-year-old man native to Fes. He has a primary education and is a retired mechanic, currently working as a traditional storyteller and living in the Old City.

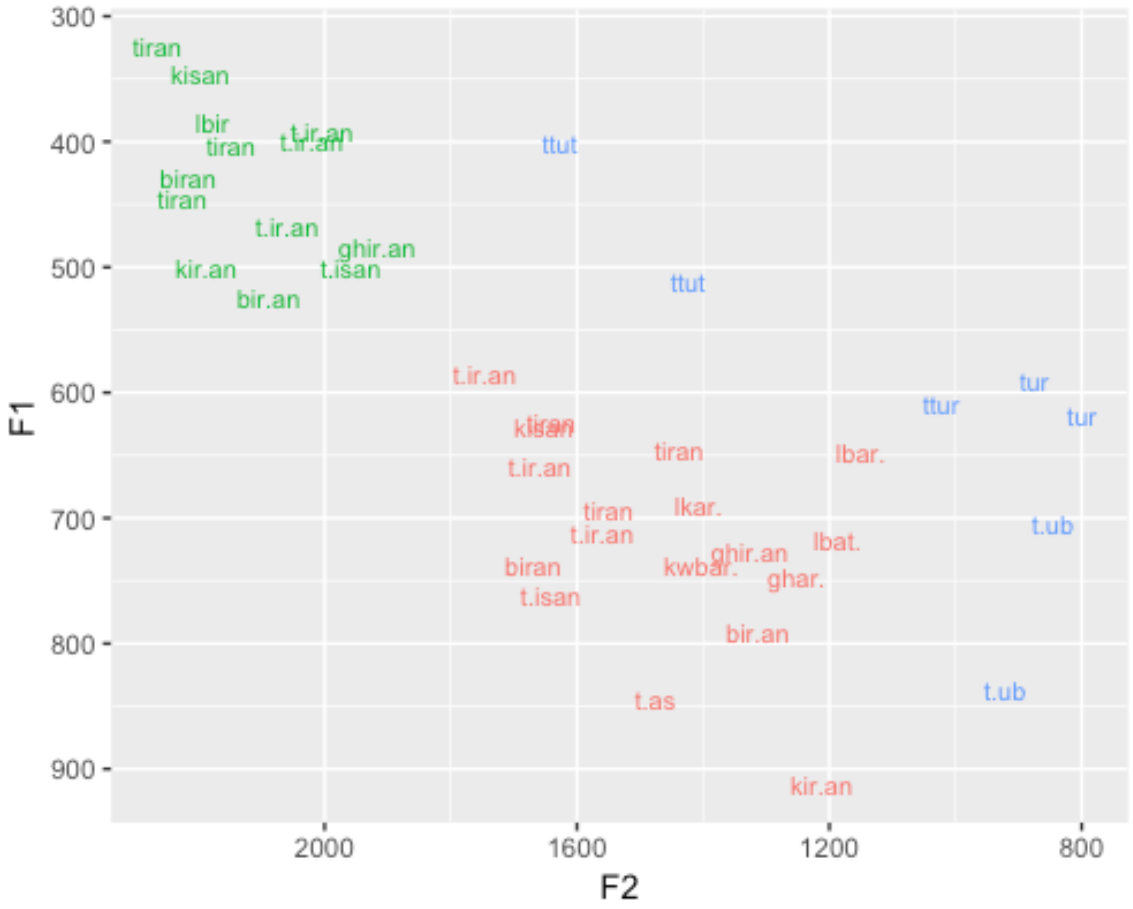

Figure 5.18: Distribution of midpoint vowel formants for Speaker 19. Colors indicate vowel type (/i/, /a/, or /u/).

There were some elicitation issues in this speaker's interview, since he was somewhat uncooperative and tended to suggest synonymous or homophonous forms in either Moroccan or Standard Arabic. The tokens marked *ṭiṛan*, for example, were meant to be the plural of 'bird,'

not ‘bull.’ Recording conditions were also not ideal, and background noise may be responsible for some mismeasured outliers. The distribution that can be discerned is gradient rather than discretely clustered, but it indicates emphatic *kiṛan*, *biṛan*, and *ɣiṛan* but plain *tiran* and *biran*.

SPK 19 :	Only [r] :	*bir~biran*
	Alternating :	*tuṛ~tiran*
		ʔ~ kʷbaṛ
	Only [ɽ] :	*baṛ~biṛan*
		kaṛ~kiṛan
		ɣaṛ~ɣiṛan

s) Speaker 20

Speaker 20 is a 37-year-old woman native to Fes. She is college-educated, works as a teacher, and lives in the New City.

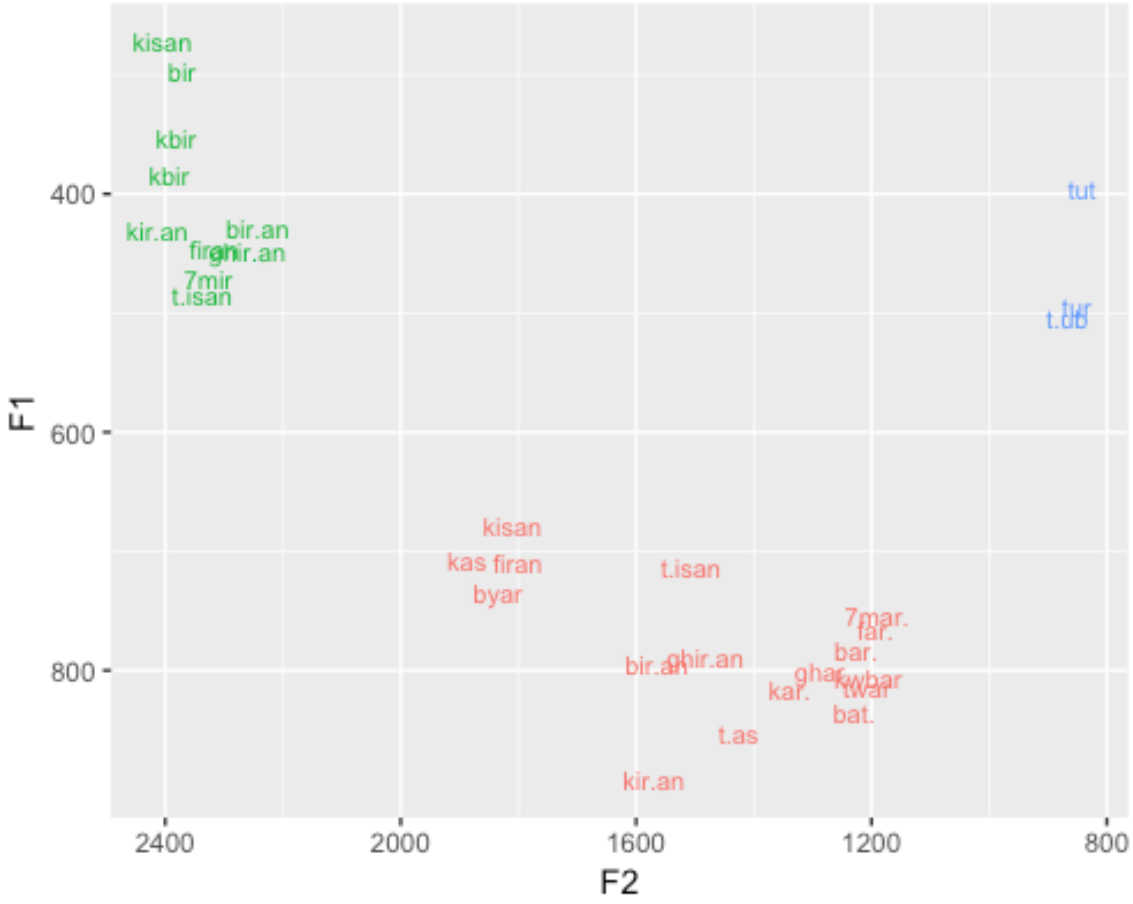

Figure 5.19: Distribution of midpoint vowel formants for Speaker 20. Colors indicate vowel type (/i/, /a/, or /u/).

Speaker 20 has no F2 lowering of /i/, and an F2 of /a/ pattern suggesting uvular *kiʁan*, *ɣiʁan*, and *biʁan*. This speaker was one of those observed to variably produce the approximant 'Fessi *r*.'

SPK 20 :	Only [r] :	*bir~byar*
	Allophonic :	*faṛ~firan*
		kbir~k^{w}baṛ
		ħmaṛ~ħmir
	Only [ɽ] :	*baṛ~biɽan*
		kaṛ~kiɽan
		ɣaṛ~ɣiɽan
		tuṛ~twaṛ

t) Speaker 21

Speaker 21 is a 32-year-old woman native to Fes. She works as an administrative assistant and has some technical post-secondary education. She lives in the New City.

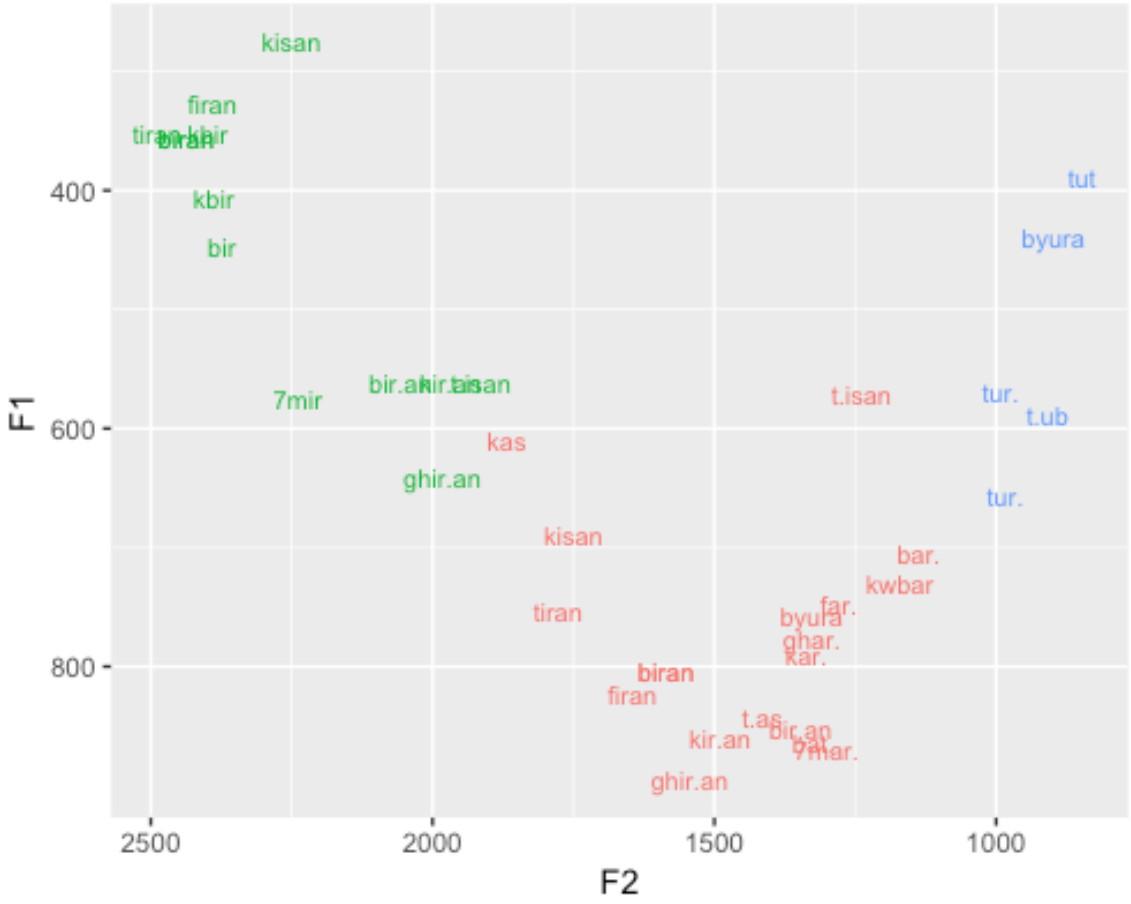

Figure 5.20: Distribution of midpoint vowel formants for Speaker 21. Colors indicate vowel type (/i/, /a/, or /u/).

Speaker 21 has /a/ in *ɣiṙan* and *kiṙan* with an intermediate F2, plain *tiran*, *biran*, *ṙiran*, and an emphatic clusters for other /a/ words.

SPK 21:	Allophonic [ɽ]~[r] :	*tuɽ~tiran*
		kbir~k^{w}baɽ
		ħmaɽ~ħmir
		faɽ~firan
	Allophonic [ɽ]~[ɾ] :	*kaɽ~kiɾan*
		ɣaɽ~ɣiɾan
		baɽ~biɽan
	Levelled to [r] :	*bir~byura/biran*

u) Speaker 22

Speaker 22 is a 56-year-old man native to Fes, but also raised partly in Beni Mellal, a city in the High Atlas. He is a professor at the university, and lives in the New City.

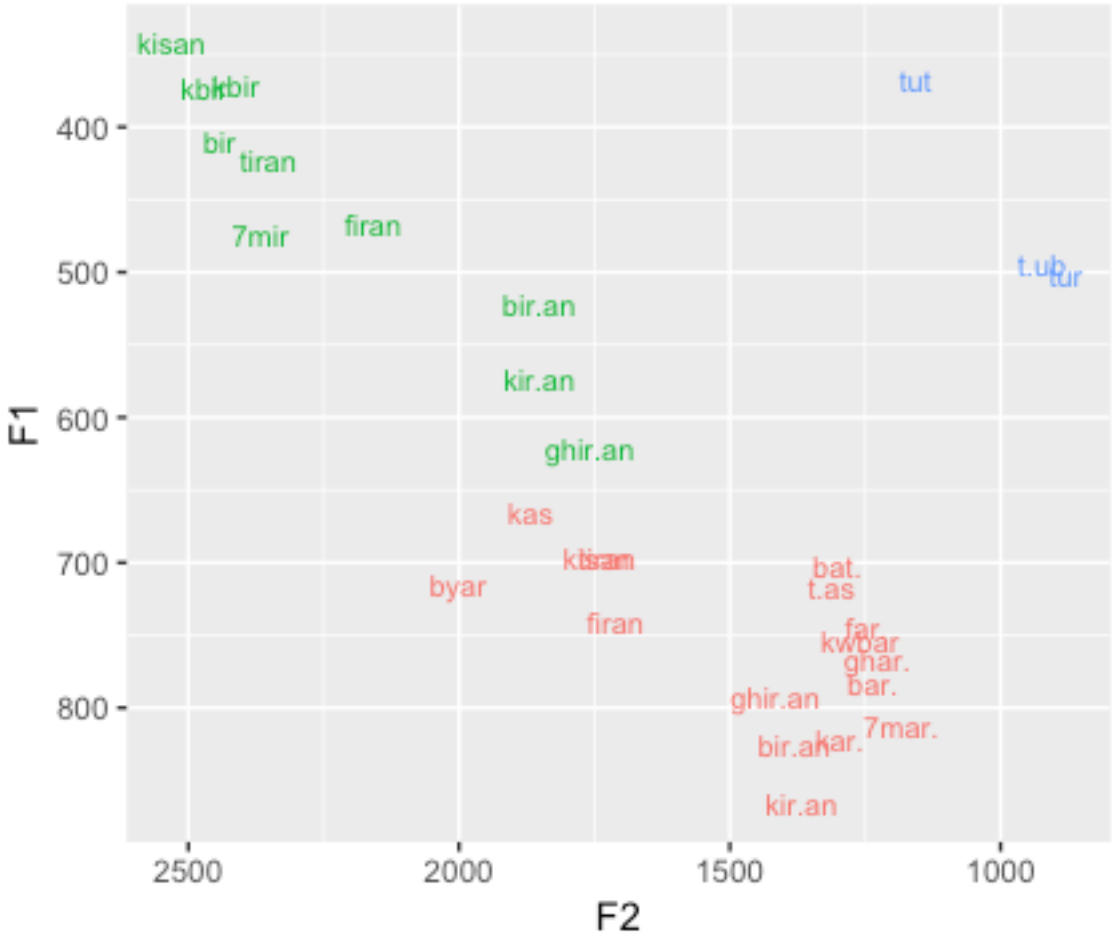

Figure 5.21: Distribution of midpoint vowel formants for Speaker 22. Colors indicate vowel type (/i/, /a/, or /u/).

Speaker 22 has a two-way split. Though *biṙan*, *ɣiṙan*, and *kiṙan* are admittedly somewhat fronter than the rest of the emphatic /a/ tokens, they do not form a distinct cluster.

SPK 22:	Only [r] :	*bir~byar*
	Alternating :	*faṛ~firan*
		tuṛ~tiran
		kbir~k^{w}baṛ
		ħmaṛ~ħmir
	Only [ɽ] :	*baṛ~biɽan*
		kaṛ~kiɽan
		ɣaṛ~ɣiɽan

v) Speaker 23

Speaker 23 is a 62-year-old man native to Sefrou, a pre-Hilalian town not far from Fes in the Middle Atlas. He has lived in the New City of Fes for 18 years, and works as a professor at the university.

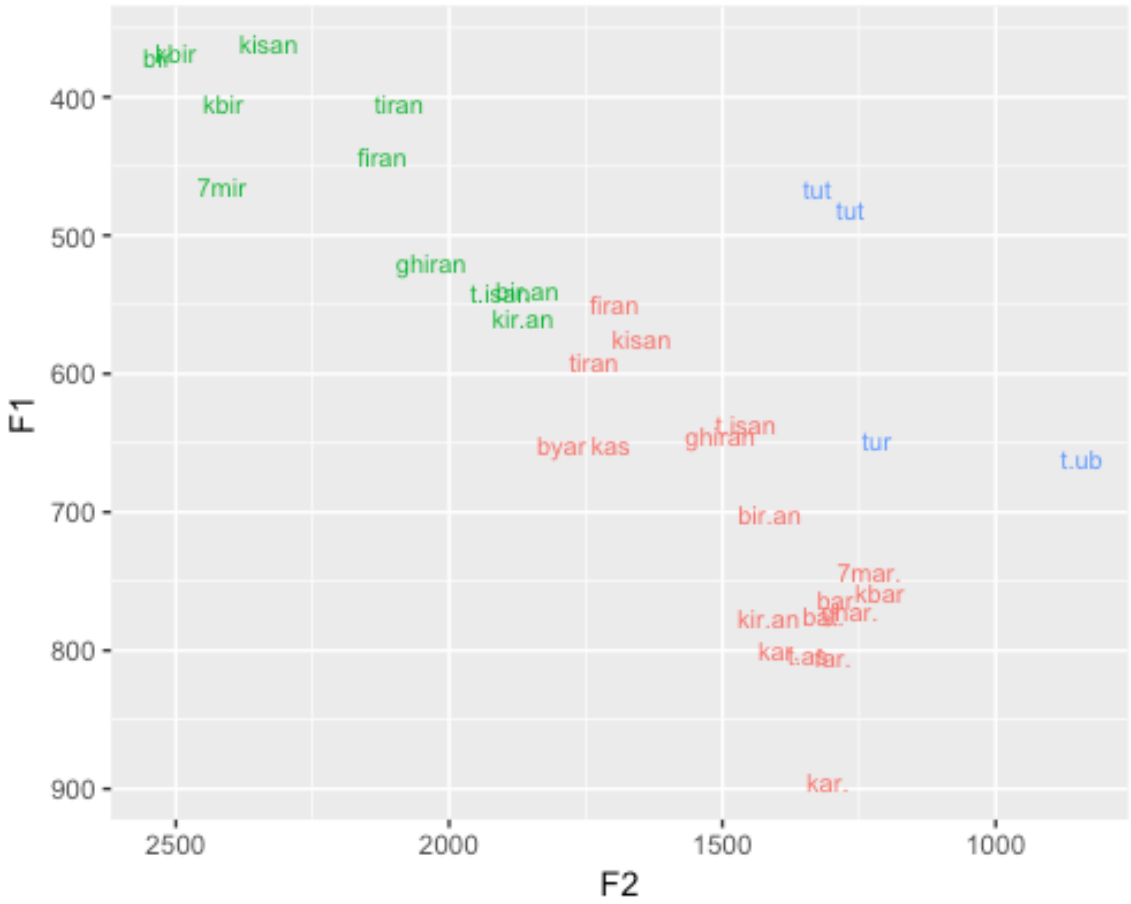

Figure 5.22: Distribution of midpoint vowel formants for Speaker 23. Colors indicate vowel type (/i/, /a/, or /u/).

This speaker has a raised plain [a], a recognizably gutturalized but front *tur*, a fronter emphatic /a/ form precluding analysis of *ɣiṛan* and *biṛan* as [ṙ], and plain *tiran*, *ṭiran*, *byar*. Speaker 23 is one of only two to level *tur* to plain [r] (the other is Speaker 03).

SPK 23:	Only [r] :	*bir~byar*
		tur~tiran
	Alternating :	*faṛ~ṭiran*
		kbir~kbaṛ
		ħmaṛ~ħmir
	Only [ṛ] :	*baṛ~biṛan*
		kaṛ~kiṛan
		ɣaṛ~ɣiṛan

w) Speaker 24

Speaker 24 is a 49-year-old man native to Sidi Kacem, a town in north-central Morocco not far from Meknès. He moved to Fes at the age of 15 and now works as a professor at the university, living in the New City.

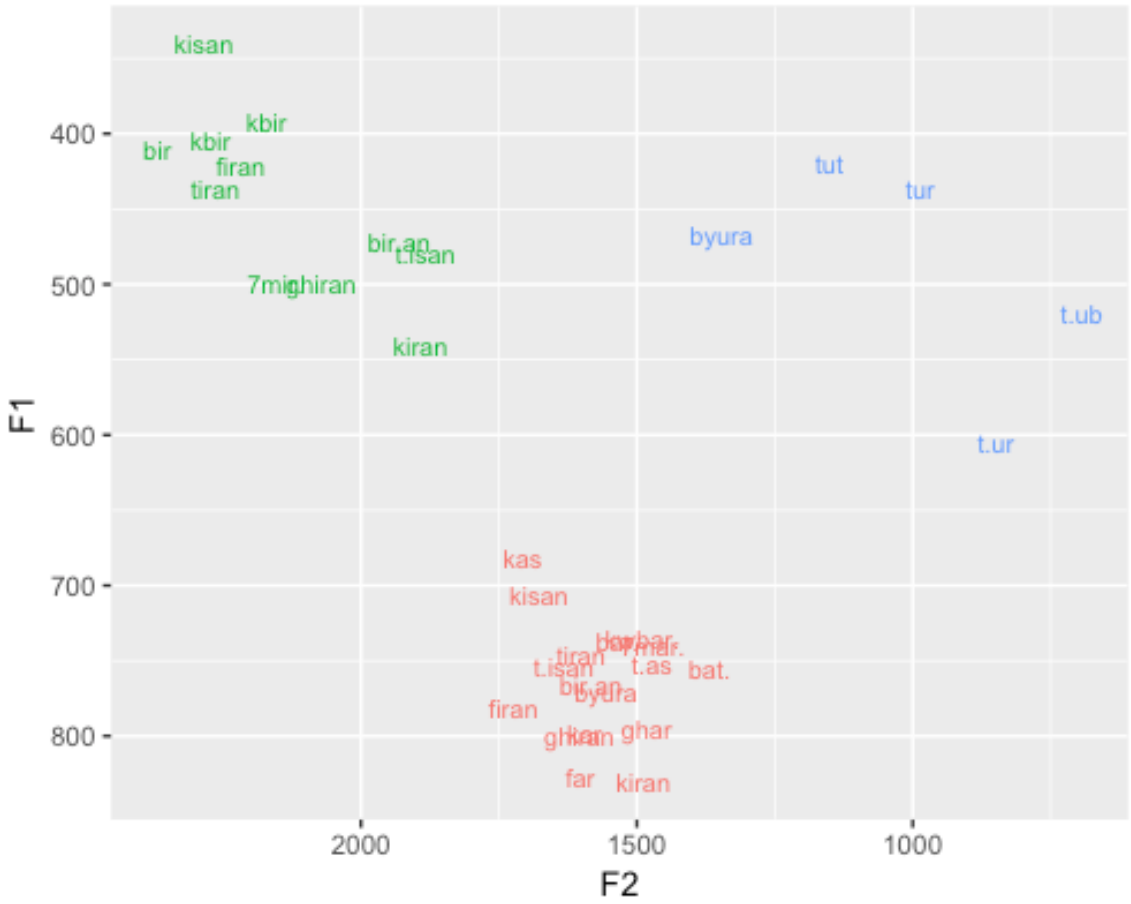

Figure 5.23: Distribution of midpoint vowel formants for Speaker 24. Colors indicate vowel type (/i/, /a/, or /u/).

Speaker 24 has an unusual distribution of /a/ vowels, with plain and emphatic allophones much closer together than for other speakers, However, as the larger-scale formant scatterplot in

Figure 5.24 shows, there is a distinction between them on the F2 dimension, with a line at about 1650 Hz F2 dividing the two. Note that this is much higher F2 of /a/ in general than we have seen for most speakers.

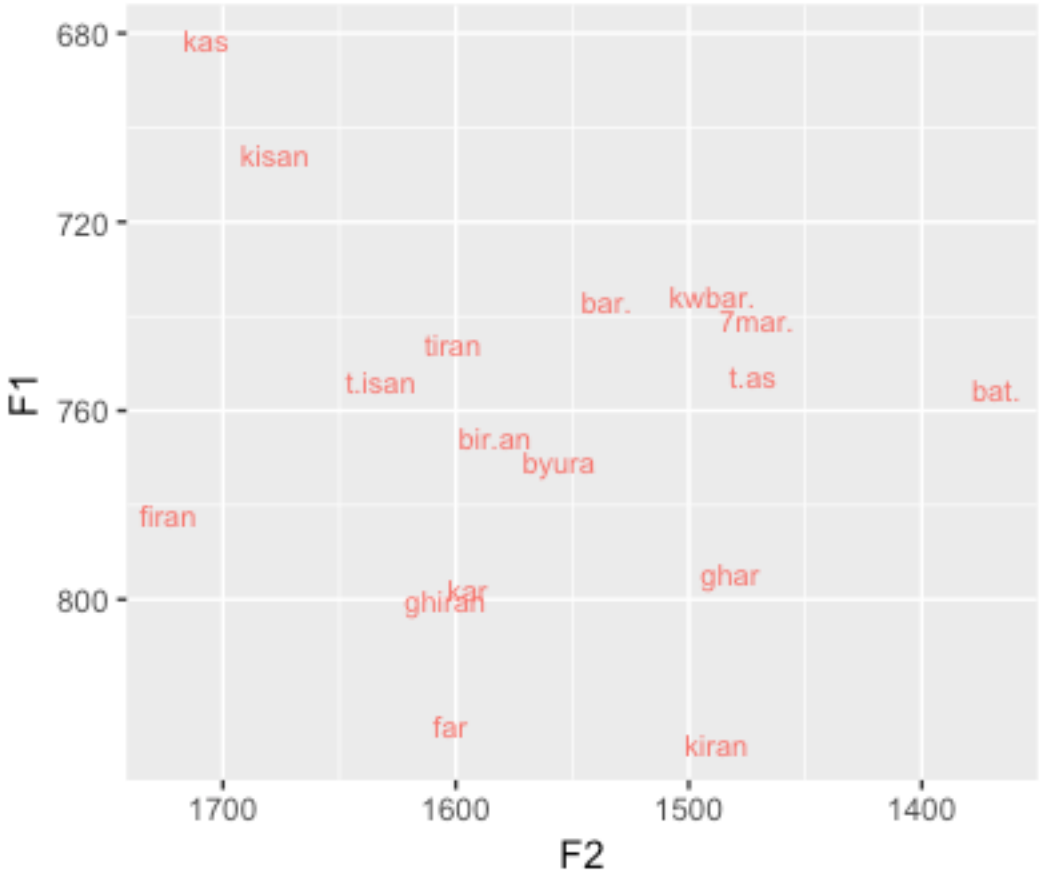

Figure 5.24: Midpoint /a/ tokens for Speaker 24.

This speaker also has [i] of *ħmir* approaching the F2 of [i] of *ɣiṛan*, but still separated from the plain cluster mostly by the guttural F1-raising effect.

SPK 24:	Only [r]:	*bir~byura*
	Alternating :	*faṛ~firan*
		tuṛ~tiran
		kbir~k^{w}baṛ
		ħmaṛ~ħmir
	Only [ṛ]:	*baṛ~biṛan*
		ɣaṛ~ɣiṛan
		kaṛ~kiṛan

5.2.2 Interpretation of Interspeaker Variation

The individual vowel patterns described in the previous section are presented in summary form in Table 5.5. This table assesses whether each singular/plural paradigm has a levelled (L), allophonic (A), or ambiguous (L/A) pattern of rhotic variants, and gives the rhotic variant in the /i/-adjacent form within the paradigm followed by the variant in the /a/- or /u/-adjacent form (so, *r-ṙ* for 'large' means plain [r] in *kbir* and uvular [ṙ] in *kbar*). Bracketed vowels indicate that the speaker produced a variant plural form having that rhotic-adjacent vowel; so for *bir*, [a] indicates *byar* and [u] indicates *byur(a).* Speakers 16 and 21 produced both a variant plural and *biran*, which is notated here as a slash before the vowel ([/a]). Color coding of speaker demographics indicates dialect background; green highlighting indicates exposure to a central or southern dialect (Speakers 11, 14, 15, 22), brown highlighting indicates exposure to a northern or Hiliian-type dialect (Speakers 05, 08, 17, 23, 24), and dark shading indicates speakers who were pointed to as illustrative of 'canonical' Fessi speech (Speakers 07, 19, 20).

#	From	S	E	Ag	*bir*	*bar*	*far***	*kar*	*ɣar***	*tur*	*ħmar*	*kbir*
02	Fes	F	C	21	L/A *r-r*	L *ṛ-ṛ*	A *r-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	A *r-ṛ*	A *r-ṛ*	A *r-ṛ*
03	Fes	M	C	23	L *r-r* [u]	L *ṛ-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	L *r-r*	A *r-ṛ*	A *r-ṛ*
04	Fes	M	C	34	L *r-r* [u]	L *ṛ-ṛ*	A *ṙ-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	L/A *ṛ-ṛ* [a]	A *r-ṛ*	A *ṙ-ṛ*
05	(Rif)	M	H	26	A *r-ṙ*	L *ṛ-ṛ*	A *r-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	*A *ṙ-ṛ*	-	A *r-ṛ*
06	Fes	M	H	33	L *r-r* [a]	L *ṛ-ṛ*	A *ṙ-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	A *r-ṛ*	-	A *ṙ-ṛ*
07	Fes	M	P	28	L *r-r* [u]	A *ṙ-ṛ*	A *ṙ-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	A *r-ṛ*	-	A *r-*
08	Rif	M	C	22	L *r-r* [u]	A *ṙ-ṛ*	A *r-ṛ*	L *ṛ-ṛ*	A *ṙ-ṛ*	A *r-ṛ*	A *r-ṛ*	A *r-ṛ*
09	Fes	M	C	37	L/A *r-r*	L *ṛ-ṛ*	A *r-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	A *r-ṛ*	-	A *-ṛ*
10	Fes	M	P	39	L *r-r* [a]	L *ṛ-ṛ*	A *r-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	A *r-ṛ*	A *r-ṛ*	A *r-ṛ*
11	Dakhla	M	H	20	L *r-r* [a]	L *ṛ-ṛ*	A *r-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	*A *ṙ-ṛ*	*A *ṙ-ṛ*	*A *ṙ-ṛ*
12	(Fes)	F	C	21	L/A *r-r*	L *ṛ-ṛ*	A *r-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	L/A *ṛ-ṛ* [a]	L *r-r*	A *r-ṛ*
13	Fes	M	C	43	L *r-r* [a]	L *ṛ-ṛ*	A *r-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	A *r-ṛ*	A *r-ṛ*	A *r-ṛ*
14	Mrkch	F	H	25	L *r-r* [u]	L *ṛ-ṛ*	A *r-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	A *r-ṛ*	A *r-ṛ*
15	Casa	M	C	22	L *r-r* [u]	L *ṛ-ṛ*	A *r-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	A *r-ṛ*	A *r-ṛ*
16	Fes	F	P	30	L *r-r* [/a]	L *ṛ-ṛ*	A *r-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	A *-ṛ*	A *r-ṛ*	*A *r-*
17	Rif	F	C	31	L *r-r* [u]	L *ṛ-ṛ*	A *r-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	A *r-ṛ*	A *r-ṛ*	A *r-ṛ*
18	Fes	F	C	30	L/A *r-r*	L *-ṛ*	A *r-ṛ*	A *ṙ-ṛ*	A *ṙ-ṛ*	A *r-ṛ*	-	A *r-ṛ*
19	Fes	M	P	67	L/A *r-r*	L *ṛ-ṛ*	-	L *ṛ-ṛ*	L *ṛ-ṛ*	*A *r-ṛ*	-	*A *-ṛ*
20	Fes	F	C	37	L *r-r* [a]	L *ṛ-ṛ*	A *r-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	L/A *ṛ-ṛ* [a]	A *r-ṛ*	A *r-ṛ*
21	Fes	F	H	32	L *r-r* [/u]	L *ṛ-ṛ*	A *r-ṛ*	A *ṙ-ṛ*	A *ṙ-ṛ*	A *r-ṛ*	A *r-ṛ*	A *r-ṛ*
22	B Mllal	M	C	56	L *r-r* [a]	L *ṛ-ṛ*	A *r-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	A *r-ṛ*	A *r-ṛ*	A *r-ṛ*
23	Sefrou	M	C	62	L *r-r* [a]	L *ṛ-ṛ*	A *r-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	L *r-r*	A *r-ṛ*	A *r-ṛ*
24	Sidi K	M	C	49	L *r-r* [u]	L *ṛ-ṛ*	A *r-ṛ*	L *ṛ-ṛ*	L *ṛ-ṛ*	A *r-ṛ*	A *r-ṛ*	A *r-ṛ*

Table 5.5: Analysis of noun paradigm patterns by speaker. *L = Levelled, A = Allophonic, L/A = consistent with either ; S = Sex (F = female, M = male), E = Education (C = College, H = Highshool, P = Primary); [a] or [u] = alternate plural form with [a] or [u] preceding /r/; r = plain /r/, ṛ = emphatic /r/, ṙ = uvularized /r/ based on F2; brown demographic shading = northern non-Fessi dialect influence, green demographic shading = southern non-Fessi dialect influence; green shading = levelled to [r], red shading = levelled to [ṛ], purple shading = allophonic with uvularized [r] in plain environment, blue shading = allophonic with uvularized [r] in emphatic environment, no shading = allophonic with no uvularized [r].*

Table 5.5 presents a situation in which idiosyncratic variation blurs the edges of a generally uniform system of lexical conditioning. The adjacent-back-vowel plurals of *bir* categorically lack emphatic phonetics, with plain /r/ generalized across the paradigm, except for one peculiar instance of [a]-backing in the speech of an L2 Arabic speaker. Similarly, *baṛ*, *kaṛ*, and *ɣaṛ* never lose post-velar emphasis for any speakers in their C_1iC_2an plurals, sometimes displaying F2 lowering in the less extreme 'uvular emphasis' range when an /i/ is present but never exhibiting an unambiguously categorical contrast between front- and back-vowel-adjacent forms.

In contrast, *faṛ~firan*, *tuṛ~tiran*, *ħmaṛ~ħmir*, and *kbaṛ~kbir* solidly preserve the vowel-conditioned emphasis contrast for most speakers. If these were the only words under consideration, and the idiosyncratic levelling and modification of their paradigms by some speakers were ignored, we could conclude that [ṛ] and [r] were allophones all along, just like Sibawayh said. As things actually stand, they occupy a grey area between conditioned allophony and unconditioned allomorphy, and the idiosyncratic introduction of levelled forms to these paradigms highlights this liminality.

For the two speakers from large south-central cities, Casablanca and Marrakech, emphatic [ṛ] has spread to the form *tiṛan*, placing this form in conformity with the *baṛ~biṛan*, *kaṛ~kiṛan*, and *ɣaṛ~ɣiṛan* pattern of emphasis-levelled plurals. Yet these speakers still preserve an alternating C_1iC_2an plural in *faṛ~firan*, so even within this small domain the system has not been fully regularized. Three other speakers, who have no shared social or regional characteristics, have generalized plain [r] in the singular of 'bull' (*tur*) and 'donkey' (*ħmar*), levelling in the opposite direction. Four other speakers, all Fessi, have introduced some degree of post-velar backing to the usually non-emphatic plural form *firan*. For three of them, 'emphatic' [ṙ] in *fiṙan* remains distinguishable from the [ṛ] in F2 because of its slightly higher F2, but Speaker 03 has levelled all the way to /ṛ/. This speaker has also levelled to plain in *tur~tiran*, which might suggest a case of across-the-board paradigm regularization until we realize that his *ħmaṛ~ħmir* and *kbir~kbaṛ* are still governed by the old allophonic rule. This intermediate uvular-type backing associated with /i/-adjacent /r/ is also seen sporadically in *tiran*, *ħmir*, and *kbir*, most consistently in the speech of the speaker who acquired a transregional military koiné while growing up in Dakhla.

In summary, (1) no speakers exhibit either a purely categorical or purely conditioned pattern of rhotic emphasis distribution, (2) lexical distribution of rhotic emphasis, while variable, is highly predictable across speakers, and (3) a rhotic variant with acoustic properties consistent with uvularization appears in some individuals' speech, generally in plain-conditioning environments and in paradigms susceptible to levelling towards /ṛ/.

5.2.3 Social Demographics as Predictive Factors

Though, as we have seen, interspeaker variation appears to be idiosyncratic, research indicates that demographic speaker variables often underlie even seemingly random patterns of linguistic

variation. If, for instance, rhotic emphasis were a change in progress in the Fessi Moroccan Arabic speech community resulting from dialect contact and levelling, we might expect to see age gradations in the degree of F2 lowering, or a gender effect conforming to the sociolinguistic principle that women drive change from below (Labov 2001).

In fact, it is difficult to discern any such patterns in these data. Linear predictive models and intergroup distributional tests did not reveal any sociolinguistic factors that are statistically predictive of formant values adjacent to /r/ or of rhotic variant type, either between words or within the scope of a single lexical paradigm. Though the relatively small size and relatively skewed composition of my speaker sample undoubtedly played a role in this negative result, It is also simply the case that the observed behavior within each contrasting social group is scattered across the full range of possible outcomes for rhotic emphasis. The following discussion briefly demonstrates this by examining intergroup formant data for three forms exhibiting interspeaker variability: *ɣiṛan, firan,* and *kbir.*

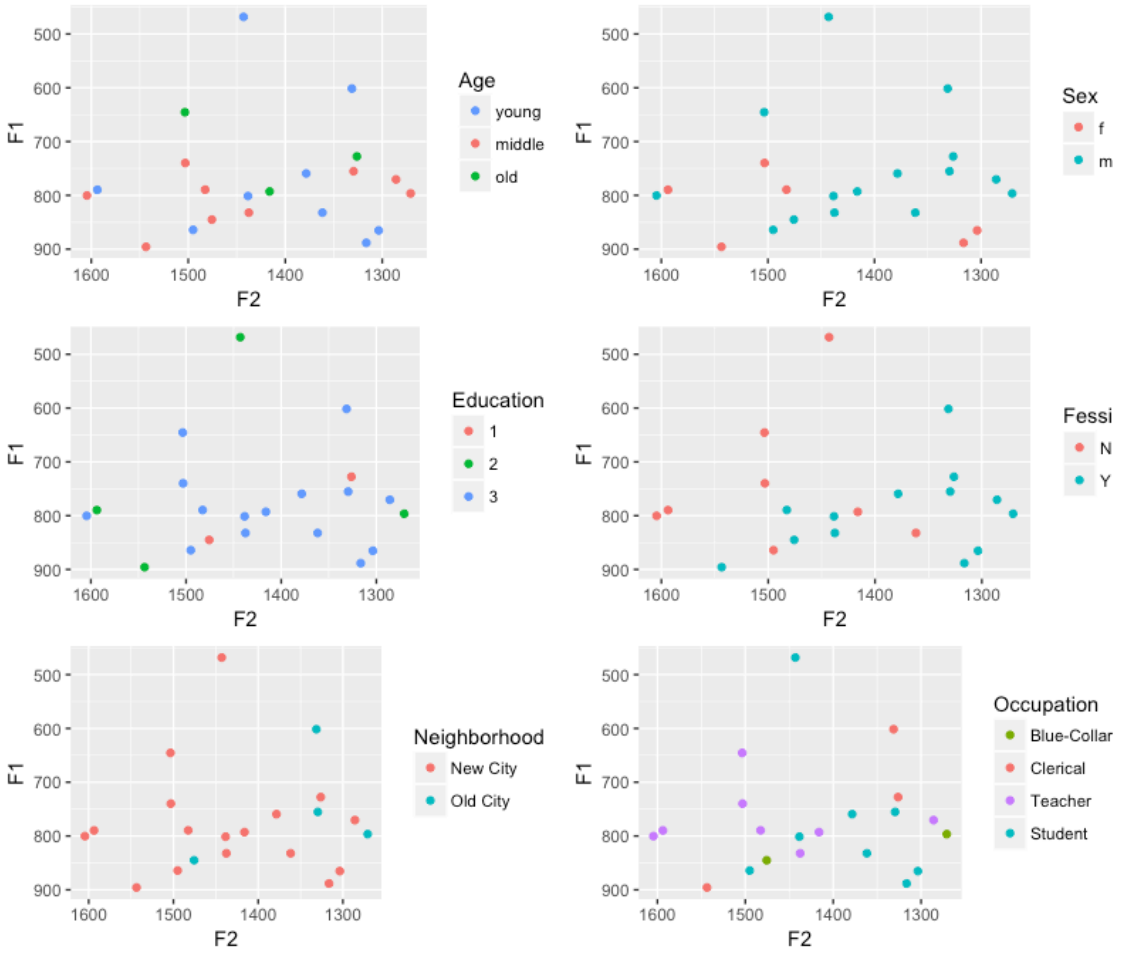

Figure 5.25: Distribution of *ɣiɻ*[a]*n* tokens by demographic factors.

For *ɣiɻan*, a form which is generally levelled to [ɻ] but for which some speakers have a fronter uvular-type variant, neither age, educational class, sex, or occupational class can tell us much about the kind of person that tends to have a fronter F2 of /a/. The 'Fessi' variable, separating native-born Fessis from those speakers with wider-ranging backgrounds, appears to suggest that Fessis are less likely to have a front/uvular [a], but this does not stand up to statistical scrutiny. A linear model attempting to predict F2 values according to 'Fessiness' has a p-value of no less than 0.39. Neighborhood of residence, another possible candidate for predictive variable, does in

fact come out as a signficant factor if a linear model is fit to the F2 data at $p = 0.046$, but on the basis of only four relatively backed 'Old City' datapoints. Even if this effect were to be acknowledged as valid, it cannot be reasonably interpreted without concomitant effects in class-related variables such as occupational class and education, of which there are none. My conclusion is that the variability in *ɣiṛan* emphasis is not predicted by social factors.

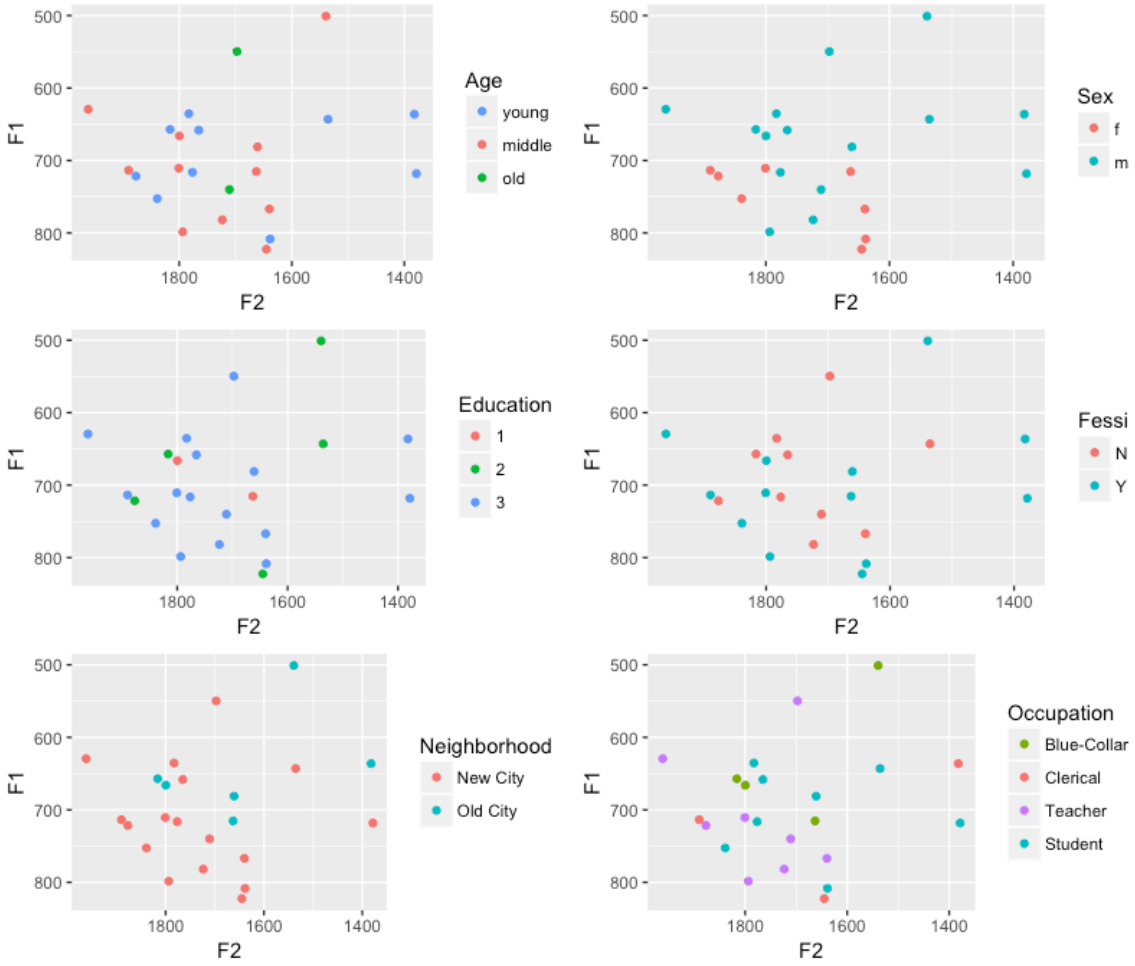

Figure 5.26: Distribution of *fir*[a]*n* tokens by demographic factors.

Next, let's look at *firan*, an alternating-*r* C_1iC_2an plural for most speakers which some speakers have levelled to [ṛ] or modified towards emphatic. Unsurprisingly, considering that many of our levellers were native Fessi, the Fessi variable doesn't tell us much. Neither does Age, Occupation, Education, or Neighborhood. Gender, however, may be a predictor, if we consider it signficant that all four people who have low F2 of /a/ in this word (Speakers 03, 06, 07, and 11) are men. Our linear model does not ($p = 0.30$).

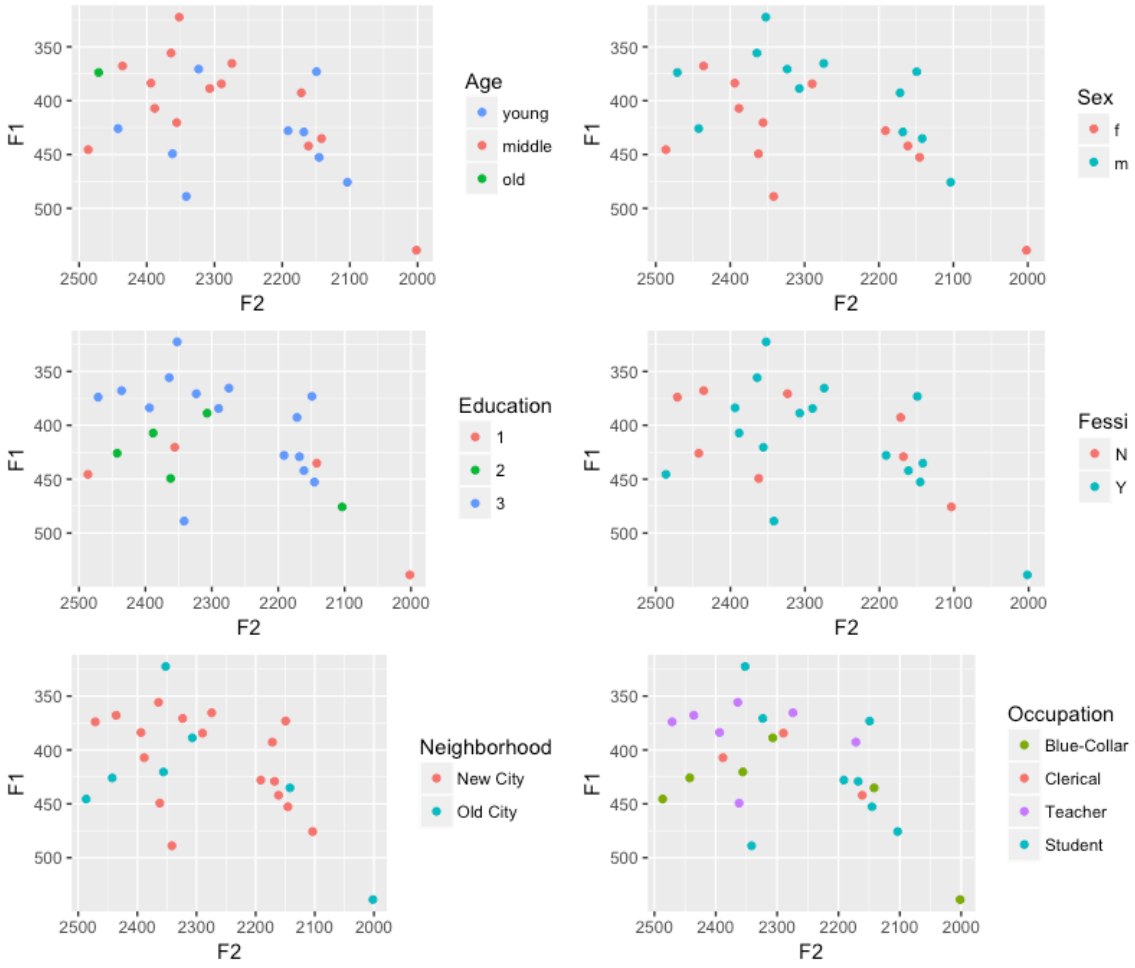

Figure 5.27: Distribution of *kb*[i]*r* tokens by demographic factors.

Finally, we consider *kbir*, a word in which /r/ is usually plain, but sometimes uvularized in the same sort of quasi-levelling towards [ṛ] that we saw in *firan*. Here, at least, our speaker-by-speaker bipartite analysis is confirmed by the overall scatterplot, with two distinct clusters emerging on the F2 dimention. Within each clusters, however, no particular demographic dominates. Young, old, men, women, the college-educated, the office workers, the inhabitants of the Medina, the natives of Fes, they are all scattered evenly throughout the plot. The only potentially meaningful result is that none of the three non-native Fessis with lowered F2 are from the Rif region. There is one from Casablanca, one from Dakhla (the military child), and one from Sidi Kacem. These three people do not form a coherent regional or social group – Sidi Kacem is in the north, while Casablanca and Dakhla are not, and the Marrakech speaker, who generally has features in common with the Casablanca speaker, belongs to the other (high F2) cluster.

As these examples demonstrate, the variation between individuals evidenced in the data cannot be reliably linked to any demographic or socioeconomic factors. While there may be some influence of regional origin on an individual's system of lexical distribution of rhotic variants, it is limited and non-deterministic. The clearest example of regionally bound variation emerging from the present analysis is the restriction of levelled *tuṛ~tiṛan* to speakers from Casablanca and Marrakech, koinéized urban dialects well to the south and west of Fes.

5.3 Summary of Rhotic Distribution Patterns

This chapter has described, in as much detail as possible, the distribution and patterns of variation of rhotic emphasis in a controlled set of word forms. The resulting information has shown that the emphatic rhotic [ṛ] cannot be easily categorized as either a contrastive segment or a conditioned allophone with relation to non-emphatic [r]. Across speakers, the default

pattern is for certain lexical stems to contain invariable [r] and [ṛ] regardless of adjacent vowel type, and for other lexical stems to alternate between [r] and [ṛ] depending on whether or not a front vowel is adjacent.

In phonetic terms, the characteristic emphatic rhotic appears to be upper-pharyngealized [rˁ], with an average F2 of /a/ below 1350 Hz that is commensurate with /a/ adjacent to emphatic coronal obstruents. However, for some speakers, /a/-adjacent rhotics in certain words are associated with consistently higher F2 values than other words within the emphatic range, falling within the 1350-1500 Hz range identified as typical of uvulars in Chapter 4. These tend to be word forms which are either /i/-adjacent and typically have invariable [ṛ], or which are /i/-adjacent and typically have alternating [r] but are susceptible to levelling by analogy to morphophonologically similar words having invariable [ṛ]. The phonological role of this uvularized or intermediate [rˠ] or [ṙ] will be explored in the next chapter, along with the broader implications of the structural indeterminacy of the rhotic emphasis contrast and the idiosyncraticity of its variability for our understanding of the constitution of phonological categories.

Chapter 6: The Phonological Organization of Marginal Emphatics

The preceding chapters have presented the acoustic and distributional facts about uvular coarticulatory spreading and the rhotic emphasis contrast in Moroccan Arabic, revealing a complex and irregular but not disordered system. This concluding chapter seeks to make sense of the observed complexities from a theoretical perspective, focusing on the organization of representational categories in phonology. We find that, as with other perceptually or distributionally difficult 'quasi-phonemes,' classical accounts of categorical phonemics are insufficient to account for the distributional and variational patterns of the rhotic emphasis phenomenon, any more than are theories which place the representational burden on gradient phonetic effects. Instead, we propose that recent approaches to phonological organization emphasizing the emergence of constrasts through probabilistic learning offer the best explanation for the data, and, what is more, that this proposal helps to explain a number of interrelated facts about the behavior of post-velar articulations in Arabic.

Section 6.1 demonstrates the inadequacy of categorical underlying representations to deal with the facts of Moroccan Arabic emphasis; in the following section (§6.2), a proposal focusing on probabilistic percetual attractors is outlined and applied to the data. Next, I discuss the implications of this proposal (§6.3), and conclude with an evaluation of this research project and suggestions for the direction of future work (§6.4).

6.1 The Categorization Problem for Emphatic Rhotics

At the start of this dissertation, I posed a simple question: are emphatic and non-emphatic rhotics separate phonological categories, or variants of a single phonological category? Are [r]

and [r̠] allophones, or are they separate phonemes? This sort of question can usually be answered using distributional tests, with evidence of lexical contrast indicating a phonemic distinction and evidence of phonetic conditioning indicating a subphonemic allophonic distinction.

In this case, however, the distributional evidence is aggressively equivocal. Minimal pairs exist, but they are rare and either have low functional load or are in the process of being lost; it is possible to identify a pattern of depharyngealization adjacent to high vowels, but it is inconsistent and mediated by lexical effects. In fact, the more information we gather about the phenomenon, the more difficult it becomes to determine its phonological status from distributional evidence. To demonstrate this, I will briefly recapitulate the distributional facts and use them to derive contradictory analyses.

In the last chapter, we considered a controlled subset of Moroccan Arabic vocabulary targeting stem alternation paradigms characterized by varying vowel backness adjacent to a rhotic consonant in the stem. Note that Moroccan Arabic, like most colloquial Arabic varieties, forms inflected and derived forms by means of 'templatic' morphological processes (McCarthy 1993), which apply complex operations of stem ablaut and affixation to an invariable ordered set of root consonants associated with each lexical item.[47] In the paradigms considered here, there are three-consonant roots varying between $C_1C_2aC_3$ and $C_1C_2iC_3$ stems from singular to plural, and two-consonant roots having singulars of the form C_1VC_2 (with variable vowel), and plurals in the productive C_1iC_2an stem.

The results indicate that for most but not all speakers, in the two $C_1C_2aC_3$~$C_1C_2iC_3$ words with a rhotic as C_3, the rhotic was pharyngealized or uvularized when the adjacent vowel

[47] While the best analysis of these 'templates' is open to debate, the fact remains that the root consonants don't vary between derived forms, while the vowels and affixed consonants do.

was /a/ but not when the adjacent vowel was /i/. This was also true for the bi-consonantal paradigm *faṛ~firan*, and a similar alternation between rhotic adjacent to /u/ and rhotic adjacent to /i/ held for most (but not all) speakers in the paradigm *tuṛ~tiran*.

In three other C_1aC_2~C_1iC_2an paradigms with a rhotic C_2 (C_1 being a labial, a velar, and a uvular respectively; two of these being French loanwords, and one a native Arabic word), the rhotic was pharyngealized or uvularized in both the singular and the plural; however, about half of the speakers maintained a subtle phonetic contrast between an apparently uvularized rhotic in the /i/-adjacent form and an apparently pharyngealized rhotic in the strictly /a/-adjacent form. In the remaining biconsonantal paradigm *bir~biran*, even for a number of speakers in which the plural was replaced by a form *byar*, *byur*, or *byura* with the rhotic adjacent to a back vowel, the rhotic was never pharyngealized or uvularized. This gave rise to a consistent minimal contrast across all speakers between a non-emphatic rhotic in *biran* 'wells' (plural of *bir*) and a pharyngealized or uvularized rhotic in *biṛan* 'bars' (plural of *baṛ*).

When individuals deviated from the patterns just described, it was either by generalizing non-emphatic [r] in *tur~tiran* or *ħmar~ħmir*, generalizing pharyngealized/uvularized [r̰] in *tuṛ~tiṛan* or *faṛ~fiṛan*, or by replacing an expected [r]/[r̰] alternation with a subtle distinction between uvularized and pharyngealized [r̰] conditioned by the presence or absence of an adjacent front vowel. These deviations could not be predicted by the social characteristics of the speaker, except in the case of *tuṛ~tiṛan* levelled to pharyngealized [r̰], which was found only in the speech of the two individuals exposed to south-central Moroccan urban dialects during childhood.

From one perspective, these data clearly support an allophonic analysis of the [r]/[r̰] distinction. Though Arabic has some suppletive allomorphy, it never exhibits unpredictable substitution of individual consonants within a root, and there is no evidence to suggest

synchronic depharyngealization of emphatic coronal obstruent phonemes in Moroccan Arabic. If there were separate phonemes /r/ and /ṛ/, however, then the predictability of the forms *ħmaṛ~ħmir*, *kbir~kbaṛ*, *tuṛ~tiran*, and *faṛ~firan* could only be explained by allomorphy. This allomorphy would be anomalous in the dialect's grammar, and would be predictable by a regular phonological rule '/ṛ/ → [r] when adjacent to /i/.'[48]

We could, then, claim that such a regular phonological process exists, and either applies to only a (seemingly random) subset of the lexicon or is obscured by some (indiscernible) other process which blocks its application. In support of this argument, we could even cite the variable tendency for /ṛ/ in words that seem not to be subject to this process to exhibit a fronted allophone when adjacent to /i/. If pressed to explain the basis of the lexical subset in which the rule does not apply, we could say something about French loanwords and words with uvular consonants having some common quality that blocks the /ṛ/-depharyngealization process, and this might hold up until a broader set of vocabulary was tested for counterexamples.[49]

From another perspective, the data clearly support a contrastive analysis of the [r]/[r̠] distinction. There is a contrastive minimal pair *biran/biṛan* which is attested for all speakers who have *biran* as the plural of *bir*, and despite some idiosyncratic variation the choice between [r] and [r̠] appears to be stable depending on word-form. Most speakers hve only [r] in the root for 'well,' and only [r̠] in the roots for 'bar,' 'bus,' and 'cave.' The fact that we can even point out a regional distinction between *tur* and *tuṛ* as the singular form for 'bull' suggests that the distinction between the two sounds is encoded underlyingly in the lexicon. Our alternating paradigms are just that – lexically specified allomorphy which just happens to appear allophonic due to the historical contingencies of the language.

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[48]Or, in optimality theory, by a constraint set disfavoring rhotic emphasis in the neighborhood of /i/.

[49]Some such counterexamples, including alternating paradigms with uvular fricatives, are provided by Heath (2002).

Even if we explain away the root-consonant-suppletion problem, though, this lexical analysis runs into problems. If the choice between /r/ and /ṛ/ is arbitrarily and lexically specified, and acquired on a word-by-word basis, then why is there so much unpredictable ('free') interspeaker variation between the two sounds in each word-form? If phonetic context is irrelevant to the emphasis specification of a rhotic consonant, then why do many speakers still exhibit some fronting of /ṛ/ when it is adjacent to a front vowel? What is conditioning this fronting, and why is it inconsistent among paradigms and speakers?

As this exposition demonstrates, a classic structuralist model of contrastive phonological representation mediated by regularly conditioned rules is not sufficient to account for the behavior of Moroccan Arabic rhotics. An optimality-theoretic account would fare no better, since the architecture of OT requires the evaluation filter to select a unique and discrete optimal surface form.[50] Given that many well-informed researchers have resorted to classifying Arabic /ṛ/ across dialects as a 'quasi-phoneme,' this is perhaps not surprising. Like American English tense /æːˤ/ and Italian geminates, it occupies a grey area in the linguistic system that presents difficulties for analysis. Some languages have 'near-mergers'; in the [r]/[ṛ] contrast, Moroccan Arabic has a 'near-split.' From a historical perspective, this is of course a logically necessary stage in the development of a phonemic split, but one which is generally presumed to be ephemeral and rapidly disambiguated through the categorical nature of language acquisition.[51] How could a 'near-split' be as stable in a grammar as this one seems to be?

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[50] The uniqueness constraint may be partially lifted in some stochastic versions of OT, but these theories still rely on the maintenance of discrete representational contrasts in candidate forms.

[51] See, for example, the asymmetrical treatment of mergers and splits in Hamann (2015).

The next section will propose an answer to this question which accounts for the variability of the data, and can also be used to explain several disparate aspects of Arabic post-velar phonology. On the other hand, it stretches the limits of phonological theory by suggesting that phonemic representation is not reliably categorical, and emerges via probabilistic, perceptually-based learning mechanisms.

6.2 Emergent Representations: Uvularization as Structurally Ambiguous

The fundamental problem for attempts at a representational analysis of rhotic emphasis is that the assumptions of distributional and phonetic categoriality are not borne out by the data. Section 6.1 highlighted distributional ambiguity, while in Chapter 4, we saw that uvular and upper pharyngeal place are only subtly and inconsistently differentiable by acoustic cues. I argue that, as has been claimed for near-mergers (Labov et al. 1991), low perceptibility is key to the preservation of this near-split as a stable element of the grammar. Across Arabic dialects, the relationship between phonetics and phonology in post-velar secondary articulation is subject to a large amount of variation, despite a stable phonetically-based contrast existing between post-velar places at the level of primary articulation. In the dialect investigated here, historical variability in rhotic pronunciation has primed /r/ to be a locus for phonological indeterminacy, above and beyond the perceptual ambiguity naturally arising from the phonetic characteristics of approximants and particurly of rhotics (Stevens 1989).

While such statements about perceptual ambiguity may be uncontroversial from the perspective of cognitive processing, it is challenging to incorporate them into the theory of phonological representation. The concept of the phoneme is founded on the notion of discrete

categorical contrasts between scpeech sounds, an axiom whose general validity is well-established by categorical perception studies among other lines of research.[52] Strategies to incorporate uncertainty into this Saussurian paradigm, such as underspecification, variable rules, competing grammars, and exemplar prototype formation, almost always do so by adjusting mechanisms rather than representations themselves. Theories of underspecification remove the site of ambiguity from the base representation altogether, requiring it to be specified at a more superficial (and hence more plausibly 'messy') level of the grammar; variable rules add a fixed probability value to processes within the mental grammar, creating a constrained site for the encoding of variability that is kept apart from representations; the competing grammars model proposes that the probabilistic dynamics at play in variation are of a higher order than the grammar itself, and involve choices between uncompromisingly discrete phonological schemata; and exemplar models, while coming closest to addressing representational concerns, still rely on the discrete categorization of tokens into exemplar clouds, which then serve as a basis for determining the surface target of an abstract discrete representation. In the exemplar case, the *realization* may be gradient, but the *underlying form* is not.

Nevertheless, key ideas drawn from exemplar-based approaches to phonology may be helpful in explaining the behavior of Moroccan [r̩]. In particular, the concept of perceptual attractors (Pierrehumbert and Pierrehumbert 1990) has been used in recent research to model the dynamics of phonological systems and the emergence of community-level regularity in grammatical representations. De Boer (2000), for example, modelled the emergence of a fully-specified vowel system from gradient acoustic information using an agent-based network model. The idea that stable and predictable systems of phonological contrast result from particular

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[52] See Pierrehumbert (1990) for a well-articulated defense of this categorical contrast principle against Ohala's more gradient surface-based approach.

distributions of phonetic input goes back to Liljencrants and Lindblom (1972), who claimed that the most typologically common vowel inventories emerge naturally as the most efficient categorization of the perceptual vowel space. Its application to probabilistic learning models may be more recent, but follows from the earlier work given our current understanding of language acquisition as a dynamic process subject to updating mechanisms (Yang 2009; Ahern 2014). Coupling the concept of an emergent attractor for category assignment with probabilistic updating, as in Wedel (2012), gives us a powerful tool for understanding poorly categorizable phenomena such as 'near-splits.'

In the specific case of Moroccan rhotic emphasis, I propose that the formant signature of adjacent vowel offers three separate perceptual attractors to the language learner. Two of these – the 'high F2' attractor associated with 'plain' (non-post-velarized) oral consonants and the 'low F2' attractor associated with 'emphatic' (secondarily upper-pharyngealized) oral consonants – are strong attractors, representing perceptually salient maxima of a probability distribution over F2. The third, however – a 'mid-low F2' attractor associated with primary uvular consonants – is a weak attractor, representing a local probability maximum easily reinterpreted as a long tail of the distribution associated with the 'emphatic' attractor. The weakness of this uvular attractor, in this model, is the source of phonetic ambiguities in the realization of [ṛ] and may help to stabilize the systemic ambiguities in its distribution. Speakers are simply not sure whether a rhotic with mid-low F2 is underlyingly uvular or not, and this uncertainty is resistant to resolution. Figure 6.1 illustrates the 'weak attractor' proposal as a schematic probability distribution.

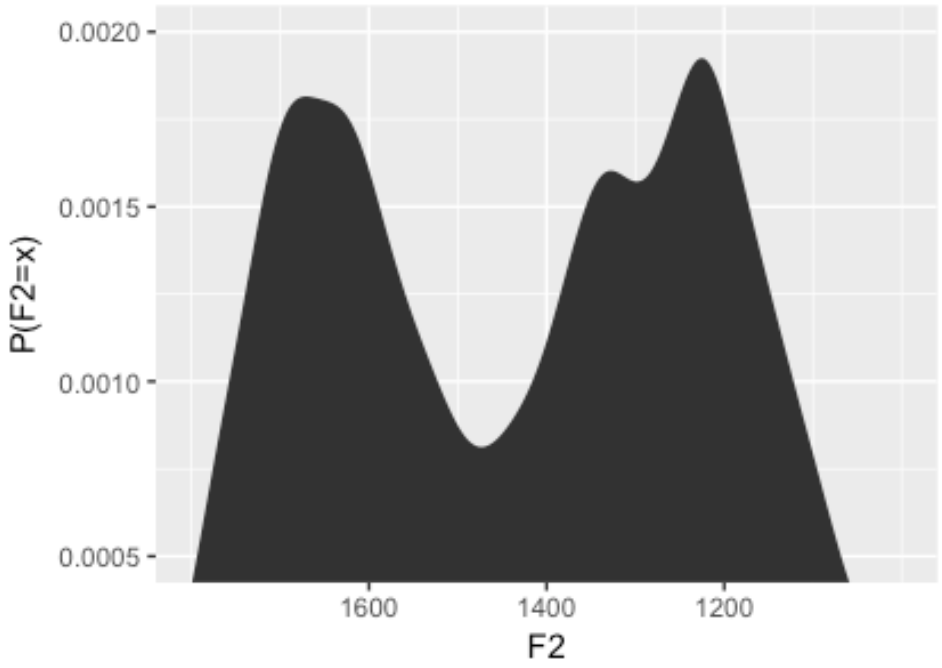

Figure 6.1: The 'weak attractor' model illustrated with respect to contrastive uvularization. The smaller peak on the left limb of the low-F2 distribution corresponds to the acoustic correlate of uvular articulation.

Why, though, would such perceptual instability be historically and grammatically stable? One possible answer lies in the phonetics of [r] itself. Unlike the coronal obstruents which exhibit a clear-cut plain/emphatic oppositional contrast, approximants do not have a clear boundary with adjacent sonorants, and exhibit greater variability in articulation (Stevens 1989, Baltazani and Nicolaidis 2013). As a result, coarticulations and articulatory variants render perceptual targets for approximants less prescise than they are for obstruents, and learners are faced with the task of generating structure-based interpretations for perceptible patterns of phonetic imprecision. Under such circumstances, it is understandable that ambiguity as to the secondary place features of /r/~/ṛ/ would be resistant to resolution, and the problem is compounded in Moroccan Arabic

by the fact that some dialects historically had a primary uvular [R], providing a precedent for the classification of /r/ as a uvular-type guttural which could easily have been preserved in transmission after the articulation itself had changed.[53]

Figure 6.2 illustrates how, under this model, a segment such as a rhotic with a wide range of F2 values will be more difficult to categorize than a uvular or a coronal obstruent emphatic. The uvular will be easy to assign to the category corresponding to the weak attractor, since it exhibits a limited range of F2 values centered on that local maximum. The primary emphatic is associated with a broader range of F2 values of which the uvular range is a subset, but it is still not challenging to categorize because it conforms to a distribution centered on the strong upper-pharyngeal attractor. The rhotic, on the other hand, straddles the gap between the attractors, leading to idiosyncratic association of tokens with different target categories.

[53] Younes, in fact, offers a similar suggestion (1994:229): 'The complex articulation of [ɾ] may be used to explain synchronic alternations and diachronic changes involving different languages and different types of /r/... The pronunciation of Arabic /r/ in some dialects or idiolects as velar or uvular may be viewed as an instance of the loss of the primary alveolar articulation while the secondary articulation is retained.'

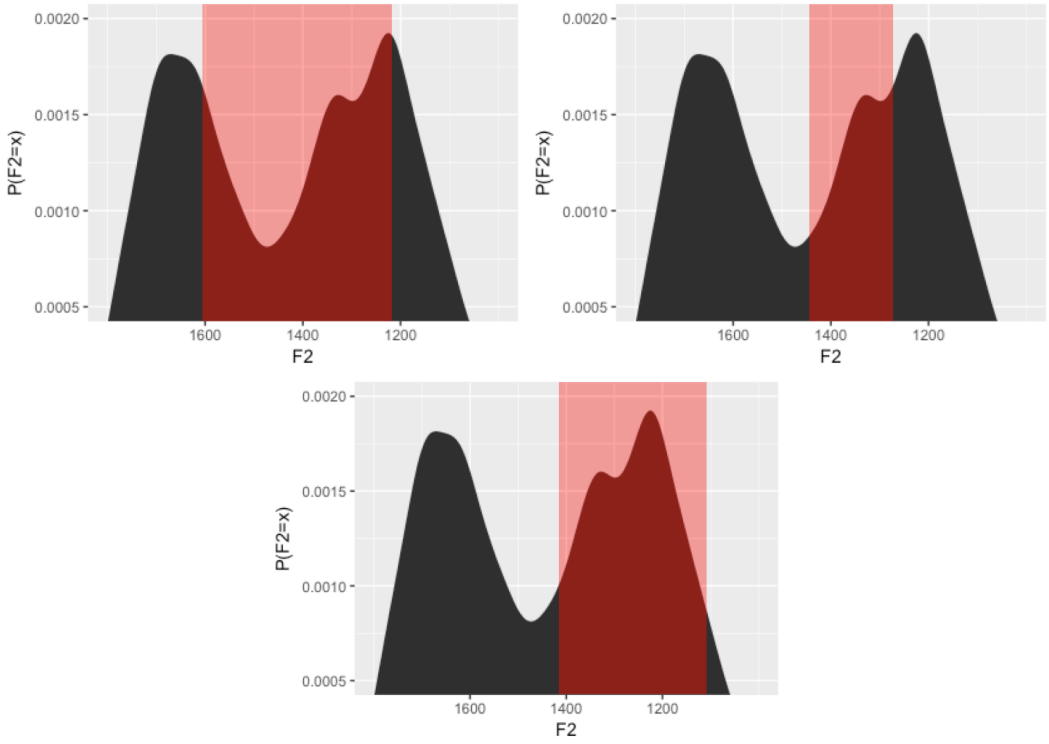

Figure 6.2: Schematic application of the post-velar attractor model to rhotics (upper left), uvulars (upper right), and coronal obstruent upper-pharyngealized emphatics (bottom).

All of this is, of course, rather speculative. Without detailed psycholinguistic experimentation and mathematical modeling, it is impossible to know with certainty how rhotic emphasis contrasts are stored in the minds of koinéized Fessi speakers of Colloquial Moroccan Arabic. What we can determine from the availlable acoustic and distributional data is that some synchronic phonological mechanism must be responsible for the stability of this 'near-split' characterized by predictable, but variable and non-categorical phonetic and lexical distinctions – a situation which is not rare cross-linguistically – and that this phonological mechanism must incorporate indeterminacy. Without formulating a complete theoretical proposal, we can point towards something we might call 'probabilistic underspecification' as a promising candidate

mechanism, in which language users faced with a specificatory gap determine the likelihood that a featural contrast exists in a certain configuration by choosing between various perceptual attractors. As discussed in the next section, applying this proposal to uvularization has bearing on miscellany of facts that go beyond the core /r/~/ṛ/ paradox, suggesting that it has explanatory value meriting further consideration.

6.3 Implications of the Emergent Indeterminacy Proposal for Arabic

As applied to Arabic, our proposal involves two particular claims: (1) approximants, and especially rhotics, are favored loci for representational ambiguity due to phonetic variability, and (2) uvularization is representationally ambiguous with upper pharyngealization due to its more limited range of perceptual correlates. These claims are empirically supported by a variety of phenomena in not just Moroccan Arabic, but also in other dialects of Arabic.

To begin with the second point, consider the constitution of the natural class of 'emphatics.' These consonants, in the most restrictive definition composed of coronal obstruents, are characterized by a post-velar secondary articulation in contrastive distribution with consonants having the same primary articulatory characteristics but no post-velarization. Note, however, that in order to accurately describe this feature I had to use the inclusive term 'post-velar.' As mentioned in Chapter 2, studies disagree on whether the secondary articulation associated with emphasis is uvular or pharyngeal, and the evidence points to wide variation among dialects, with some even exhibiting velarization or glottalization as correlates of emphasis (though this is rare). Diachronic indeterminacy between uvularization and pharyngealization, in particular, points to the perceptual confusability of the two secondary

articulations, which renders any specification more precise than post-velarization difficult to maintain and transmit. Specification of *primary* uvularity in contrast to pharyngeality, however, is a necessary feature of the grammar, with the high-functional-load contrast between (at least) /χ/ and /ħ/ supporting this distinction.[54] As we have seen, the uvulars have a clear, though limited, coarticulatory acoustic signature overlapping with the acoustics of emphatic consonants, and which we have no reason to believe is not also associated with secondary uvularization. So, there is a tension here between contrastiveness and confusability which we see most saliently represented in the unparsability of rhotic emphasis, but which also emerges in the phonetic variability of coronal emphatics. The token-by-token data in Chapter 5 contain many cases in which a [ṭ]-adjacent vowel migrates into a fronter formant space within the uvular range, though the overall emphatic distribution remains further back (as reported in Chapter 4).

Another piece of evidence for considering representational ambiguity to be a feature of secondary, rather than primary, uvular articulation is the erratic behavior of the uvular stop /q/. Though I have not focused on this segment here, there is considerable evidence from descriptive grammars and phonetic studies that /q/ is variably interpreted by Arabic speakers either as a purely guttural uvular stop or as an emphatic dorsal stop triggering emphasis spread in contrast to /k/ (Abo Mokh and Davis 2018). In a separate analysis of the Fessi speakers described in Chapters 4 and 5, for example, I found that speakers varied in whether /q/ in the word *qas* caused uvular-range F2 lowering in adjacent vowels (Freeman 2019). These patterns of variation, however, could *not* be predictably linked to patterns of rhotic emphasis variation, or

[54] This contrast cannot be leaned upon too heavily as evidence relevant to emphasis, though, since according to the Sylak-Glassman/Moisik/Esling model, primary pharyngeals are lower pharyngeal in contrast to the upper pharyngealization of emphatics. It is useful, however, in establishing that uvularity must be a discrete articulatory target, since the contrastive primary uvulars do not exhibit variability in place of primary articulation.

to any demographic characteristics of the speaker. Like the /r/~/ṛ/ contrast, this '/q/~/ḳ/' contrast has unpredictable manifestations that point to an underlying structural uncertainty. Crucially, the 'plain guttural' tokens were also found to *lack* uvular-type F2 lowering, while the 'emphatic dorsal' tokens were the ones with the uvular-type F2 signature on adjacent vowels. Recall from Chapter 3 that the F2 lowering associated with adjacent /q/ was found to be more stable across the vowel than the F2 lowering associated with /χ/ and /ʁ/, favoring a feature-based interpretation for /q/ more than for /χ/ and /ʁ/. If F2-lowering /q/ is in fact *secondarily* uvular in its underlying representation, whereas the uvular fricatives are *primarily* uvular, and secondary uvularization is an unstable subclass of phonological emphasis, this would explain the observed asymmetry in gradiency. Further research would, of course, be needed to solidify this claim, but the evidence we have suggests that it is a plausible interpretation of the facts.[55]

A final phenonmenon relating to the claim that uvularization is uniquely confusable with upper pharyngealization is the *exclusion* of other closely associated secondary articulations from emphatic-like phonological behavior. While this may not apply across all Arabic varieties, in Moroccan Arabic we see that velarized labials such as the [mˠ] in [mːˠi] do not spread their velarity to neighboring vowels in the same way that uvularized consonants spread their uvularity and pharyngealized consonants spread their pharyngeality. Instead, the velarization is limited to the adjacent, transitional part of the following vowel (Zeroual et al. 2011). This indicates that, whatever complex processes ultimately govern its behavior, Moroccan Arabic velarization is not confusable enough with uvularization or pharyngealization to be even inconsistently realized as emphasis. In terms of Figure 6.1, it

[55] This proposal would also be consistent with the primary/secondary uvularization distinction used by Davis (1995) to analyse the differential spreading effects between uvulars and emphatics, and supported for [g] (← /ḳ/ ?) < /q/ in a Palestinian dialect by Abo Mokh and Davis (2018).

is on the right limb of the plain distribution rather than the left limb of the emphatic distribution, and so does not participate in the dynamics of representational uncertainty on that dimension.

Turning now to the first point presented above, that rhotics and other approximants are unusually favorable to phonological ambiguity, we need turn no further than the history of Arabic rhotic emphasis to find support for this claim. As discussed in Chapter 2, early medieval descriptions of Arabic consider /r/ to be basically guttural or emphatic, with a tendency to lose this property in the environment of high vowels. This is our allophonic situation, '/ṛ/ → [r] when adjacent to /i/,' and these descriptions make it clear that allophony was the historical starting point for Arabic rhotic emphasis. As we have seen, phonetic conditioning has since drifted towards phonemic contrast in many modern dialects, but it is worth interrogating the basis of the conditioned process itself. The presence of most secondary or marginal emphatics in Arabic can be explained by spread of the emphatic feature from a primary emphatic consonant such as /ṣ/ or /ṭ/, and /ṛ/ is anomalous in this respect. Words such as [ṛaʔs] 'head' and [θawṛ] 'bull' in Classical/Standard Arabic never contained an emphatic consonant historically, only a rhotic. I propose that the rhotic emphasis rule emerged from learners using *vowel backness* (low F2) as a perceptual cue for emphasis in the environment of the perceptually ambiguous /r/, in a way that would not have been available for more acoustically and articulatorily distinct obstruent consonants. Partial vocalization of the consonant and heavy bidirectional coarticulation[56] would have made it unclear whether the low F2 was a property of the vowel or the approximant, and once the rhotic emphasis generalization was established in the speech community, it stuck. Later partial association of rhotic emphasis

[56]Both characteristic features of flapped/trilled rhotics that I encountered in my data; see Savu (2013) for a detailed phonetic discussion of the phenomena.

with contrastive emphasis led to the chaotic 'near-split' situation I have described for colloquial Moroccan A, and which has almost certainly arisen in other dialects as well (cf. Watson 2007, Youssef 2019). The original source of [ɾ̣], though, was a reanalysis of a purely phonetic effect in terms of unrelated phonological features borrowed from other parts of the grammar, made possible by the wide margin of interpretative error associated with [r]. The only other consonant which may have undergone a similar trajectory in Arabic is /l/, with its low-frequency lexically conditioned emphatic variant [l̪]. Tellingly, /l/ is also an approximant.

Another prediction of the ambiguous approximant claim which is borne out for Arabic is that /r/ will be, generally, a locus of variation. This is perhaps trivial, as a long tradition of cross-linguistic dialectological and sociolinguistic research has documented /r/ as a salient sociolinguistic variable (Bloomfield 1933, Labov 1966, Pankhurst 2012, Lerner 2016). There is, however, no *a priori* reason for rhotics to be more susceptible to indexicalization than other phonetic variables, and proposing that they have an inherent perceptual indeterminacy that must be assigned meaning by the language learner goes a long way to explaining why they are so salient in social variation. In Arabic, uvular [R] is a well-documented feature of various socially marked colloquial varieties, including the speech of religious minorities in Baghdad (Abu Haidar 1991) as well as the Fessi elite in diaspora (Hachimi 2007). Another highly enregistered sociolinguistic variable in Arabic happens to be /q/ (Al-Wer and Herin 2011), making it possible to extend the argument that ambiguity engenders meaningful variation to the uvular dimension as well.

In summary, then, the idea that phonological ambiguity is a fundamental property of both uvulars and rhotics both supports and is suppported by a variety of facts about Arabic. The fact that irresolvable phonological ambiguities arise in miscellaneous other languages indicates that this is not just a quirk of Arabic, but that there must be some way of encoding partially

ordered chaos into the general theory of phonology. The strictly constrained rate-matching predicted by Labovian variable processes[57] does not apply to this case, while a competing grammars model would involve both a level of clarity in the distinction between systems which was far from evident in our data and an impracticable multiplicity of systems to accomodate all possible partitions of the feature speace. In proposing dynamic and continuous reassessment of the appropriate categorization of a specific poorly delimitable region of phonological space, the solution proposed here could perhaps be characterized as coupling underspecification with an exemplar-based approach. As our understanding of probabilistic learning and the cognitive basis of linguistic structure continues to improve, no doubt we will approach a firmer answer to the riddle of the quasi-phoneme.

6.4 Directions for Future Research

The work presented in this dissertation has sought to evaluate the phonological system of Moroccan Arabic through a fine-grained phonetic analysis of individuals' speech. This approach has certain advantages, but it also has its limitations. On the one hand, patterns emerging from this sort of data are unlikely to be misrepresentations, since the details of each utterance are being taken into account. On the other, this level of scrutiny can only be applied to a small subset of the grammar, lexicon, and stylistic range of a language – we are looking at a patch of trees in the proverbial forest, and the best we can do is to plan for a highly representative patch of trees. It is my belief that the sample of Colloquial Moroccan Arabic speech considered here is indeed representative with respect specifically to the rhotic emphasis contrast and the

[57] The kind of situation lending itself to a strict variable rule analysis is exemplified by Gregory Guy's work (1991) on final stop deletion in English.

uvular/upper pharyngeal distinction, but many important issues surrounding these two phenomena remain open for further investigation.

First, the question of sociolinguistic variation remains to be fully addressed. It is conceivable that sociolinguistic variation which did not emerge in the analysed wordlist task may have been present in the free speech section, or that a more comprehensive (if less detailed) survey of Fessi speakers would yield more intelligible patterns of interspeaker variation. Interdialect comparison to nearby 'pre-Hilalian' populations less exposed to koiné influences, such as older, less mobile speakers in Taounate or Sefrou, would also help to shed light on the role of dialect levelling in the formation of the system I have described. Comparison in the opposite direction, to a 'maximum koiné' situation such as the largely immigrated and non-Sahraoui Moroccan population of Dakhla, would further help to elucidate the process of koinéization.

Second, the model of perceptual attractors and ambiguity I have described in this chapter begs the question of how speakers actually perceive the /r/~/ṛ/ contrast, and how, if at all, uvularization and variable fronting of /ṛ/ fit into their perception of the contrast. This could be answered fairly straightforwardly using experimental methods, for instance by asking speakers to disambiguate minimal pairs or to choose between levels of a two- or three-way contrast when presented with an auditory stimulus. One could even ask speakers for 'grammaticality judgments' about the naturalness of post-velar(ized) consonantal segments spliced with vowels having varying formant structure, to better understand the importance of adjacent vowel acoustics as a perceptual cue for post-velar place.

A third issue which needs to be addressed is that of variability in the primary, rather than secondary, articulation of rhotics. Due to the broad scope of this variability, encompassing vocoids, frication, approximants, taps, and flaps, my analysis abstracted away from the

phonetics of the rhotic segment itself to focus on the adjacent-vowel effects allowing acoustic comparison with other post-velar consonants. It is certain, however, that revisiting the data with an eye to constraints on the primary articulation of [r]/[r^{ʁ}]/[r^{ʕ}] would reveal some meaningful phonetic, lexical, or sociolinguistic constraints, which could potentially assist in accounting for the patterns of adjacent vowel effects described here.

Relatedly, the analysis could be expanded to include a greater variety of words and phonemes. We were only able to mention in passing the lexical conditioning of emphasis spread associated with the uvular stop, and were unable to fully address the issue of adjacent uvulars favoring rhotic emphasis.[58] The other 'marginal emphatics,' most notably emphatic [l̪], should also be considered in greater detail.

Finally, languages other than Arabic may hold the key to understanding the relationship between uvularization and pharyngealization. Salishan and Northwest Caucasian languages in particular have complex inventories of post-velar consonants that include such rarities as pharyngealized uvulars (Sylak-Glassman 2014:113 ff.) which are extremely relevant to understanding the organization of post-velar place. Miller-Ockhuizen's 2003 study of the Khoisan language Ju|'hoansi, while mostly focusing on phonational aspects of the laryngeal and epilaryngeal features complicating gutturality in that language, offers an excellent example of what could be done in this respect. It is to be hoped that the comparative phonetic and phonological literature on gutturals will continue

[58] The explanation for this phenomenon is, however, almost certainly the same as that given for the back-vowel conditioning of emphatic rhotics in the previous section – a coincidental acoustic effect being historically attributed to post-velar specification of the rhotic consonant, and later becoming more or less lexically arbitrary.

to develop and that as it does, the information I have presented here will prove useful to future researchers.

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