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Revisiting areal and lexical diffusion: the case of Viennese Monophthongization in Austria's traditional dialects

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Abstract: This paper investigates the geographical and structural diffusion of "Viennese Monophthongization" (VM). By means of a new numerical measure to assess and compare formant movement in 18 lexical items, we provide evidence that VM is an ongoing, regular sound change transforming [aɛ̯] and [aɔ̯] gradually into [æː] and [ɒː]. Data are based on direct dialect recordings of 76 speakers in two age groups in 19 eastern and central Austrian rural locations. Results indicate that VM is diffusing from Vienna in a wave-like fashion. Even though VM is reported to have been established in other bigger cities for more than 30 years, the data show no evidence of diffusion from these cities. There are also other factors affecting the degree of formant movement: The phonetic-phonological environment (stress and the following consonant) explains most of the variance in the data, whereas no frequency effects could be found. Social identity, cultural space, and gender-related network structures are discussed as additional social factors.

Keywords: areal diffusion; formant measurement; lexical diffusion; sound change; Viennese Monophthongization

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1 Introduction

The Viennese Monophthongization (=VM) is a process whereby the diphthongs [aɛ̯] and [aɔ̯] change to the monophthongs [æː] and [ɒː], e.g. in [d̥raɛ̯] ('three') > [d̥ræː] and [haɔ̯s] ('house') > [hɒːs] (e.g., Moosmüller 1991; Moosmüller and Scheutz 2013). The VM originated in Vienna and has been well documented for Vienna's local dialects since the early 20th century (Gartner 1900; Kranzmayer 1953; Luick 1932; Traunmüller 1982). More recent studies indicate that it has diffused not only to the wider Viennese metropolitan area, but also to the local dialects of other larger cities in Austria such as Linz, Graz, Salzburg, and even to rather distant Innsbruck (Moosmüller 1991; Moosmüller and Scheutz 2013; Moosmüller and Vollmann 2001). Despite the empirical evidence that VM has spread from Vienna to some western, more densely populated cities, the process of diffusion beyond (larger) cities has not been extensively investigated.

One reason for this might be the methodological obstacles resulting from the phonetically continuous nature of VM. The process of monophthongization takes place in a gradual shift ranging from clear-cut monophthongs to clear-cut diphthongs. Consequently, broad categorizations based solely on impressionistic phonetic transcriptions are not fully adequate to study this sound change and its sociolinguistic distribution (such transcripts are, nevertheless, sometimes used, cf. e.g., Fanta-Jende 2020). To overcome these obstacles, instrumental phonetic measurements are urgently needed (such measurements have already been used to investigate VM, cf. e.g., Moosmüller and Scheutz 2013; Moosmüller and Vollmann 2001). The raw data resulting from instrumental phonetic measurements, however, are difficult to compare inter-individually and need to be normalized for comparison (cf. e.g., the methodical approach in Moosmüller and Scheutz 2013 drawing on the Bark Difference Metric; for a comparison of different vowel formant normalization procedures cf. e.g., Flynn 2011). In particular to observe small gradual shifts characteristic for sound changes in progress a measure capable of registering small differences in formant movement is required. In the following, we draw on a method first introduced in a pilot study by Luttenberger and Fanta-Jende (2020). One of the key features of this method is that it does not normalize individual formant values but differences between formant values, i.e. it is a technique for formant movement normalization. In the present paper, the applicability of this method is for the first time applied to investigate a larger corpus of different speakers and dialect regions. Using this method, we address the questions of how far and in which pattern VM has so far diffused into the rural dialects of Austria (for early evidence cf. Fanta-Jende 2020).

The diffusion literature proposes a number of different patterns by which innovations may spread geographically (for an overview, cf. Britain 2013). According to "wave-theory", linguistic innovations diffuse gradually, evenly and geographically continuously from their point of origin, reaching nearby places before those further distant (Bailey et al. 1993: 381–382; Nevalainen and Raumolin-Brunberg 2003: 170; Wolfram and Schilling-Estes 2003: 721). Other researchers, however, support a more hierarchical model of linguistic diffusion in which innovations first spread to larger and more densely populated cities, from there to smaller regional towns, before filtering down into rural areas (Bailey et al. 1993; Chambers and Trudgill 1998; Kerswill 2003; Trudgill 1983). Using new data and acoustic phonetics, one aim of the present paper is to re-examine the areal diffusion of the VM: Is it gradually diffusing from Vienna only? Or do other cities play a role as diffusion centers as well?

In addition, we want to analyze the most important linguistic constraints shaping the progression and diffusion of VM. Is it a regular or irregular sound change? Following Seidelmann (2014), VM should represent a prototypical case of "sound change in a narrow sense" (=Neogrammarian change) since the articulation of the diphthongs [aɛ̯] and [aɔ̯] is supposed to change phonetically gradually to the monophthongs [æː] and [ɒː]. Such sound changes should affect the entire lexicon at once with differences in the pace of change shaped only by phonological/phonetic factors (Labov 1994). There is, however, empirical evidence for an alternative account of sound change, namely "lexical diffusion" (Wang 1969), i.e. a process whereby "a phonological rule gradually extends its scope of operation to a larger and larger portion of the lexicon" (Chen and Wang 1975: 256). Note that the progression of a particular change through the lexicon of a speaker or a variety is affected by many external and internal linguistic constraints. Lexical diffusion is, importantly, not to be identified with irregularity in change (Wang 1969: 9). In the present study we want to investigate the extent to which VM is affected by lexical diffusion, and, more generally, whether VM is a regular sound change or not.

To examine both the areal and linguistic embedding of the diffusion of VM, we analyze a corpus constructed within the Special Research Program "Deutsch in Österreich" (='German in Austria'; https://dioe.at/; 27.01.2022). Our data consist of 1,346 realizations of the variables /aɛ̯/ and /aɔ̯/ across 18 lexical items. To be able to perform apparent time analyses we recruited 76 speakers from two age groups (18–35 years and 65 years and older) from 19 rural locations in Austria. To adequately measure the realizations of the vowels, we used instrumental phonetic analyses. For comparing the measurements, we calculated indices which are the basis for our further statistical analyses.

In what follows, we first elaborate on areal and lexical diffusion (Section 2), before we explain the variables in more detail (Section 3). In Section 4, we present our design, methods, and materials. Results are shown in Section 5. We discuss these results in Section 6. Finally, Section 7 provides a brief conclusion.

2 Diffusion and sound change

In variationist sociolinguistics it has become usual to distinguish the actuation of a new variant from its diffusion. Regarding the latter, one can further differentiate the diffusion of a new variant within the speech community (Section 2.1) from its diffusion within the linguistic system (Section 2.2).

2.1 Diffusion at the micro- and the macro-level

Following Labov (2001), two major factors contribute to the diffusion of new variants within the speech community, namely identity and language contact. Regarding identity, variants seem to diffuse if they are associated with a favorable social persona that speakers want to claim for themselves. Their diffusion is thus attached to what Le Page and Tabouret-Keller (1985) call “acts of identity”.

Considering language contact, we have to integrate different dimensions: On the micro-level, social network structure seems to play a central role in the diffusion of linguistic features. While a close-knit network structure tends to inhibit linguistic change from outside of the community, loose-knit networks seem to succumb to change more readily. Loose-knit network structures typically exert less pressure to conform to the group’s norms and allow for more contact with speakers (potentially of other varieties) from other social networks (Milroy 1987; Milroy and Milroy 1992). Since ties between various networks are most frequent in the urban lower middle class/upper working-class population, these groups are considered as the most important drivers of diffusion (Labov 2001; Milroy 1987). Conversely, the rural farming population as well as the lower working-class population are characterized by a more delimited, less diverse network structure and thus demonstrate a much greater resistance to change (Labov 2001; Milroy 1987). Although social stratification in the German-speaking countries is said to be less rigid than in the Anglo-American world, studies have indicated that network structures have a similar impact on language variation and change: In particular so-called *kleine Leute* (‘ordinary people’) have shown to stick more closely to local networks, and among other things, this manifests in an increased use of (local) dialect features, which are employed to project and create identity within their “sub worlds” (Kallmeyer 1994/1995; for the impact of network structures in rural Austria cf. Lippi-Green 1989).

At the macro-level, diffusion research has focused on the “geographical pathways” of new variants. Several proposals have been made to model geographical diffusion (cf. for an overview e.g., Britain 2012: 2035–2039, 2013: 478–482). Wave theory and the hierarchical gravity model are the most influential. The wave theory (sometimes known as ‘contagion diffusion’) proposes that innovations spread geographically gradually out from the original home of the linguistic innovation, comparable to the way a stone causes outwardly radiating ripples when dropped into still water. The "wave" radiates outwards until either its driving force is dissipated (Trudgill 1983: 85), or it hits a certain barrier like a cultural, political, or geographical border (Bailey 1973; Bloomfield 1973: 317). Seen from a variationist perspective, one would not expect the "wave front" to mark a clear border between an area consistently using the old variant, on one side, and an area using only the new variant, on the other (Chambers and Trudgill 1998). Instead, there should be a constant diminution of the variant's use with higher amounts at the innovation center – Trudgill described this variable, quantitative perspective on the geographical progression of change as 'the spatial diffusion of ratios' (Trudgill 1983: 61). Since most variants originate "in a highly specific linguistic context", as Sankoff (1982: 685) states, one would additionally expect "[t]he original innovators […] [to] use the new variant in more and more general contexts, while speakers distant from the center of innovation start to use it, but only in the original restricted environments". Consequently, geographical diffusion should go hand in hand with the spread of the change into ever more linguistic (e.g., phonological, lexical, syntactic) environments (Wolfram and Schilling-Estes 2003: 717; see Section 2.2). As Chambers and Trudgill (1998: 162) argue "the kind of heterogeneity that exists in transition zones" often reflects this variable embedding in different linguistic contexts.

The general validity of the wave model underpins the so-called "Fundamental Dialectology Principle" (Nerbonne and Kleiweg 2007: 154), which states that spatial distance is the best predictor of dialect similarity (cf. eg., Nerbonne 2010; Nerbonne and Heeringa 2007). Yet, wave theory has been criticized, since it "depends entirely on a perfectly geographically even distribution of interactions and mobilities and a perfect pattern of denser interactions in locations geographically near to the origin of the innovation and evenly sparser interactions at ever greater distances from the core, regardless of terrain" (Britain 2012: 2035). Such differences in interactions und mobility, in turn, are foregrounded in the so-called "gravity model" (Trudgill 1974; Chambers and Trudgill 1998: 166–186), also labeled the "urban hierarchy model" (Britain 2012: 2035). This approach proposes that "[i]nnovations diffuse discontinuously from one center of influence to other centers […] and from each of those into the intervening regions (in waves that sometimes overlap)" (Chambers and Trudgill 1998: 166).

The underlying intuition is that there are more interactions between the urban populations of cities than between the urban and the rural populations simply by virtue of the greater number of city inhabitants and the prevalence of transportation infrastructure connecting densely populated areas. This would imply more network ties between cities than between city and countryside and therefore more micro-level speaker contact (Trudgill 1974, 1983). Chambers and Trudgill (1998: 179) even adapt, from economic geography, a formula, stating that the rate of diffusion between two locations is directly proportional to the product of both locations' populations, though inversely proportional to their squared distance. Additionally, the pre-existing linguistic similarity of both locations should further increase the rate of diffusion. Several studies have provided evidence of the validity, at least in some contexts, of this demographically hierarchical model (e.g., Hernández-Campoy 2003; Kerswill 2003; Trudgill 1974, 1983).

Figure 1 illustrates how VM would be expected to geographically diffuse comparing the wave theory with the gravity model approach.

In spite of the intuitive plausibility of the gravity model, Nerbonne and Heeringa (2007: 274) argue that "research has not overwhelmingly vindicated … a gravity-like effect in linguistic diffusion. There have been voices of affirmation, but even these have noted several counterexamples". Both Trudgill (1986: 47–49) and Bailey et al. (1993: 371–378), for instance, have documented the occurrence of "counter-hierarchical" diffusion, where a feature spreads from rural to urban regions, and Britain

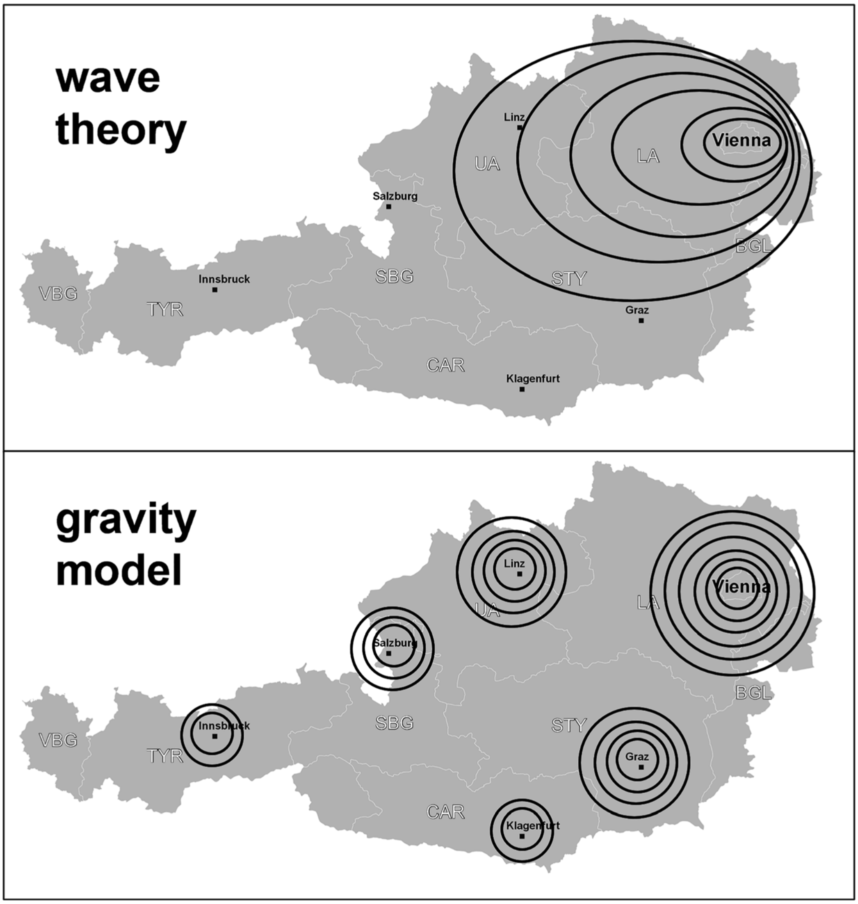

Figure 1: Geographical diffusion of the VM in Austria presupposing the wave theory versus presupposing the gravity model.

(2020) has shown evidence across a number of variables of southern British English of urban innovations reaching sparsely populated rural areas before nearby towns and cities. Horvath and Horvath (2001), in turn, have shown that there are not only “space effects”, as the gravity model supposes, but also “place effects … the ensemble of sociolinguistic conditions within a speech locality” (Horvath and Horvath 2001: 53). They argue in favor of a so-called Cultural Hearth model of innovation diffusion, a combination of both wave and hierarchical diffusion whereby a feature gains a foothold in both urban and rural areas of a region before diffusing beyond. Ultimately, as Britain (2012: 2039) concludes, all models proposed on geographical diffusion (so far) are characterized by a “failure to adopt a richly socialized and interactional perspective on the spaces across which features diffuse”.

There is, thus, an urgent need for more fine-tuned research on areal diffusion. This is particularly true for Austria, where no comprehensive empirical research has yet been conducted on this topic. Nonetheless, when it comes to linguistic innovations spreading from Vienna older dialectological research seems to assume the wave model (e.g., Kranzmayer 1956: 7), while more recent dialectologists lean toward the gravity model (e.g., Wiesinger 1992: 297).

2.2 The Neogrammarian controversy

In the late 19th century, the Neogrammarians argued that sound laws suffer no exceptions (=“Ausnahmslosigkeit der Lautgesetze”):

> Every sound change, inasmuch as it occurs mechanically, takes place according to laws that admit no exception. That is, the direction of sound shift is always the same for all the members of a linguistic community except where a split into dialects occurs: and all words in which the sound subjected to the change appears in the same relationship are affected by the change without exception. (Osthoff and Brugmann 1878: VIII; translation from Lehmann 1967: 204)

However, this view has always been contentious: Whereas advocates of the Neogrammarian doctrine went even further and proposed additional “laws” – e.g., the “Reihenschrittgesetz” (‘parallel movement law’), stating that sounds of the same class should change in the same manner (Wiesinger 1982) – its critics adopted the position that ‘every word has its own history’ (Gilliéron 1921; Jaberg 1908: 6), from which it follows that sound laws are merely abstractions, not empirical facts at all.

An early attempt to find regularities within the irregularities which appear to leak through the Neogrammarian net of postulated phonetic laws is the lexical diffusion approach. Its advocates propose that a “phonological rule gradually extends its scope of operation to a larger and larger portion of the lexicon” (Chen and Wang 1975: 256). As not all lexemes are affected at the same time, any ongoing process appears to be accompanied by irregularities when we study sound change *in situ*. By contrast, the outcome of a change may appear exceptionless if “all relevant items have been transformed by the process” (Chen and Wang 1975: 256). If the process stops before having affected all lexemes, however, this will not be the case.

The lexical diffusionist view has found considerable empirical support in the last few decades (for further references, cf. e.g., Bybee 2002; Lin et al. 2014; Ogura 1987; Phillips 2006, 2015). Not least, this applies to studies on German vernacular dialects in Austria and beyond. While traditional Austrian dialectology was heavily influenced by the so-called “Viennese school” that strongly supported the Neogrammarian view (e.g., Kranzmayer 1956: VII–VIII), more recent studies turned towards the lexical diffusion approach because they found most ongoing sound changes in German vernacular dialects not affecting all lexemes at the same time (e.g., Bülow et al. 2019; Scheutz 1985; Schwarz 2015; Vergeiner et al. 2021 and others). In contrast to traditional dialectology, however, these studies focused on changes caused by dialect-to-standard contact. Thus, there are hardly any recent findings specific to phonetically induced changes in Austria.

The Neogrammarian doctrine still has its upholders – most famously maybe Labov (1994) (cf. also Bermúdez-Otero 2015; Campbell 2004; Hale et al. 2015). In order to defend the Neogrammarian position in view of the empirical evidence supporting the lexical diffusion approach, some researchers differentiate various types of sound change. For example, Kiparsky (1995) relates lexical diffusion to the operation of lexical rules and “Neogrammarian change” to those of postlexical rules. A similar distinction is made by Labov (1981: 280–286, 1994: 543). He distinguishes between the abrupt substitution of one phoneme for another (=lexical diffusion) and gradual change taking place across continuous articulatory space (=“Neogrammarian change”). This enabled him to predict which types of change were most likely to follow Neogrammarian principles (e.g., vowel shifts in place of articulation, consonantal changes in the manner of articulation, vocalization of liquids, etc.), and which would be subject to lexical diffusion (shortening, lengthening, consonant changes in place of articulation, metathesis of stops and liquids, etc.) (Labov 1994: 543). Importantly for our case here, he argues that monophthongization “seem[s] to hold an intermediate position”, sometimes following Neogrammarian and sometimes lexical diffusionist expectations. Labov (1994: 78) also interlinked the question of lexical diffusion with the motivations for change, and hence the distinction between “change from below” and “change from above”. While “change from below” is supposed to be exceptionless, since changes are triggered here by “internal, linguistic factors”, “change from above” is characterized by lexical diffusion due to the fact that this type of change “represent[s] borrowings from other speech communities that have higher prestige”. Thus, irregularities develop through interference between different varieties (Labov 1994: 474).

One also has to note, however, that Labov’s (1994) claim is problematic since diffusion always requires borrowing (Britain 2016; Bülow et al. 2019: 32–33; see

Section 2.1). Several studies also show that lexical diffusion can occur in changes which initially characterized as "changes from below" due to the operation of postlexical rules, such as the gestural reduction of post-vocalic /l/ in American English (Lin et al. 2014; cf. also Phillips 2006 for several other examples). It is very often assumed that sound change, even when characterized by lexical diffusion, is regular or at least shows regularities. Besides phonetic-phonological factors – which, of course, the Neogrammarians were fully aware of and embraced – most research on lexical diffusion has focused on frequency effects (cf. e.g., Bybee 2002, 2015; Phillips 2006, 2015). Although many studies found correlations between word frequency and instances of change, no clear-cut conclusions have emerged (cf. e.g., Todd et al. 2019). While most researchers found that higher word frequencies promote change (cf. e.g., Bybee 2002; Ogura 1987), others have reported the opposite (cf. e.g., Phillips 2006). Regarding findings in which high-frequency words seem to be less affected by change, Phillips (2006, 2015) argues that frequent words are more easily accessible and thus less prone to analogical reinterpretation. This does not hold, however, for reductive processes in which frequent words are found to change faster (Bybee 2002, 2015). In addition, as Phillips (2006, 2015) makes clear, in view of frequency effects one has to differentiate various phonetic-phonological environments as well as different word classes (cf. also Ogura 1987). Bearing this in mind, frequency effects alone can rarely account for lexical diffusion – one also has to consider various lexical properties such as semantics (Yaeger-Dror 1996) and morphology (Schleef 2013) (for a discussion, cf. Bülow et al. 2019; Todd et al. 2019).

3 Viennese Monophthongization

During the history of the Germanic languages, the "extreme" diphthongs *ai* and *au* have been monophthongized multiple times (in turn, the diphthongs re-emerged several times through diphthongization processes). The term Viennese Monophthongization can be used to label two different processes of monophthongization

Process	MHG reference and equivalent sound in the respective varieties	Variety	Sound change	Example
1st monophthongization (12th/13th century)	*ei* – /ɔɛ̯/	dialect level	/ɔɛ̯/ > /aː/	/hɔɛ̯s/ > /haːs/ 'hot'
2nd monophthongization (beginning of the 20th century) = Viennese Monophthongization (VM)	*î* – /aɛ̯/ *û* – /aɔ̯/	dialect and standard level	/aɛ̯/ > /æː/ /aɔ̯/ > /ɒː/	/d̥raɛ̯/ > /d̥ræː / 'three' /haɔ̯s/ > /hɒːs/ 'house'
	ei – /aɛ̯/ *ou* – /aɔ̯/	standard level	/aɛ̯/ > /æː/ /aɔ̯/ > /ɒː/	/t͡svaɛ̯/ > /t͡svæː/ 'two' /raɔ̯xn̩/ > /rɒːxn̩/ 'to smoke'

Figure 2: Monophthongization processes in Vienna.

(Luttenberger and Fanta-Jende 2020). Both processes have in common that they originated in Vienna and resulted in salient *a*-sounds (see Figure 2).

The first monophthongization process dates back to the 12th/13th century and affected Middle High German (MHG) *ei* (cf. Kranzmayer 1956: 60 and Wiesinger 2001 for a detailed discussion). While in most Bavarian dialects of Austria the diphthong /ɔe̯/ prevailed, an /aː/ monophthong emerged in the traditional Viennese dialects (Kranzmayer 1956), e.g., /haːs/ ('hot') instead of /hɔe̯s/. Note that the Viennese /aː/ monophthong only began to diffuse beyond the city borders of Vienna from the beginning of the 20th century (Pfalz 1910: IX).

The beginning of the 20th century is also when the second monophthongization originated in Vienna as part of a broader phonological process transforming /aɛ̯/ and /aɔ̯/ into /æː/ and /ɒː/ (Gartner 1900; Luick 1932). Within dialectology, this process, the focus of our study here, was originally labeled Viennese Monophthongization. This is why we use the term Viennese Monophthongization (VM) only when referring to this particular process. VM affects the diphthongs /aɛ̯/ and /aɔ̯/ both in the traditional dialects and in the standard language. However, an important distinction must be made with regard to the variety in which the diphthongs /aɛ̯/ and /aɔ̯/ appear. Note that whereas in the Bavarian dialects /aɛ̯/ and /aɔ̯/ developed initially from MHG *î* (e.g., in /d̥raɛ̯/ 'three') and MHG *û* (e.g., in /haɔ̯s/ 'house') this is not necessarily the case in Austrian Standard German where /aɛ̯/ and /aɔ̯/ could also have developed from MHG *ei* (e.g., in /t͡svaɛ̯/ 'two') and MHG *ou* (e.g., in /raɔ̯xn̩/ 'to smoke') (see Figure 2; cf. also Vergeiner et al. 2020). In Austrian Standard German, MHG *î* had merged with MHG *ei* and MHG *û* merged with MHG *ou* before VM began to affect Viennese German.

Since MHG *î* and *û* did not merge with MHG *ei* and *ou* in the Bavarian dialects of Austria, the present study will focus on those lexemes which initially developed /aɛ̯/ and /aɔ̯/ from MHG *î* and MHG *û* in both the Bavarian dialects and Austrian Standard German (Figure 2, grey shaded). Following Moosmüller et al. (2015: 344), the phonemes /aɛ̯/ and /aɔ̯/ are typically realized as [aɛ̯] and [aɔ̯] in both the Austrian standard language and the traditional Bavarian dialects.[1]

In the case of VM, /aɛ̯/ and /aɔ̯/ have come to be realized as [æː] and [ɒː] due to an assimilatory process. Regarding the development [aɛ̯] > [æː] (e.g., in /d̥raɛ̯/ > /d̥ræː /'three'), there seems to be only a slight raising of the tongue, resulting in a relatively high F1 (as it is for the diphthong's [a]-onset). Additionally, a fronting of the tongue causes a heightening of F2 and F3 (approximating it to the diphthong's [ɛ]-offset).

1 Note, however, that for some locations in the Bavarian dialect regions of Austria additional developments need to be considered: /aɔ̯/ is in some western Bavarian dialects affected by 'palato-centralization' ("Mittelgaumigkeit") resulting in a centralized and possibly unrounded offset of the diphthong which could lead to [ɑɜ̯] realizations (Kranzmayer 1956: 50). Due to a slight retraction ("Verdumpfung") of the onset, /aɛ̯/ can also be phonetically realized as [ɑɛ̯] in some eastern dialects of the Burgenland.

Regarding the change [aɔ̯] > [ɒː] (e.g., in /haɔ̯s/ > /hɒːs/ 'house'), the tongue is moved back to the pharyngeal region, accompanied by a lowering of the jaw and maybe the tongue (approximating it to the diphthong's [a]-onset), yet the lip stays protruded (as it is for diphthong's [ɔ]-offset). This results in a higher F1 and F2 when compared to [ɔ], F2 being in between [a] and [ɔ] (Moosmüller and Scheutz 2013).

According to Moosmüller and Vollmann (2001), the assimilatory process started with assimilating the offset, before the onset also became affected. This not only accounts for Vienna, but also for other regions, where the change is still in progress. As Moosmüller and Scheutz (2013: 175) point out, in Vienna the process has already come to an end, hence enriching "the vowel inventory of the Viennese dialect […] by two new long vowels" (while at the same time, the diphthongs are lost). In contrast, in locations where the change is still in progress, VM is "a variable phonological process" – instead of being phonemicized, the original diphthongs are still "preserved as underlying forms" affected by a postlexical rule (cf. also Moosmüller 1991: 66–68).

In both new sounds [æː] and [ɒː] the duration of the diphthongs /aɛ̯/ and /aɔ̯/ is not entirely maintained. Thus, Vollmann and Moosmüller (1999) suggest that the process of diffusion started "in weak prosodic positions, i.e. both lexically and postlexically unstressed diphthongs are affected. Further generalization of the process to prosodically strong positions results in the realization of long monophthongized diphthongs" (Vollmann and Moosmüller 1999: 348; cf. also Moosmüller 1991: 66–68).

In Vienna, VM is assumed to have originated in the dialects of the lower social classes. Today, however, it can be also found in the informal and even formal speech of the middle- and upper-class (Moosmüller and Scheutz 2013: 175). Thus, VM is no longer restricted to the traditional dialect, but also characterizes the standard language in Vienna, especially in the speech of younger people (Moosmüller 1991: 66; Moosmüller and Vollmann 2001: 47; Moosmüller et al. 2015: 344). Although Viennese variants tend to be (overtly) stigmatized within Austria (Scheutz 1999: 117), VM seems, nevertheless, to be diffusing steadily. Moosmüller (1991) attributes the spread of VM to the (covert) prestige Viennese variants have in Austria (cf. e.g., Scheuringer 1990) – a fact that reflects the economic, political, and cultural importance of Vienna as capital and as by far the largest city in Austria. The occurrence of VM outside of Vienna has been documented in particular for the formal and informal (vernacular) speech in major cities like Salzburg, Linz, Graz, and even Innsbruck (Moosmüller 1991; Moosmüller and Scheutz 2013; Moosmüller and Vollmann 2001). However, Fanta-Jende (2020) also reports some instances of VM in a few of Austria's rural Central and South Central Bavarian dialects. As in Vienna, in rural areas [æː] seems not to be restricted to the dialect pole of the dialect-standard axis but seems also to occur in formal situations, though less frequently. The results of Luttenberger and Fanta-Jende (2020) for three rural speakers in Eastern Austria indicate that although

VM is largely absent in situations with high attention paid to speech (e.g., reading tasks), it is already present in formal interviews. Hence VM might increasingly become a feature of the (eastern) Austrian standard language.

4 Methods and data sample

In order to investigate both the areal and linguistic diffusion of VM in Austria's vernacular dialects, we draw on a dialect survey conducted within the framework of the Special Research Program "German in Austria. Variation – Contact – Perception" (='German in Austria'; https://dioe.at/; 27.03.2021). In what follows, we explain our sample (Section 4.1), materials (Section 4.2), and methods (Section 4.3).

4.1 Participants and research locations

To investigate the diffusion of VM, we focus on 19 research locations in eastern and central Austria around the cities of Vienna, Graz, Linz, and Salzburg (see Figure 3 and Table 1 for the abbreviations). Both the research literature (see Section 3) and our own pre-tests suggest that this region is most likely to be affected by VM.

All localities were selected according to such strict criteria as a certain degree of remoteness, low population size (<2,500 inhabitants), low rates of commuting and tourism, and economies based mainly on agriculture. Note, that the villages are not only at different distances from Vienna, but also from other major Austrian cities

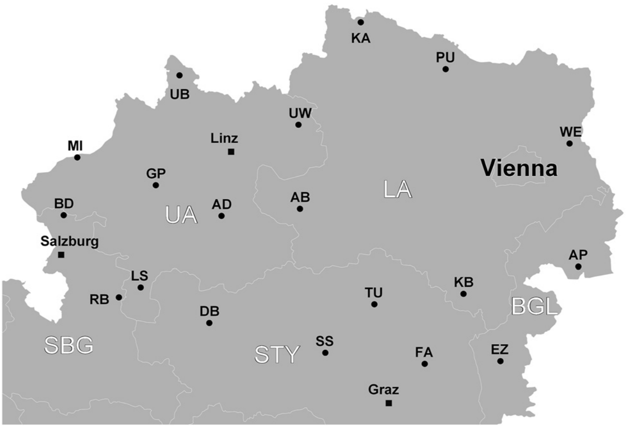

Figure 3: Localities under investigation in eastern and central Austria (UA, upper Austria; LA, lower Austria; SBG, Salzburg; STY, Styria; BGL, Burgenland).

Table 1: Localities under investigation and the federal states of Austria to which they belong.

AB	Allhartsberg	Lower Austria	LS	Lasern	Upper Austria
AD	Adlwang	Lower Austria	MI	Mining	Upper Austria
AP	Apetlon	Burgenland	PU	Pulkau	Lower Austria
BD	Berndorf	Salzburg	RB	Rußbach	Salzburg
DB	Donnersbach	Styria	SS	Sankt Stefan	Styria
EZ	Eisenzicken	Burgenland	TU	Turnau	Styria
FA	Feistritz	Styria	UB	Ulrichsberg	Upper Austria
GP	Gaspoltshofen	Upper Austria	UW	Unterweißenbach	Upper Austria
KA	Kautzen	Lower Austria	WE	Weikendorf	Lower Austria
KB	Kirchberg	Lower Austria			

such as Linz, Salzburg, and Graz.[2] This allows us to test if VM is primarily diffusing from Vienna or also from other big cities.

In each locality, four speakers of the local dialect were recorded. The sample for each village consists of two older (65+ years) and two younger speakers (18–35 years), with one male and one female speaker per age group. In sum, there are 76 speakers in the sample.

Besides age and gender, traditional dialectological criteria for sampling were applied (cf. e.g., Chambers and Trudgill 1998): The older speakers can be characterized as NORM/Fs (=non-mobile, old, rural males/females). Also, the younger dialect speakers can be described as rather immobile: They and their parents were born and raised in the locations under investigation or in the immediate neighborhood. Furthermore, their social as well as their working lives are centered in these localities. Additionally, they work in manual professions, predominantly in agriculture, and did not receive higher education.

4.2 Materials and stimuli

Our data consist of dialect recordings conducted by trained fieldworkers deploying a questionnaire that included picture naming tasks, completion tasks, and translation tasks. The speakers were instructed to use only vernacular dialect during the interview. A rather controlled setting should force the speakers to maintain attention

2 The exact distance from the center does not always correspond directly to the degree of remoteness as geological barriers, such as mountains, forests, waterways, etc. might hinder accessibility.

Table 2: Items and tasks.

		Item	Translation	PoS	Task
/aɛ̯/	EI1	*weiß*	‘white’	Adjective	Picture naming task
	EI2	*Freitag*	‘Friday’	Noun	Completion task (lexical field)
	EI3	*schneiden*	‘cut’	Verb	Completion task (paradigm)
	EI4	*leicht*	‘easy’	Adjective	Completion task (paradigm)
	EI5	*Weib*	‘woman’	Noun (sg.)	Translation task (single lexeme)
	EI6	*Weiber*	‘women’	Noun (pl.)	Translation task (single lexeme)
	EI7	*Zeit*	‘time’	Noun	Translation task (sentence)
	EI8	*weit*	‘far’	Adjective	Translation task (sentence)
	EI9	*meine*	‘my’ (sg.)	Pronoun	Translation task (sentence)
/aɔ̯/	AU1	*Haus*	‘house’	Noun	Picture naming task
	AU2	*blau*	‘blue’	Adjective	Picture naming task
	AU3	*Maus*	‘mouse’	Noun	Picture naming task
	AU4	*Bauer*	‘farmer’	Noun	Completion task (paradigm)
	AU5	*brauchen*	‘need’	Verb (1. pl.)	Completion task (paradigm)
	AU6	*braucht*	‘need’	Verb (2. pl.)	Completion task (paradigm)
	AU7	*gebraucht*	‘needed’	Verb (participle)	Completion task (paradigm)
	AU8	*brauchen*	‘need’ (inf.)	Verb (infinitive)	Translation task (sentence)
	AU9	*auf*	‘on’	Preposition	Translation task (sentence)

to their speech and keep them from shifting along the dialect-standard axis.[3] For the present study we selected 18 lexical items, with 9 lexical items containing /aɛ̯/ (=EI1 … EI9) and 9 lexical items containing /aɔ̯/ (=AU1 … AU9) (see Table 2). As noted above, in all lexemes containing /aɛ̯/ this vowel developed from MHG *î*, while in all lexemes with /aɔ̯/ this vowel developed from MHG *û*. The only exception is *blau* (/blaɔ̯/ ‘blue’), which is derived from MHG *blâ*. In this item /aɔ̯/ resulted through analogical leveling (compare the MHG genitive *blâwes*, with *w* vocalized in the Early New High German period) (all information on the MHG forms is based on Lexer 1872–1878).

Our corpus consists not only of various items having the target sounds in different phonetic-phonological environments, but also of lexemes from different word classes and with different word frequencies. Additionally, we account for different word forms of the same paradigm (see EI5 and EI6 as well as AU5, AU6, AU7 and AU8), which allow us to investigate the role of certain morphological constraints.

Most items (EI1 to EI6 and AU1 to AU7) are realized in isolation. Those items were elicited without any syntactic context by means of either picture naming tasks,

3 In view of VM being a reductive phenomenon, it would be useful to also account for more uncontrolled data. Fanta-Jende (2020), for example, suggests a much wider distribution of VM in Austria, maybe because parts of her study are based on interview data.

Table 3: Valid and missing data per item.

	EI1	EI2	EI3	EI4	EI5	EI6	EI7	EI8	EI9	∑
n (valid)	75	75	74	61	74	75	72	74	76	664
n (missing)	1	1	2	15	2	1	4	2	0	28
	AU1	**AU2**	**AU3**	**AU4**	**AU5**	**AU6**	**AU7**	**AU8**	**AU9**	**∑**
n (valid)	71	73	76	76	76	76	74	76	76	682
n (missing)	5	3	0	0	0	0	2	0	0	10

completion tasks, or translation tasks with a single word form to translate. Five items (EI7, EI8, EI9, AU8, and AU9), however, were part of a complete sentence the speakers had to translate. Of these items, three are stressed content words (EI7, EI8, and AU8) and two are unstressed function words (EI9 and AU9). Thus, these items allow us to investigate the occurrence of the VM within syntactical contexts and under different types of stress.

Since not all speakers realized every item mentioned above, our data encompass 664 occurrences of /aɛ̯/ and 682 occurrences of /aɔ̯/. As Table 3 shows, in particular, for the item EI4 (*leicht* 'light') we did not always get the expected form containing the variable /aɛ̯/. Here, 15 speakers used other lexemes.

4.3 Data processing

As already mentioned above, outside of Vienna VM is still "a variable phonological process" (Moosmüller and Scheutz 2013: 175; cf. also Moosmüller 1991: 66–68). Hence, it is not possible to unambiguously classify all variants dichotomously as either being a diphthong or a monophthong. Rather, the realizations range from indicating clear diphthongs to clear monophthongs on a continuous spectrum. To take into account VM's continuous nature we draw on instrumental phonetic measurements performed with the software package Sound Tools Extended 5.0.4 (STx, Noll et al. 2019). To normalize our measurements, we apply the normalization method for formant movement introduced in Luttenberger and Fanta-Jende (2020).

Our measurements comprise formant analysis of both the first (F1) and second formants (F2). If a given vowel is unambiguously a monophthong, the formant frequency of both the F1 and the F2 should remain rather static, whereas in the case of a diphthong, a movement in formant frequency from the onset to the offset is expected. To adequately ascertain the formant movement, we started by determining the initial and the final point of each vowel in a spectrogram computed with the "Speech-Analysis" setting in STx. We then measured the formant frequency of both the F1 and the F2 at 20 points of the vowel articulation. Using the formant tracker implemented in STx helped to ensure that these measuring points were equally distributed across the vowel. These automatic measurements were manually controlled and, if necessary, corrected.[4]

To calculate the average formant frequencies of the vowel's onset (f_s), we used the arithmetic mean of the formant frequency in the 4th, 5th, and 6th measuring point (f_4, f_5, f_6). Likewise, to calculate the average formant frequencies of the vowel's offset (f_e), the arithmetic mean of the formant frequency in the 14th, 15th, and 16th measuring point was used (f_{14}, f_{15}, f_{16}). We did not use the first and the last measuring points of the vowel as the formant frequencies in those regions tend to be heavily influenced by coarticulatory effects (Reetz 1999; Stevens 2000). Thus, we obtain $f_s = \frac{f_4+f_5+f_6}{3}$ and $f_e = \frac{f_{14}+f_{15}+f_{16}}{3}$.

The calculation $f_s - f_e$ provides the (absolute) formant movement f_m. Due to the fact that formant frequency varies considerably between individuals – dependent on the physiological length of the vocal tract (Neppert 1999) – we had to normalize f_m. We did so by dividing f_m by the sum of $f_s + f_e$, obtaining $f_M = \frac{f_s - f_e}{f_s + f_e}$. Thus, the values for f_M range between -1 and $+1$. Consequently, a "perfect" monophthong, where $f_s = f_e$, would result in $f_M = 0$. A clear diphthong, in turn, would provide values clearly beyond or below 0, the algebraic sign depending on the type of the diphthong (see below).

Although the minimum for f_M is -1 and the maximum is $+1$, values above 0.5 and below -0.5 are implausible for articulatory reasons considering a prototypical range of 250–900 Hz for the F1 and 600–2,500 Hz for the F2 (for German vowels cf. e.g., Neppert 1999). Preliminary testing has shown that in practice a value between -0.05 and $+0.05$ for f_M can be interpreted as reflecting a clear monophthong (Luttenberger and Fanta-Jende 2020). For purposes of presentation, we multiply f_M with -20, so that the reference value for diphthongs is about ∓ 1 with negative values indicating a decrease in formant frequency and positive values indicating an increase. Ultimately, our index for the normalized formant movement (f_μ) is calculated as follows: $f_\mu = (-20) \times \frac{f_s - f_e}{f_s + f_e}$.

An important property of f_μ is that changes in a lower frequency range are more strongly weighted than changes in a higher frequency range. To give an example: $f_\mu(1,700, 2,000) = 1.62$, whereas $f_\mu(1,400, 1,700) = 1.94$. This difference is no disadvantage, since also in the psychoacoustic make-up of the vowel space changes are perceived more strongly in a lower frequency range (for a discussion, cf.

4 Most commonly, manual correction was necessary due to diminished formant intensity near nasals and interfering noise.

Table 4: Expected f_μ-values for the vowel variants under investigation.

Sound	F1	F2	f_μ-values
[aɛ̯]	Decreasing	Increasing	Prototypically between ∓3 and ∓4
[aɔ̯]	Decreasing	Decreasing	Prototypically between −3 and −4
[æː]	Static	Static	Prototypically close to 0
[ɒː]	Static	Static	Prototypically close to 0

e.g., Iivonen 1994). An important property of f_μ is that $|f_\mu\ (x,y)| = |f_\mu\ (y,x)|$. So, for example, $f_\mu\,(1,500, 2,000) = 2.86$ and $f_\mu\,(2,000, 1,500) = -2.86$. Since we are not aware of any reason to assume that the amount of the formant movement is perceived differently when reversed, this is a positive feature of f_μ.

Table 4 shows the expected f_μ-values for the main variants of the present study. Note, that due to the continuous nature of VM, only prototypical values are reported in Table 4. We will elaborate on this in the next section.

5 Results

In this section we first report the general results (Section 5.1), before we focus on diffusion within the speech community and hence areal and sociolinguistic factors (Section 5.2). In Section 5.3 we elaborate on differences between our test items, before we finally discuss vowel duration and its relation to VM in Section 5.4.

5.1 General results

As already discussed in Section 4.3, we use f_μ-values to assess the amount of formant movement and therefore the extent of monophthongization. The average f_μ-values for all 19 research locations are shown in Figure 4 – on the left for /aɛ̯/ and on the right for /aɔ̯/. Here and in the following maps the inner cycles always display the indices for F1, whereas the outer cycles represent the indices for F2. For purposes of presentation, the continuous f_μ-values are divided into discrete values. As can be seen from the maps, for /aɛ̯/ as well as for /aɔ̯/, both monophthongs and diphthongs occur in our research area.

As mentioned in Section 4.3, prototypical [aɛ̯]-diphthongs are characterized by a falling F1 and a rising F2 due to an increasing closure of the jaw and fronting of the tongue (see e.g., the spectrogram in Figure 5, upper left corner; see Table 5 for the formant values of the provided examples). As Figure 4 illustrates, [aɛ̯]-diphthongs

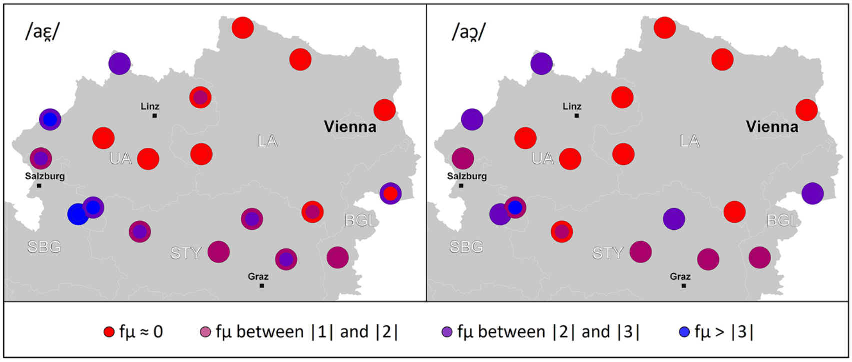

Figure 4: Average f_μ-values in the research locations for /aɛ̯/ (left) and /aɔ̯/ (right).

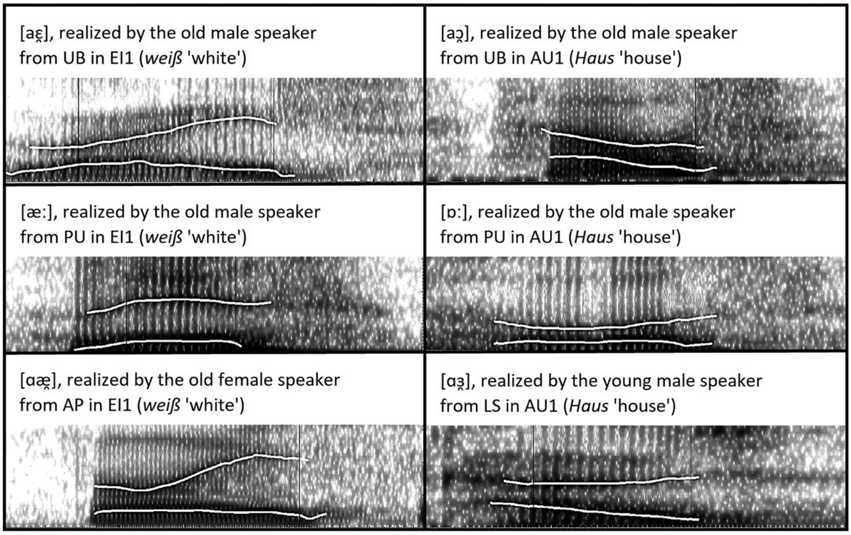

Figure 5: Spectrograms of typical realizations of /aɛ̯/ and /aɔ̯/.

occur mainly in the western and southern parts of the research area, whereas in the central and eastern parts prototypical [æː]-monophthongs appear. The monophthongs are characterized by rather static formants for the F1 and for the F2 (f_μ between -1 and 1) (see for illustration the spectrogram in Figure 5, left, in the middle).

For /aɔ̯/, prototypical [aɔ̯]-diphthongs are characterized by both a falling F1 and F2 due to an increasing closure of the jaw and rounding of the lips towards the offset (see e.g., the spectrogram in Figure 5, upper right corner). The diphthongs again

Table 5: Formant values for the examples in Figure 5.

	[aɛ̯]	[æː]	[ɑæ̯]	[ɑɔ̯]	[ɒː]	[ɑɜ̯]
Location	UB	PU	AP	UB	PU	LS
Speaker	Old male	Old male	Old female	Old male	Old male	Young male
Item	EI1 (*weiß*)	EI1 (*weiß*)	EI1 (*weiß*)	AU1 (*Haus*)	AU1 (*Haus*)	AU1 (*Haus*)
f_s of F1	571 Hz	477 Hz	516 Hz	763 Hz	488 Hz	573 Hz
f_e of F1	379 Hz	478 Hz	465 Hz	459 Hz	500 Hz	337 Hz
f_m of F1	–192 Hz	1 Hz	–51 Hz	–304 Hz	12 Hz	–236 Hz
f_μ of F1	–4.04	0.03	–1.03	–4.99	0.24	–5.18
f_s of F2	1,284 Hz	1,723 Hz	1,158 Hz	1,346 Hz	913 Hz	1,355 Hz
f_e of F2	1,949 Hz	1,712 Hz	2,184 Hz	1,134 Hz	1,102 Hz	1,438 Hz
f_m of F2	665 Hz	–11 Hz	1,026 Hz	–212 Hz	189 Hz	83 Hz
f_μ of F2	4.12	–0.07	6.14	–1.71	1.87	0.59

occur mainly in western and southern parts of the research area (but appear to be present in a slightly smaller geographical area, see below). Prototypical [ɒː]-monophthongs for /aɔ̯/ can be observed in the center and in the east of the research area. Again, the monophthongs are characterized by a rather static formant movement. Especially towards the end of the vowel, lip protrusion might be undone rather early resulting in a [ɐ]-like quality[5] (see, for illustration, the spectrogram in Figure 5, right, in the middle).

Besides these general trends, there are some additional developments in certain research locations: As an even more emphasized variant of the monophthongal realization "reverted diphthongs" have been reported (Kranzmayer 1956: 49). While rarely occurring, we found some instances of such "reverted diphthongs" in Kautzen (KA) and Pulkau (PU) for both /aɛ̯/ and /aɔ̯/. For both vowels the onset of the "reversed" variant comes close to the monophthongal variant, while the offset is slightly centralized and in the case of /aɔ̯/, lip protrusion is removed very early, resulting in [ɛɐ̯] and [ɔɐ̯] respectively.

We also found instances of a centralization of the /aɔ̯/-offset, resulting in a rather steady F2 alongside a falling F1 while auditorily exhibiting an [ɜ]-like quality. Kranzmayer (1956: 50) reports such variants, inter alia, for the so-called Salzkammergut, a region to the southeast of the city of Salzburg. Accordingly, we were able to observe such variants mainly from speakers in Lasern (LS) (see Figure 5, lower right corner). In addition, for speakers from Apetlon (AP), we found a backing of /aɛ̯/, again already described by Kranzmayer (1956: 50) for

5 Whether this can be regarded as a purely coarticulatory effect or a realization of a triphthong for /aɔ̯/ (as suggested by Kranzmayer 1956) must remain an open question for now.

parts of the Burgenland. This variant is comprised of a rather high and static F1 and a sharp rise in F2 resulting in the realization [ɑæ̯] (see Figure 5, lower left corner).

Despite these rather rare divergent developments mentioned above, both the formant movements of F1 and F2 turn out to be very similar. In this regard, the averaged f_{μ}-values of the F1 and the F2 are highly correlated[6] for both /aɛ̯/ (r =–0.727, p = 0.000***) and /aɔ̯/ (r = 0.780; p = 0.000***) – see also Figure 6.

Highly significant correlations between the f_{μ}-values of the F1 and the F2 can also be found for all items (see Table 6). Thus, we assume that the f_{μ}-values of F1 and F2 provide reliable insights into the degree of monophthongization.

However, as can be seen in Figure 4, there is not only a clear-cut correspondence between the f_{μ}-values of the F1 and the F2 of the same vowel, but also between the F1 and the F2 of the various vowels /aɛ̯/ and /aɔ̯/. Thus, we report significant correlation

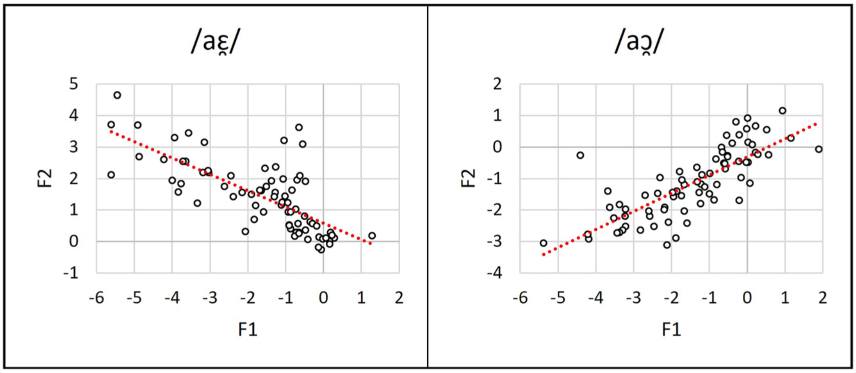

Figure 6: Correlation between the averaged f_{μ}-values of the F1 and the F2 for /aɛ̯/ (left) and /aɔ̯/ (right).

Table 6: Correlation between the averaged f_{μ}-values of F1 and F2 per item.

	AU1	AU2	AU3	AU4	AU5	AU6	AU7	AU8	AU9
Corr F1*F2	***	***	***	***	***	***	***	***	***
	EI1	**EI2**	**EI3**	**EI4**	**EI5**	**EI6**	**EI7**	**EI8**	**EI9**
Corr F1*F2	***	***	***	***	***	***	***	***	***

6 Here and in what follows, correlations are calculated using Pearson correlation coefficients. To calculate differences, we use – unless otherwise reported – t-tests.

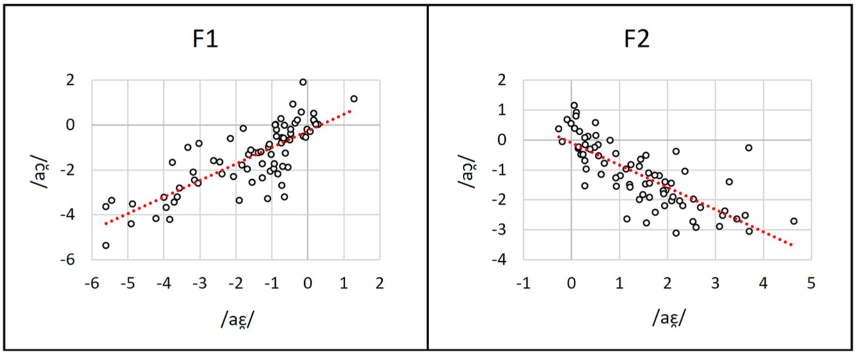

Figure 7: Correlation between the averaged f_μ-values of the F1 of /aɛ̯/ and /aɔ̯/ (left) and the F2 of /aɛ̯/ and /aɔ̯/ (right).

for both the averaged f_μ-values of the F1 ($r = 0.792$, $p = 0.000$***) and the F2 ($r = -0.766$, $p = 0.000$***) of /aɛ̯/ and /aɔ̯/ (see Figure 7).

Overall, these correlations indicate a parallel change of /aɛ̯/ and /aɔ̯/. However, as both Figures 4 and 7 reveal, the formant movements regarding /aɔ̯/ seem to be generally smaller when compared to /aɛ̯/, especially with respect to the F2 (here, in contrast to the F1, the difference is also significant:[7] $p = 0.015$*). One possible explanation is that /aɔ̯/ is earlier and/or more strongly affected by the VM. However, the smaller formant movement for /aɔ̯/ could also be explained by an overall reduced tongue movement bearing in mind that the vowels are formed at the back in the mouth.

5.2 Areal and sociolinguistic factors

As already explained in Section 5.1, monophthongs for /aɛ̯/ and /aɔ̯/ seem to appear particularly in the east of our research area (see Figure 4). At first glance, a wave-like diffusion from Vienna seems best able to explain this distribution of variants. To validate this first impression, correlation analysis (Pearson correlation coefficients) was performed. If VM is spreading only from Vienna, one would assume that closer proximity to Vienna correlates with a higher rate of monophthongization while close proximity to other major cities should have no significant effect on monophthongization rates. Consequently, we tested whether the (averaged) f_μ-values of

7 Since the f-values of the F2 of /aɛ̯/ are generally positive and those of /aɔ̯/ negative, we use absolute values here for testing.

the F1 and the F2 of /aɛ̯/ and /aɔ̯/ correlate with (a) the direct distance of each research location to Vienna (in km), (b) the travelling time from each research location to Vienna by car (in minutes), (c) the distance (again as the crow flies) of each research location to the closest major city of more than 100,000 inhabitants (in km), and (d) the travelling time from each research location to the closest major city of more than 100,000 inhabitants (in minutes). Results are shown in Table 7.

The correlation analyses show significant results for the factor distance to Vienna: The further away a research location is from Vienna (in km and minutes), the larger becomes the averaged formant movement of the F1 and the F2 of /aɛ̯/ and /aɔ̯/. As expected, the travelling time to Vienna shows a generally higher correlation than the linear distance. In contrast, neither the distance nor the travelling time to major cities in general is significantly correlated with the f_μ-values. The only exception includes the F2 of /aɔ̯/ – surprisingly, the distance to a major city correlates with a larger formant movement. This is, however, not the case when considering distance in minutes. Ultimately, cities other than Vienna do not seem to contribute to the diffusion of VM to a greater extent.

Note, however, that *r* is below 0.5 for all correlations in Table 7. Hence, none of these correlations can be interpreted as especially strong. This is also illustrated in Figure 8, where the distance to Vienna in minutes is plotted against the averaged f_μ-values of the F1 and the F2 of both variables. Although we can see a clear trend, the values are widely scattered. This suggests the presence of additional factors affecting the geographical diffusion of the VM. We will discuss this in more detail in Section 6.

As noted in Section 4.1, our data comprise both older and younger speakers. According to the apparent-time hypothesis, the diffusion of VM as an ongoing change should be accompanied by age-related differences regarding the degree of monophthongization. As the box plots in Figure 9 indicate, with the grey box-plots representing the data of the older speakers and the white box-plots representing

Table 7: Correlations between the averaged f_μ-values of F1 and F2 to Vienna and the closest major city.

	F1 of (aɛ̯)	F2 of (aɛ̯)	F1 of (aɔ̯)	F2 of (aɔ̯)
Distance Vienna (km)	$r = -0.430$, $p < 0.001$***	$r = 0.389$, $p < 0.001$**	$r = -0.429$, $p < 0.001$***	$r = -0.289$, $p = 0.011$*
Distance Vienna (min)	$r = -0.493$, $p < 0.001$***	$r = 0.446$, $p < 0.001$***	$r = -0.480$, $p < 0.001$***	$r = -0.307$, $p = 0.007$**
Distance major city (km)	$r = 0.165$ n. s.	$r = -0.175$ n. s.	$r = 0.139$ n. s.	$r = 0.266$ $p = 0.020$*
Distance major city (min)	$r = 0.033$ n. s.	$r = -0.042$ n. s.	$r = 0.026$ n. s.	$r = 0.142$ n. s.

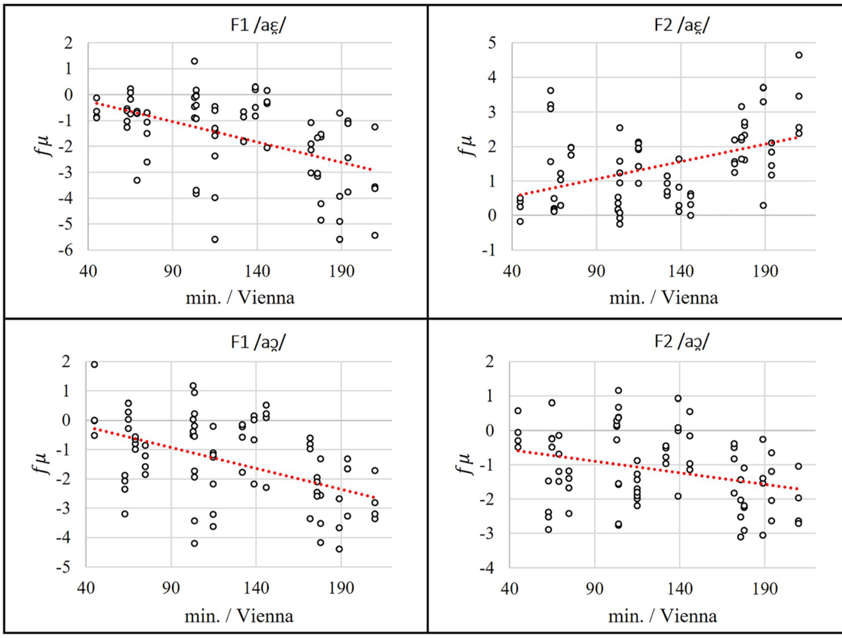

Figure 8: Correlation between the traveling time and the averaged f_μ-values of the F1 and F2 of /ae̯/ and /aɔ̯/.

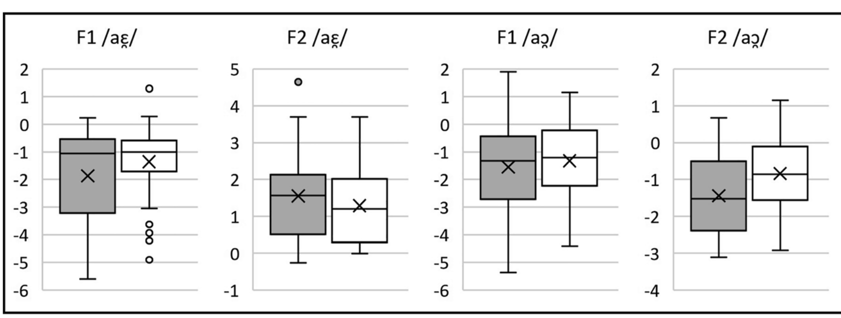

Figure 9: Age-related differences (grey = older speakers, white = younger speakers).

the data of the younger speakers, only minor, non-significant differences between the two age groups can be found for the averaged f_μ-values of the F1 and F2 of /ae̯/ and /aɔ̯/.

On average, the older speakers show a slightly stronger formant movement, in particular regarding the F1 of /ae̯/ and the F2 of /aɔ̯/. In general, the boxplots show a wide range of variance for both age groups. This is not very surprising, if one considers that our research area comprises locations where VM is already well-established as well as locations where it is still spreading and maybe even locations where the change has yet to gain momentum. Figure 10 reinforces this interpretation. Here, the averaged f_{μ}-values for all 19 research locations are charted separately for older (upper half) and younger speakers (lower half).

In the eastern part of the research area, in the four locations in lower Austria around Vienna (KA, PU, WE, and AB), both older and younger speakers generally use monophthongs. Thus, it appears that the sound change has been completed here already. In contrast, in four locations in the western part of the research area, in Salzburg and western Upper Austria (MI, BD, LS and RB) but also in AP rather close to Vienna, both old and young speakers generally use more or less diphthongized forms, without any clear trend of younger speakers to use more monophthongized forms. Hence, it is the area in-between, in central and eastern Upper Austria and northern Styria, where VM seems to be diffusing (TU, SS, FA, KB, EZ, GP, AD, DB, UB, and UW). In these regions younger speakers tend to realize a much smaller formant movement compared to older speakers, which is also statistically significant (for the F1 of /aɛ̯/: $p = 0.020$*; for the F2 of /aɛ̯/: $p = 0.039$*; for the F1 of /aɔ̯/: $p = 0.049$*, for the F2

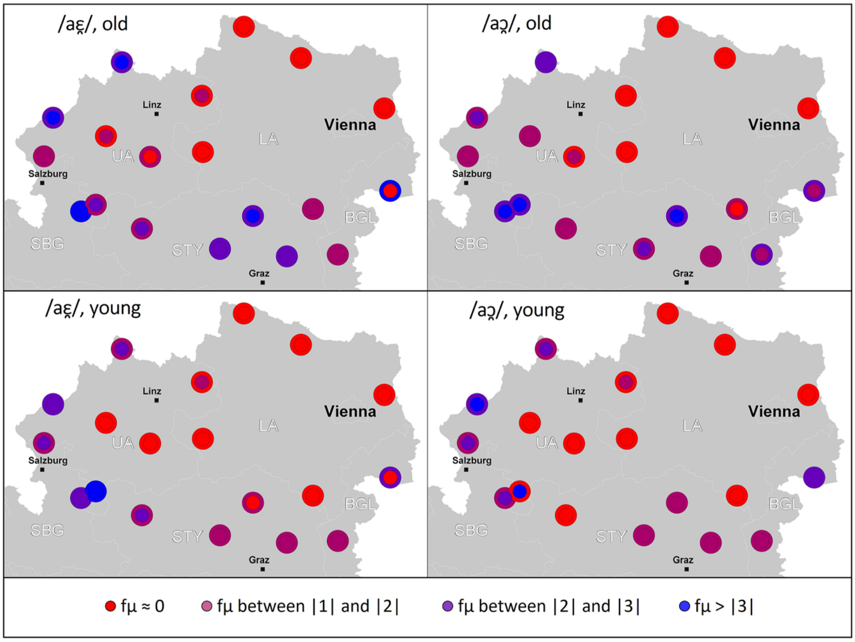

Figure 10: Age-related differences in the research locations.

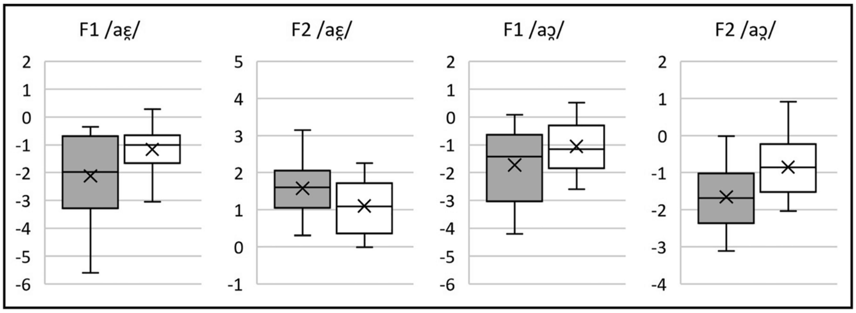

Figure 11: Age-related differences (grey = old speakers, white = young speakers) in central/eastern Upper Austria and northern Styria.

of /aɔ̯/: p = 0.004**). As Figure 11 shows, in these locations the averaged f_μ-values for the younger speakers are around ±1, which is the threshold for monophthongs, whereas the averaged f_μ-values of the older speakers are not in the range of prototypical monophthongs.

However, it is not areal variation alone that interacts with age-related variation. Additionally, one also has to account for gender-related differences (see Figure 12).

As becomes obvious, younger and older men show no great differences (none of them are statistically significant), and on average, for the F1 of /aɛ̯/ and the F1 of /aɔ̯/ older males even realize less formant movement. For women, the situation is quite different – on average older women use clearly more diphthongized forms than younger women, with statistically significant results for the F1 of /aɛ̯/ (p = 0.008**) and the F2 of /aɔ̯/ (p = 0.034*). If one compares males and females, there are no significant differences for the younger speakers, only for the older ones (for the F1 of /aɛ̯/: p = 0.006**, for the F2 of /aɔ̯/: p = 0.49*). Thus, these results suggest that older

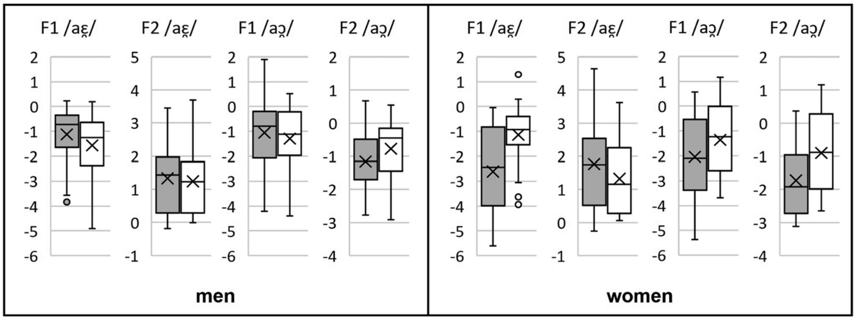

Figure 12: Age-related differences (grey = older speakers, white = younger speakers) by gender.

women behave most conservatively, whereas men in general as well as younger women are more innovative. This finding is rather surprising, since women are assumed to lead language change not only in the English-speaking countries (Labov 2001), but also in the German-speaking world (Moosmüller 1987; Sieburg 1992; Twilfer 2014; notably, the studies on German again focused on changes caused by dialect-to-standard contact). We come back to this point in Section 6.

5.3 Internal linguistic factors

In what follows, we investigate whether VM is a regular sound change or not. Figure 13 shows the f_{μ}-values for /aɛ̯/ for each item, with the boxplots on the left for the F1 and the box-plots on the right for the F2. The items are ordered according to their degree of formant movement of the F1.

Figure 13 indicates certain differences between the items: The formant movement is on average relatively low for EI6 (*Weiber* 'women'), EI7 (*Zeit* 'time'), and EI9 (*meine* 'my'). EI1 (*weiß* 'white'), EI3 (*schneiden* 'to cut'), EI4 (*leicht* 'easy'), and EI8 (*weit* 'far'), in turn, show a relatively strong formant movement for both formants. EI5 (*Weib* 'woman') and EI2 (*Freitag* 'Friday') are in-between, but with EI5 (*Weib* 'woman') showing on average a relatively high formant movement for F2 but a rather low formant movement for F1, whereas EI2 (*Freitag* 'Friday') is characterized by a relatively low formant movement for F2.

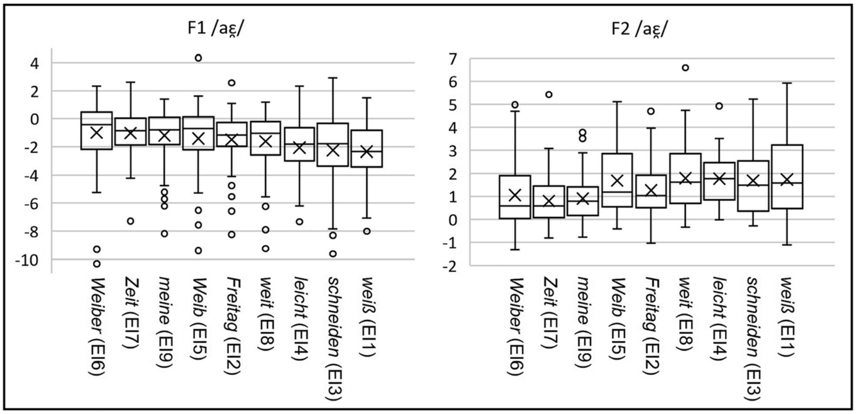

Figure 13: Item specific differences for /aɛ̯/.

Table 8: Item-specific differences for /aɛ̯/, upper right side for the F2, lower left side for the F1.

F1 ↓ F2 →	***weiß* (EI1)**	***Freitag* (EI2)**	***schneiden* (EI3)**	***leicht* (EI4)**	***Weib* (EI5)**	***Weiber* (EI6)**	***Zeit* (EI7)**	***weit* (EI8)**	***meine* (EI9)**
weiß	–	n. s.	n. s.	n. s.	n. s.	**	***	n. s.	**
Freitag	n. s.	–	n. s.	**	n. s.	n. s.	**	**	n. s.
schneiden	n. s.	n. s.	–	n. s.	n. s.	**	***	n. s.	*
leicht	n. s.	n. s.	n. s.	–	n. s.	***	***	n. s.	***
Weib	n. s.	n. s.	n. s.	n. s.	–	***	***	n. s.	**
Weiber	**	n. s.	**	***	n. s.	–	n. s.	***	n. s.
Zeit	**	n. s.	**	***	n. s.	n. s.	–	***	n. s.
weit	n. s.	n. s.	n. s.	n. s.	n. s.	n. s.	n. s.	–	***
meine	*	n. s.	n. s.	n. s.	n. s.	n. s.	n. s.	n. s.	–

To test whether these differences are statistically significant and whether the lexical item has an effect on the formant movements, we applied one-way ANOVAs.[8] They substantiate that the various items are indeed affecting the f_{μ}-values. For F1 partial $\eta^2 = 0.123$ ($p = 0.000$***), while for F2 partial $\eta^2 = 0.226$ ($p = 0.000$***). This means that for the F1 about 12 % and for the F2 about 23 % of the intra-individual variance can be attributed to the influence of the various items. It needs to be mentioned that the inclusion of further factors and covariates (e.g., distance to Vienna, gender, age) does not improve the model, hence the remaining intra-individual variance seems to be rather unspecific. Applying (Bonferoni corrected) post hoc tests demonstrate that in particular the items EI6, EI7, and, with regard to F2, EI9 differ significantly from the other items (see Table 8).

We find similar results for /aɔ̯/, as Figure 14 already indicates.

Figure 14 illustrates that AU9 (*auf* 'on') is characterized on average by a low formant movement for F1 and F2. The items AU5 (*brauchen* 'need' 1. Pl), AU6 (*braucht* 'need' 2. Pl), AU8 (*brauchen* 'to need' inf.), and AU7 (*gebraucht* 'needed' part. II) show a similar, slightly larger formant movement for both formants. The same accounts for AU4 (*Bauer* 'farmer'). AU2 (*blau* 'blue') is characterized on average by a relatively large formant movement for F1 and an even larger formant movement for F2. AU1 (*Haus* 'house') and AU3 (*Maus* 'mouse') show a very interesting pattern – they have on average a rather large formant movement for F1, but a very low formant movement for F2. To test significance, we again applied one-way ANOVAs. They show item-specific effects: For F1 partial $\eta^2 = 0.250$ ($p = 0.000$***) and for F2 partial $\eta^2 = 0.213$ ($p = 0.000$***), so that for F1 about 25 % and for F2 about 21 % of the intra-individual

8 Here and in what follows the violations of sphericity are corrected using the Greenhouse-Geisser correction.

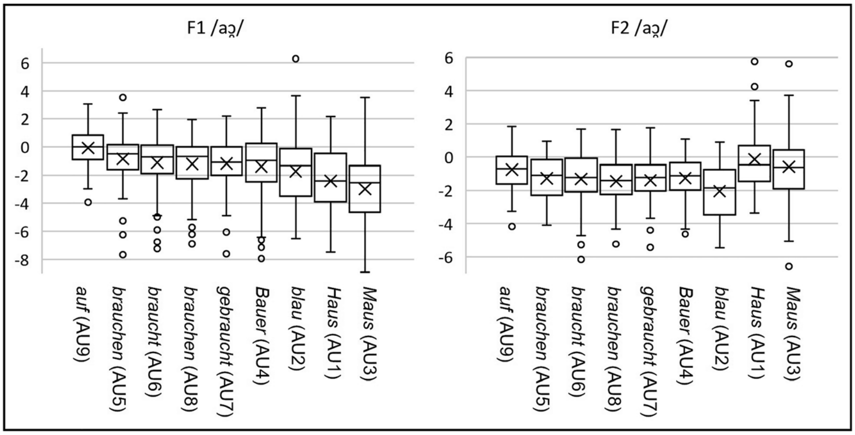

Figure 14: Item specific differences for /aɔ̯/.

variance can be attributed to item specific effects. Again, taking account of other factors and covariates does not improve the model. The (Bonferoni corrected) post hoc tests indicate that for F1 it is in particular the items AU1, AU3, and AU9 that differ significantly, whereas for F2 the items AU1, AU2, and partially also AU9 show significant differences (see Table 9).

To account for the item-specific differences several factors need to be considered: One factor often mentioned within the lexical diffusion approach is word frequency and considering the status of the VM as a reductive process, one would assume that higher word frequencies promote change (Bybee 2002, 2015; see Section 2.2). We tested this for all lexemes using the dictionary of the frequency of word usage in spoken, everyday speech from Ruoff (1990). Applying correlation analysis (Pearson correlation coefficients) shows there is no significant correlation between the f_μ-values of either /aɛ̯/ or /aɔ̯/ and word frequency.

Based on frequency, one would expect, for instance, the rather frequent lexeme AU1 (*Haus* 'house') and the rather infrequent lexeme AU3 (*Maus* 'mouse') to show distinct behavior, which is obviously not the case. The fact that these two items show a similar, yet rather exceptional behavior can be attributed to another factor commonly referred to, namely the phonetic-phonological environment. In both items /aɔ̯/ is followed by /s/, an alveolar sound, which may restrain the tongue from being pulled back, resulting in a reduced F2-movement.

In the case of /aɛ̯/ one would expect the opposite effect in relation to /s/. Indeed, EI1 (*weiß* 'white') shows a relatively high f_μ-value for F2, maybe a result of the following alveolar sound favoring a forward movement of the tongue. However, the same should be true for postvocalic /t/ and /d̥/, which is also clearly not the case: Even

Table 9: Item specific differences for /aɔ̯/, upper right side for the F2, lower left side for the F1.

F1 ↓ F2 →	***Haus*** **(AU1)**	***blau*** **(AU2)**	***Maus*** **(AU3)**	***Bauer*** **(AU4)**	***brauchen*** **(AU5)**	***braucht*** **(AU6)**	***gebraucht*** **(AU7)**	***brauchen*** **(AU8)**	***auf*** **(AU9)**
Haus	–	***	n. s.	***	***	***	***	***	n. s.
blau	**	–	***	***	***	**	**	**	***
Maus	n. s.	**	–	n. s.	n. s.	n. s.	n. s.	n. s.	n. s.
Bauer	**	n. s.	***	–	n. s.	n. s.	n. s.	n. s.	n. s.
brauchen	***	n. s.	***	n. s.	–	n. s.	n. s.	n. s.	*
braucht	**	n. s.	***	n. s.	n. s.	–	n. s.	n. s.	n. s.
gebraucht	***	n. s.	***	n. s.	n. s.	n. s.	–	n. s.	*
brauchen	**	n. s.	***	n. s.	n. s.	n. s.	n. s.	–	**
auf	***	***	***	**	***	***	***	***	–

though EI3 (*schneiden* ‘to cut’) and EI8 (*weit* ‘far’) show on average a larger f_{μ}-value for F2, EI2 (*Freitag* ‘Friday’) and in particular EI7 (*Zeit* ‘time’) do not.

To account for the item-specific differences, one also has to consider the status of VM as a reductive process. As such, it should affect unstressed positions earlier – this might contribute to the greater monophthongization of the unstressed function words *meine* ‘my’ (EI9) and *auf* ‘on’ (AU9), but maybe also of *Weiber* ‘women’ (EI6) when compared to *Weib* ‘woman’ (EI5). It is rather unlikely that the phonetic-phonological environment and/or morphological factors cause the difference between EI5 and EI6 – for the latter, one has to emphasize the quite uniform f_{μ}-value with regard to AU5 (*brauchen* ‘need’ 1. Pl), AU6 (*braucht* ‘need’ 2. Pl), AU8 (*brauchen* ‘to need’ inf.), and AU7 (*gebraucht* ‘needed’ part. II).

However, what is striking about *Weiber* ‘women’ (EI6) when compared to *Weib* ‘woman’ (EI5) is that the speakers tend to articulate the former with considerably less emphasis than the latter, maybe because of the test design: The questionnaire consists of several substantives, which are elicited first in the singular and thereafter in the plural. Because most speakers get used to this pattern, they tend to give “automatized”, quick answers for the plural forms. Something similar accounts for the inflectional forms in verbal paradigms (see the rather small formant movement for AU5 [*brauchen* ‘need’ 1. Pl], AU6 [*braucht* ‘need’ 2. Pl], and AU7 [*gebraucht* ‘needed’ part. II]). This should also hold for the item *Freitag* ‘Friday’ (EI2), which was elicited within the lexical field of weekdays. However, *Freitag* ‘Friday’ (EI2) seems not to be characterized by generally low f_{μ}-values.

One would also expect items elicited in syntactic contexts to be articulated more quickly and thus laxer, which should favor monophthongization. However, this seems not entirely to be the case, in particular not for EI8 (*weit* ‘far’), though it may account for EI7 (*Zeit* ‘time’) and AU8 (*brauchen* ‘to need’ inf.).

Ultimately, one can conclude that there are item-specific differences, which may (at least partially) be explicable by factors like stress and phonetic-phonological environment. Note, however, that such factors cannot account for all the differences shown above (of course one has to consider limitations in our data materials, especially with regard to the number of items tested). Lexical factors in a narrower sense like word frequency seem not to play a major role. In general, although VM seems to affect various word forms in subtly different ways, one has to consider that these factors only account for about 25% of the intra-individual variation. Before we elaborate on this in Section 6, we focus on the interplay of formant movement and vowel duration.

5.4 Formant movement and vowel duration

It has been suggested that VM triggers a reduction in vowel duration, in particular in unstressed positions (Vollmann and Moosmüller 1999: 348). Our data indeed support the assumption that monophthongized vowels are shorter. On average there is a correlation between the f_μ-values and the respective vowel duration: This accounts for the F1 of /ae̯/: r = –0.437 (p = 0.000***), for the F2 of /ae̯/: r = 0.541 (p = 0.000***), for the F1 of /ao̯/: r = –0.284 (p = 0.0013**), and for the F2 of /ao̯/: r = –0.390 (p = 0.000***). Hence, the longer the vowel, the larger the formant movement. However, we have a strong effect (r > 0.5) only for the F2 of /ae̯/. As Figure 15 shows, the correlation between formant movement and vowel duration is only a general tendency. Under any circumstances, one has to be cautious to claim causality – it may be, as Vollmann and Moosmüller (1999) state, that there is a correlation between formant movement and vowel duration because the monophthongization causes a shortening of vowel duration. But it could also be the other

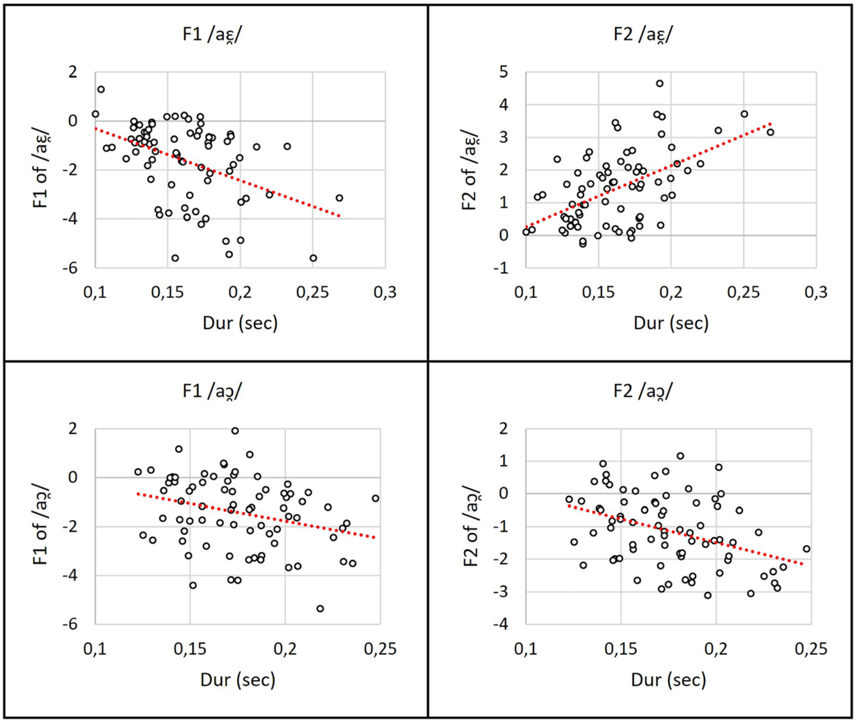

Figure 15: Correlations between vowel duration and f_μ-values.

way around, and the vowels are more monophthongized because they are shortened. Both aspects seem intertwined.

Regarding Figure 16, the complex interplay of vowel duration and monophthongization also becomes apparent when looking at the vowel duration of the various items. Figure 16 reveals substantial differences between the items. Tested again with one-way ANOVAs, these differences prove to be significant – for /aɛ̯/ partial η^2 = 0.403 (p = 0.000***) and for /aɔ̯/ partial η^2 = 0.626 (p = 0.000***).[9] Hence about 40% of the variance of the vowel duration of /aɛ̯/ and about 63% of the variance of the vowel duration of /aɔ̯/ can be explained by the various items. Note that this is a considerably larger effect than reported in Section 5.3 for the formant movements. Thus, the various items seem to affect the vowel duration much more than the formant movement, which may be explained by the fact that vowel duration is more closely connected to speech rate. It is also noteworthy that considering the f_μ-values as covariates does not improve the models.

It is the items EI6 (*Weiber* 'woman'), EI7 (*Zeit* 'time'), EI9 (*meine* 'my'), EI2 (*Freitag* 'Friday'), and EI8 (*weit* 'far') along with AU9 (*auf* 'on'), AU5 (*brauchen* 'need' 1. Pl), AU6 (*braucht* 'need' 2. Pl), AU8 (*brauchen* 'to need' inf.), and AU7 (*gebraucht* 'needed' part. II) that have a rather short vowel duration. These are either the items that are elicited within a syntactic context (EI7, EI8, EI9, AU9, AU8) or the items for which the

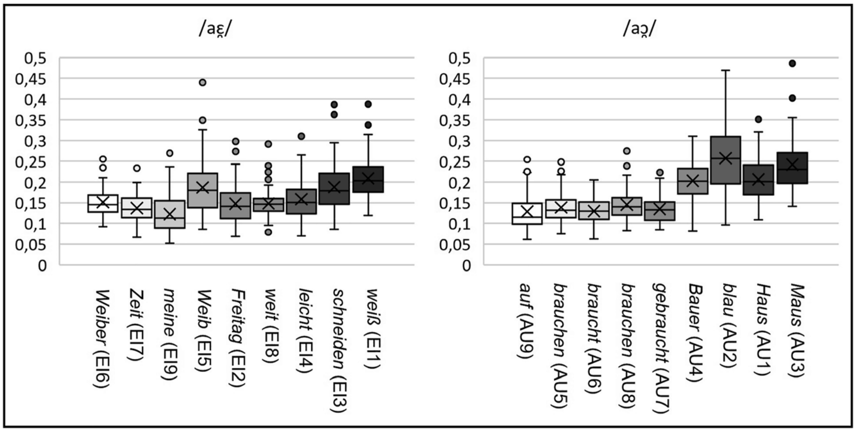

Figure 16: Vowel duration per item.

9 As (Bonferroni corrected) post hoc tests show, all items differ significantly, except with regards to /aɛ̯/ EI1/EI5, EI2/EI4, EI2/EI6, EI2/EI7, EI2/EI8, EI3/EI4, EI3/EI5, EI4/EI6, EI4/EI8, EI6/EI8, and EI7/EI8; with regards to /aɔ̯/ there are no significant differences between AU1/AU4, AU2/AU3, AU5/AU6, AU5/AU7, AU5/AU8, AU5/AU9, AU6/AU7, AU6/AU9, AU7/AU8, AU7/AU9, and AU8/AU9.

Table 10: Correlations between vowel duration and f_μ-values per item.

	EI1	EI2	EI3	EI4	EI5	EI6	EI7	EI8	EI9
Dur*F1	*	n. s.	***	***	n. s.	n. s.	***	***	**
Dur*F2	**	**	***	***	***	***	***	***	***
	AU1	**AU2**	**AU3**	**AU4**	**AU5**	**AU6**	**AU7**	**AU8**	**AU9**
Dur*F1	n. s.	*	*	***	**	n. s.	*	**	n. s.
Dur*F2	n. s.	n. s.	***	***	**	n. s.	n. s.	n. s.	n. s.

above-mentioned "conditioning effect" of the test design are relevant (EI6, EI2, AU7, AU6, AU8). As argued above, the lax and hence fast articulation of these items may facilitate monophthongization, with only EI8 and maybe EI2 as counterexamples.

However, it is not primarily these mostly quickly articulated items where vowel duration correlates with the f_μ-values, as Table 10 indicates. Table 10 shows the significant correlations between vowel duration and f_μ-values per item.

Table 10 indicates a significant correlation between vowel duration and the f_μ-values for most of the items. This even holds true for items where, on average – even when shortened – vowel duration is quite long, e.g., EI3 (*Maus* 'mouse'). Bearing this in mind, it seems quite plausible to argue that monophthongization is partially causing a shortening of vowel duration, though a generally shorter vowel duration seems also to facilitate monophthongization.

There are, however, exceptions, where the f_μ-values and vowel duration are not correlated at all – in particular for /aɔ̯/ (e.g., AU9 [*auf* 'on'], AU6 [*braucht* 2. Pl], and AU1 [*Haus* 'house']). Ultimately, this finding suggests that the interplay between vowel duration and formant movement is quite elusive.[10]

6 Discussion

This study aimed to investigate both the areal and the structural diffusion of VM. To do so, we employed a new and powerful numerical measure to assess the degree of formant movement. This measurement technique gives meaningful results

10 A major reason for this may be that other factors are also influencing vowel duration, most importantly age. On average, there is a significant difference between older and younger speakers when it comes to vowel duration (p = 0.000***) with older speakers showing longer duration. These differences are accompanied only by very minor, non-significant differences between male and female speakers.

(see Section 5) and allows for greater comparability of individuals. In what follows, we will, first, discuss the results relevant to the geographical diffusion of VM (Section 6.1), before we, secondly, focus on its structural diffusion (Section 6.2).

6.1 Diffusion: areal and sociolinguistic factors

At the beginning of the 20th century, Viennese Monophthongization began to diffuse beyond the city borders of Vienna. The present study indicates that VM is still diffusing into the rural vernacular dialects of eastern Austria. VM is thus an ongoing sound change which proceeds, like many other changes in Austria (cf. e.g., Bülow et al. 2019; Scheuringer 1990; Scheutz 1985; Vergeiner et al. 2021), through horizontal (i.e., non-standard dialect to non-standard dialect) and (most probably also because of Vienna's prestige) vertical (non-standard to standard) convergence.

So far, VM seems to have diffused into most vernacular rural dialects of Lower and Upper Austria as well as into Burgenland and northern Styria. Until now, however, VM has not affected the non-standard vernacular dialects of Salzburg or western Upper Austria, where the older diphthong realizations are preserved (see Figure 4). VM has also not reached the very rural village of Apetlon (AP) in Burgenland, although its distance to Vienna is comparatively small.

Even if VM has already reached some speakers in larger cities such as Salzburg, Graz, and Linz (Moosmüller 1991; Moosmüller and Scheutz 2013; Moosmüller and Vollmann 2001) before diffusing into the intermediate rural areas, the findings of our study provide evidence for a wave-like diffusion originating only from Vienna. Regarding the rural dialects, VM radiates in "orbits" around the innovation center of Vienna. Note, however, that these "orbits" are neither fully circular nor have clear borders but are rather transition zones (Chambers and Trudgill 1998; Trudgill 1983) with a gradual increase in averaged formant movement originating from the core zone around Vienna (see Figure 17; for a similar finding for urban varieties cf. Moosmüller 1991: 68).

The results indicate that cities other than Vienna do not seem to contribute to the diffusion of VM to a greater extent (see Section 5.1), although it is reported to have been present in Salzburg, Graz, and Linz for more than 30 years (Moosmüller 1991; Moosmüller and Scheutz 2013; Moosmüller and Vollmann 2001). Thus, we have a long-term case of what Taeldeman (2005) termed "urban insularity" with stable dialect differences between the cities (and their commuter belts), on the one hand, and the rural areas that surround them, on the other.

At first sight, it is rather surprising that cities other than Vienna do not act as diffusion centers for VM. One has to consider, however, that Vienna is of particular importance for language change in Austria. Vienna is a good example of a "primate

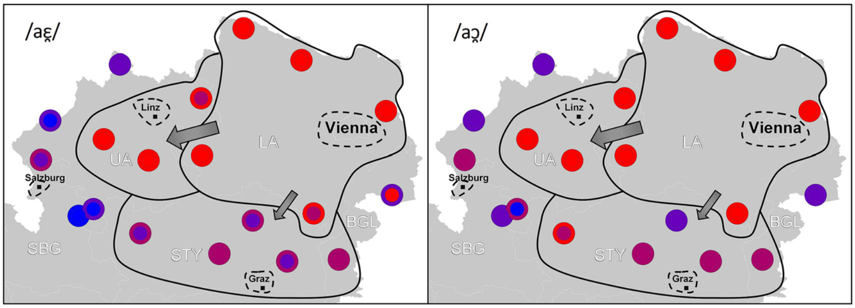

Figure 17: Simplified illustration of wave-like diffusion of the VM for /aɛ̯/ (left) and /aɔ̯/ (right).

city" – with about 1.9 million inhabitants it is by far the biggest city in Austria with about one-fifth of the country's total population. It is about seven times larger than Graz (288,000 inhabitants), the second largest city in Austria. Bearing in mind that our research area comprises only about 250 km around Vienna, it is rather plausible that the influence of Vienna as the innovation center vastly outweighs the influence of all other cities.

However, it is not the distance to Vienna alone that matters – this becomes obvious, for example, with respect to Apetlon in Burgenland, where VM has not yet been able to make inroads. One possible explanation is that Apetlon is characterized (from an etic as well as an emic perspective) by a quite unique local dialect when compared to the vernacular varieties spoken in the surrounding areas. Thus, for instance, with regards to /aɛ̯/, the traditional realization in Apetlon is [ɑæ̯], not [aɛ̯]. Maybe it is because of these specific local characteristics that speakers from Apetlon are more resistant to this ongoing sound change. Britain (2005), for example, has provided similar empirical evidence of how local structural incompatibility with an incoming change can slow down innovation adoption. Both our work here and that of Britain support the assumption made by Chambers and Trudgill (1998: 179) that pre-existing linguistic divergence can have the effect of decreasing the diffusion rate.

As the example of Apetlon already indicates, the role of cultural space needs to be taken into consideration. VM seems to diffuse particularly quickly through the area along the Danube river in Lower and Upper Austria. It is this Danube area which forms the historical "heartland" of Austria with Vienna as its center. People here tend to have a stronger Austrian identity than people from other Federal States where more regional cultural identities can be witnessed, e.g., in Styria. This also might explain why the diffusion of VM southward to Northern Styria and (Southern) Burgenland seems to be delayed, despite these regions being closer to Vienna (in purely geographical terms). Others have also shown how such cultural regions can coincide with the geographical distributions of diffusing linguistic innovations. Labov (2011: 208–235), for example, describes in detail the social, cultural, economic, political, and ideological factors that unify the Inland North as a cultural area in the Northern United States, the area that experienced the spread of the now famous Northern Cities Vowel Shift (cf. also Milroy 2004: 171–172). Thus, the results are in line with Horvath and Horvath's (2001: 53) Cultural Hearth model whereby an innovation takes hold across a cultural region before spreading to others (see Section 2.1; cf. also Britain 2012: 2036).

Besides these geo-cultural factors, contact and social network structure are also centrally implicated in the diffusion of new variants (Milroy 1987, 2004; Milroy and Milroy 1992). Particularly for rural Austria the specifics of social network structure need to be considered regarding gender-related dialect differences. This might help explain why among the older speakers men lead change, not women, as is commonly assumed to be the case in variationist linguistics (Labov 2001; for an overview Cameron 2003). Particularly within the older generation gender roles used to be very rigid. Unlike among the urban working and middle class, the focus of most variationist studies, rural Austrian women were, until relatively recently, much more confined to their villages and to the farm for their domestic activities than men.[11] Thus, they had fewer contacts to social networks outside their own village and hence little opportunity to be exposed to new variants. It is because of this that women are generally considered to be more linguistically conservative than men in the traditional dialectology of German (for further references cf. e.g., Schwarz 2015: 513–514). The orientation in Anglo-American dialectology towards the NORM (non-mobile old rural man) suggests that the opposite was believed to be the case in English-speaking communities (cf. e.g., Orton 1962: 15).[12] Nowadays, even in very rural areas, the differences between women and men with regard to this aspect of their network structure appears to have largely disappeared as a result of increased female participation in work outside the home/farm, especially in white-collar tertiary sector employment (Oedl-Wieser 2018: 43–44). This may help to account for the fact that among the younger speakers gender-related differences in the use of VM have largely vanished.

11 Cf. e.g., Oedl-Wieser (1997), who stated for rural Austria in the 1990s: "Because of their responsibility for the family especially women in remote areas stick much longer to their local community and are forced to spend most of their time in a restricted area. In some regions with a high share of men who are commuting daily or weekly, women are managing the everyday life in the region so that we can speak of clear tendencies of 'feminisation' of rural areas."

12 It is noteworthy that for studies in urban contexts, the exact opposite explanation is given – it is argued that men act more conservatively because their network structures are more closed, and those of women more open, cf. e.g., Holmes (1997) and Cameron (2003).

6.2 Diffusion: internal linguistic factors

According to the Neogrammarian doctrine, sound change should be lexically abrupt and phonetically gradual, whereas the lexical diffusion approach supposes sound changes to be lexically gradual regardless of whether they are phonetically gradual or phonetically abrupt (Phillips 2006: 31–34; cf., for the terms used, Wang 1969: 14). However, the differences are more subtle, when considering that neither the Neogrammarians nor their successors ever excluded the possibility of various word forms showing differences in sound change. They argued that such differences only exist when they are caused by purely phonetic or phonological factors (Osthoff and Brugmann 1878; cf. also Labov 1994). Thus, the question is not whether sound change is lexically gradual, but what is the specific cause of it? Whereas the Neogrammarians excluded all but phonetic-phonological factors in sound change (hence assuming autonomy for phonetics/phonology), in the lexical diffusion approach other factors may also be taken into consideration.

In this light, our data support some of the Neogrammarian assumptions (see Section 2.2 for details). Both vowels /aɛ̯/ and /aɔ̯/ seem to be affected by the change in parallel, providing evidence for the “Reihenschrittgesetz” ‘parallel movement law’ (cf. Vergeiner et al. 2021; Wiesinger 1982). Furthermore, all items are affected by the change, at least in those localities where VM appears. Even when we find certain differences between individual items, these differences can be mostly explained by phonetic-phonological factors, particularly by the following sound (e.g., in the case of /aɔ̯/ before /s/, see Section 5.3) and by stress patterns. Not surprisingly, function words and otherwise unstressed words are affected most strongly by monophthongization.

In addition, we provided evidence for a correlation between formant movement and vowel duration. A higher speech rate seems to cause a lower vowel duration and hence a smaller formant movement, although a smaller formant movement also may cause a lower vowel duration. Thus, both factors seem to interact – quite plausible considering VM’s status as a reductive process (Vollmann and Moosmüller 1999: 348; cf. also Moosmüller 1991: 66–68).

In contrast, morphological aspects or word frequency do not account for the differences between the items investigated. At most there is an indirect effect with syntactic and/or pragmatic factors causing certain items to be articulated in a more or less lax manner. Consequently, monophthongs are more likely to appear within lax articulation.

Therefore, we argue that the Neogrammarian approach to sound change, with its focus on phonetic-phonological factors, is largely sufficient to explain the diffusion of VM within the linguistic system. This is rather surprising, bearing in mind that for most other ongoing sound changes in German vernacular dialects the lexical diffusion hypothesis is much more fitting (Bülow et al. 2019; Schwarz 2015). These other sound changes, however, are clearly "sound replacements" caused by dialect-to-standard-contact within bidialectal speakers of both standard and local dialect.

So VM is a rare example of Neogrammarian sound change "in the narrow sense" in Austrian traditional dialects. Although it also spreads via contact (see Section 6.1), speakers "adapt" their pronunciation patterns by gradually changing the articulation gestures of the pre-existing sound. Within the framework of natural phonology, this process can be described in terms of postlexical rules (Moosmüller 1991: 66–68). In such changes, factors other than phonetic-phonological ones only play a minor role (Kiparsky 1995; Seidelmann 2014).

There is, however, another way to look at this sound change. It is the Neogrammarians who propose that sound change is a highly regular, law-like, even mechanical process (cf. again Labov 1994; Osthoff and Brugmann 1878). If this were the case, one would expect sound change to be very uniform both between and within individuals. This is, however, not the case. The data show a high amount of intra-individual variation, which can neither be explained by the items nor by any extra-linguistic category. The extent of this variation is too great to simply be considered as noise or errors in the data – especially when regarding the controlled type of data used in our study. With Lowie (2017) we argue that this type of intra-individual variation may be a crucial prerequisite of a changing system, possibly inexplicable and irregular, at least by using "Neogrammarian mechanics" (cf. also Vollmann and Moosmüller 1999 as well as Bülow et al. 2019 for further discussion).

7 Conclusions

In the present study we investigated the geographical and structural diffusion of an urban dialect feature – Viennese Monophthongization – into the rural vernacular dialects of Austria. In doing so, we applied and tested a new numerical measure to assess and compare the degree of formant movement of 76 speakers in 19 locations in eastern and central Austria.

Our results show that Viennese Monophthongization is diffusing in a wave-like fashion around Vienna into rural Austria. This can be attributed to Vienna's status as a "primate city". We do not find evidence that VM is spreading from other major cities where it is reported to have been established for more than 30 years. This indicates a case of long-term "urban insularity". Besides the influence of Vienna, we discussed other major factors like linguistic similarity, geo-cultural identity, and gender-related network structures as contributing to the diffusion of Viennese Monophthongization.

With regard to lexical diffusion, we investigated 18 stimuli representing various lexemes and word forms. Our results indicate that the phonetic-phonological environment – stress and the following consonant – accounts for most item-related differences. In contrast, lexical factors like word frequency have no influence on the degree of formant movement. In spite of the popular assumption of the complete regularity of sound change, there are, however, item-related differences that remain unexplainable – at least for the moment.

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Author contribution: Dominik Wallner and Jan Luttenberger collected the data. Jan Luttenberger performed the phonetic measurements. Philip C. Vergeiner performed the statistical analyses. Philip C. Vergeiner wrote the first draft of the manuscript with input from Jan Luttenberger and Lars Bülow. Lars Bülow and David Britain revised and complemented the manuscript. All authors commented on the manuscript.
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