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ARTICLE

The role of speaker sex and sexuality in an ongoing sound change: Nasal vowels in Parisian French

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ABSTRACT

This article examines the progression of the counter-clockwise nasal vowel chain shift in Parisian French, investigating in particular the influence of biological sex and of sexuality on the propagation of this change from below. The research presented forms part of a study on the participation of sexual minorities in ongoing sound change; this study aims to address the continued exclusion of sexual minorities from sociolinguistic studies, which not only invisibilizes queer people, but underlines their behaviour, linguistic or otherwise, as gender-deviant. Using a sociophonetic methodology, an analysis of nasal vowel quality provides evidence for sex- and sexuality-differential linguistic behaviour in the advancement of the nasal vowel chain shift. The results confirm the progressive but non-conformative linguistic behaviour of women, both straight and queer, as outlined by Labov (1990) and numerous other sociolinguistic studies, but also indicate that queer men are centre-stage in driving the change forward. This research is a first step in formalizing data-driven principles about the linguistic behaviour of sexual minorities and their role in language change, akin to the principles advanced to account for the behaviour of women.

Keywords: sociophonetics; Parisian French; sexuality; gender; language change

RÉSUMÉ

Cet article examine l'avancement d'un changement en chaîne des voyelles nasales en français parisien, en étudiant en particulier l'influence du sexe biologique et de la sexualité sur la propagation de ce changement linguistique d'en bas. Les recherches présentées font partie d'une étude pilote sur la participation des minorités sexuelles aux changements sonores en cours ; ce projet vise à aborder la question de l'exclusion continue des minorités sexuelles des études sociolinguistiques, ce qui invisibilise les personnes queer, et qui souligne aussi leur comportement, linguistique ou autre, comme déviant de genre. En employant une méthodologie socio-phonétique, l'analyse de la qualité phonétique des voyelles nasales montre clairement l'influence du sexe et de la sexualité des locuteurs sur l'avancement du changement en chaîne. Les résultats confirment le comportement linguistique progressif des femmes, souligné par Labov (1990) et de nombreuses autres études sociolinguistiques, mais indiquent également que les hommes queer jouent un rôle principal dans l'évolution linguistique en question. Ces recherches constituent une première étape dans la formalisation de principes empiriques qui décrivent le comportement linguistique des minorités sexuelles, comparables à ceux qui ont été avancés pour les femmes, afin de mieux préciser leur rôle dans les changements linguistiques en cours.

1. INTRODUCTION

The speech of homosexual men and women remains markedly understudied within the discipline of language variation and change, where heterosexuality has been largely presented as the default norm (Queen, 2013: 371). The participation of women in language change has long been a central theoretical focus in variationist sociolinguistics. From as early as 1905, female speakers have been shown to lead language change and, in some cases, to be as much as a generation ahead of men in the adoption of innovative linguistic features (Gauchat, 1905). Labov (1990) formalized the description of women's linguistic behaviour in the form of three data-driven principles which, when considered together, give rise to the so-called 'gender paradox': 'women deviate less than men from linguistic norms when they are overtly prescribed, but more than men when the deviations are not prescribed' (Labov, 2001: 93; see Cheshire, 2002, for criticism), but the extent to which queer men and women participate in mainstream language change remains, to a certain extent, a mystery. There is some evidence to suggest that gay men participate in on-going sound change more readily than straight men (Munson et al., 2006) and that lesbians demonstrate more resistance to change than heterosexual women (Pierrehumbert et al., 2004). The focus of these analyses, however, was not on the participation of sexual minorities in mainstream language change; rather, these studies conjectured that this was the case on the basis of production and perception analyses.

This article will begin to interrogate the validity of these claims and to advance data-driven principles, like those advanced to account for the behaviour of women, for the linguistic behaviour of sexual minorities. It will examine the participation of straight and queer men and women in the ongoing counter-clockwise nasal vowel chain shift in Parisian French, whereby /ɛ̃/ is subject to backing and lowering, /ɑ̃/ to backing and raising, and /ɔ̃/ to raising, becoming very close. The article begins by outlining the relevant theoretical concepts from variationist sociolinguistics and by surveying the findings of research on queer speech (Section 2), before examining the wealth of research on the French nasal vowels (Section 3), focusing in particular on evidence for systemic chain shifts and the acoustic characteristics of the nasal vowels. The sampling techniques, data elicitation, and corpus construction protocols are detailed in Section 4, including the acoustic and statistical analyses employed. The results (Section 5) present regression analyses of both the /ɛ̃/-/œ̃/ merger in Parisian French and, of course, of the progression of the counter-clockwise nasal vowel chain shift. The final section synthesizes the results, discussing mechanisms that govern the systemic sound change in question, and advancing preliminary data-driven principles regarding the behaviour of queer men and women in situations of change from below.

2. THEORETICAL BACKGROUND

Labov (1972; 2001) distinguishes between two processes of language change, namely, 'change from below' and 'change from above'. Linguistic changes from below are initiated by language internal factors, such as paradigm simplification, and the change is initially restricted to a subset of the speech community (e.g., the merger of /a/ and /ɑ/ to /a/ is a well-established feature of supralocal French which began as a change from below; Armstrong and Pooley, 2010: 107). Linguistic changes from above, on the other hand, involve the adoption from elsewhere of linguistic features that carry overt or covert prestige (e.g. the adoption of supralocal [ʁ] in southern regional French; Armstrong and Pooley, 2010: 189). Changes from above are therefore externally motivated, whereas changes from below are, at least initially, internally motivated. The processes are not entirely independent (see Hawkey, 2016 for discussion). For example, /ɔ/-fronting to [œ] originated as a change from below in *français populaire*, or the speech of the urban proletariat in Paris (Martinet, 1958). This change from below then became well established in the speech of Parisians from other social classes, thus gaining covert prestige as a non-standard feature of Parisian French. This prestige motivated its adoption, as a change from above, elsewhere: throughout the supralocal area (Armstrong and Low, 2008) and in southern regional French (Mooney, 2016a).

Labov (1990; 2001) advanced data-driven principles to account for the linguistic behaviour of male and female speakers. In situations of change from above, women are said to favour the use of incoming prestige variants more than men (Labov, 2001: 274) but, in situations of change from below, women favour the use of innovative, non-standard forms more than men (Labov, 2001: 292). In both situations of change, women have been shown to be more progressive than men, accelerating the adoption of the new variant in the speech community. Since changes from above often involve the adoption of supralocal variants, or those that are perceived to be more 'standard', women's progressiveness has often been interpreted as their orientation to linguistic variants that carry prestige due to wider currency and use. On the other hand, in situations of change from below, women demonstrate seemingly paradoxical behaviour by orienting themselves towards the proliferation of innovative, non-standard forms. This apparent inconsistency in women's orientation to prestige has been labelled the 'gender paradox' by Labov: 'Women deviate less than men from linguistic norms when they are overtly prescribed, but more than men when the deviations are not prescribed' (2001: 293). While there is a wealth of cross-linguistic data that confirms these principles advanced by Labov, the shift in focus of variationist theory over time has called into question the significance of such findings in isolation. For example, Eckert (2008) notes that the replication of the 'gender pattern' does not tell us anything about the behaviours and ideologies that underpin this behaviour: 'This generalisation [...] says nothing about [...] what kinds of meaning people attach to the conservative and innovative variant, who does and does not fit the pattern and why' (2008: 455). In short, Labov's findings are based on divisions involving (binary) biological sex and he uses the term 'gender' to acknowledge that these differences are socially, rather than biologically motivated.

Queen (2013: 368) uses the term 'gender' as an umbrella term for 'sex, gender, sexuality, and sexual identity', not to imply that they are interchangeable terms, but to acknowledge (at least some of) the complex interacting factors at play when analysing gender identity. The study reported in this article aims, while adopting a relatively traditional Labovian variationist methodology, to incorporate information on the sexual identity of speakers so as to advance a more nuanced understanding of gender and sex-differential linguistic behaviour. Traditional variationist studies including sexuality or sexual identity as an independent variable in their analyses are few and far between. This is primarily because heterosexuality has long been considered as the default norm: 'heterosexuality [is] taken for granted in virtually all of the work […] that dealt with language and gender' (Queen, 2013: 371). Where there have been studies of non-heterosexual speakers, these have primarily focused on gay men, on how they sound and speak (Cameron and Kulick, 2003: 74), and on the gay-specific words they use or have used.

In the last two decades of the twentieth century, there was a tendency to examine gay male speech using exclusively conversational and discourse analysis frameworks (Queen, 2007: 316). More recently, there have been studies of gay and lesbian speech in the discipline of sociophonetics, a branch of variationist sociolinguistics. The primary focus of these studies has been to address two widely held assumptions about the speech of queer people. First, the familiar linguistic stereotype, called 'the voice', that gay men sound different from straight men. Secondly, that homosexual speech behaviour constitutes an approximation of opposite sex norms: 'homosexual men are thought to talk like women, and lesbians, to the extent that they are imagined to talk in a particular way at all, are believed to talk like men' (Cameron and Kulick, 2003: 74). As such, many studies have focused primarily on the phonetic correlates of 'sounding gay' (Podesva and Kajino, 2014: 105), on comparing the speech of gay men with that of straight women and men (Munson and Babel, 2007: 416), and on comparing the speech of lesbians with straight and bisexual women (Waksler, 2001). While many studies have identified to some extent the phonetics correlates of 'the voice' for gay men (see Smyth and Rogers, 2002: 299), such as pitch, vowel clarity, fricative frequencies, etc., there is little mention in these studies of how gay men and lesbians behave in situations of language change: 'there is a dire need for embedding research on the phonetic correlates of sounding gay in larger-scale community studies' (Podesva and Kajino, 2014: 110). Where linguistic changes in progress have been considered, the participation of sexual minorities in ongoing change was not the primary focus of the study. For example, Munson et al. (2006) found that gay men had lower, retracted /ɛ/, and fronter /u/ than straight men in English, therefore using more advanced variants in an ongoing change in progress: 'We might conjecture from this that gay men are participating in this ongoing change more readily than straight men' (2006: 430). Pierrehumbert et al. (2004) have also noted that lesbian speakers appear to demonstrate a resistance to ongoing change. In both case, these points are raised as an aside, and both studies raise questions that this analysis of Parisian French nasal vowels will begin to address.

3. LINGUISTIC BACKGROUND

The phonological system of the prescriptive norm, standard French, distinguishes four nasal vowel phonemes (/ɛ̃/, /œ̃/, /ɑ̃/ and /ɔ̃/). The standard spoken norm, also known as supralocal French, contrasts only three nasal vowels (/ɛ̃/, /ɑ̃/ and /ɔ̃/) (see

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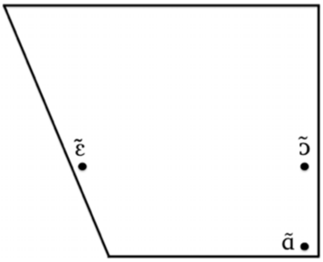

Figure 1. Supralocal French nasal vowels.

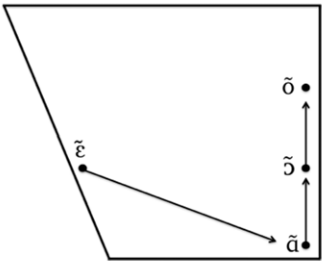

Figure 2. Chain shift in Parisian French.

Figure 1) due to the merger of /ɛ̃/ and /œ̃/ to /ɛ̃/ (Pooley, 2006: 368). This means that the words *brun* ('brown') /bʁœ̃/ and *brin* ('sprig') /bʁɛ̃/ are both pronounced [bʁɛ̃] by the majority of speakers in northern France. This merger of the front nasal vowels constitutes a change from below which originated in Parisian French and diffused, as a change from above, throughout the supralocal area as part of the process of dialect levelling (see Mooney, 2016b: 332-334).

Additionally, in contemporary Parisian French, these three nasal vowels appear to be undergoing a counterclockwise chain shift (see Figure 2; Mettas, 1973; Walter, 1994; Hansen, 1998, 2001) in which /ɛ̃/ approaches /ɑ̃/, /ɑ̃/ approaches /ɔ̃/, and /ɔ̃/ becomes very rounded and close, e.g., *bain* ('bath') /bɛ̃/ →[bɑ̃], *banc* ('bench') /bɑ̃/ →[bɔ̃], *bon* ('good') /bɔ̃/ →[bõ]. The chain shift taking place in Parisian French constitutes a change from below in progress. Hansen (2001) notes that the shift is being led by intermediate variants in certain contexts and that it was nowhere near complete in the early noughties. Hansen identified two structural, language internal, factors accelerating the chain shift (2001: 45): variants occurring in stressed position (final syllable of the rhythmic group) were more advanced than variants occurring in unstressed environments (see Mettas, 1973; Fónagy, 1989); within rhythmic groups, variants occuring in final syllables of polysyllabic words also exhibited more evidence for change in progress (see Léon, 1983; Malderez, 1991).

Hansen notes that the counter-clockwise movement of this shift contrasts with the 'rotation [...] observée pour les voyelles du français canadien qui vont vers l'avant' (2001: 45), e.g., *bain* /bɛ̃/ →[bẽ], *banc* /bɑ̃/ →[bɛ̃], *bon* /bɔ̃/ →[bɑ̃]) (cf. Carignan, 2011). Mooney (2016b) has also identified a nasal vowel shift in the regional French of Béarn, southwestern France, where the youngest generation have been shown to lead three systematic ongoing changes in the nasal vowel

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system: /ɑ̃/-backing; /ɔ̃/-centralisation, and /œ̃/-fronting. This push chain shift is argued to have been initiated by the individual adoption of one supralocal feature, /ɑ̃/-backing, in regional French, with /ɔ̃/ and /œ̃/ moving forward in the vowel space to preserve the functional integrity of the four term nasal vowel system in southern regional French.

In addition to the studies cited above, there have, of course, been a large number of studies focusing on the phonological status and phonetic quality of the (European) French nasal vowels. These studies are largely based on laboratory speech and provide a wealth of descriptive detail on the nasal vowels, examining them from a variety of perspectives: speech perception (Delvaux et al., 2004; Woehrling and Boula de Mareüil, 2006; Delvaux, 2009); articulatory phonetics (Maeda, 1990; Teston and Demolin, 1997; Montagu, 2004; Delvaux et al., 2002; Delvaux et al., 2008; Carignan, 2013); acoustic phonetics (Longchamp, 1979; Maeda, 1982, 1993; Montagu, 2007); phonology (Durand, 1988, 2009; Delais-Roussarie and Durand, 2003; Durand and Eychenne, 2011). In the fields of articulatory and acoustic phonetics, there is much emphasis placed on the mapping of articulatory gestures onto acoustic cues for nasalization and thus many of the studies cited above fall into both categories.

3.1. Acoustic characteristics of nasal vowels

The first two formant frequencies are commonly held, in acoustic phonetic studies of oral vowels, to have general non-linear articulatory correlates : F1 exhibits an inverse correlation with vowel height; F2 exhibits a positive correlation with vowel frontness/backness. It is worth noting, here, that filtering through the nasal cavity can distort somewhat the reliability of interpreting formant values in these articulatory terms; velopharyngeal (VP) coupling can cause formant value changes that are not due to the configuration of the oral cavity, including the tongue (Carignan et al. 2013; Carignan, 2014: 24; Carignan, 2018b: 19-20): 'the inferred shape of the acoustically excited tract is obscured by the acoustic effects of nasalisation' (Carignan et al., 2015: 34). Additionally, formant measurements above F2 may not be wholly reliable because F3 is severely affected by nasalization (Maeda, 1993: 151; De Mareüil et al., 2007): 'due to nasal zeroes, F3 can be divided into two peaks of lesser intensity and/or shift towards higher frequencies' (Delvaux et al., 2002: 2). For this reason, F3 is not included in the analysis in Sections 4 and 5.

The effects of VP coupling on formant frequencies is relatively well documented. Carignan (2018b: 23) notes, for example, that VP coupling tends to result in a general increase in F1 for close vowels, a decrease in F1 for open vowels, and to a decrease in F2 for non-front vowels. When measuring formant frequencies for nasal vowels on the basis of information in the waveform and spectrogram, however, it is not possible to know whether these values are the result of tongue height and retraction or an acoustic consequence of nasalization. There are other articulatory gestures, such as pharyngeal contriction and lip rounding/protrusion (Maeda, 1993: 165), that can also affect formant values: 'a constriction in the lower pharynx is correlated with an increase in F1, while expansion is correlated with a decrease in F1; lip rounding and/or protrusion is correlated with a decrease in all formants' (Carignan, 2014: 24).

For /ɛ̃/, F1 values have been shown to be the result of tongue height, not nasalization (Carignan, 2018b: 26), and pharyngeal constriction, while F2 is the result of VP coupling, tongue backing, and velic lowering (Carignan, 2014: 31; Carignan et al., 2015: 49). For /ɑ̃/, F1 values have been shown to be the result of VP coupling, lip rounding, and lower pharyngeal expansion, while F2 is the result of VP coupling, tongue backing, lip rounding, and velic lowering (Carignan, 2014: 31; Carignan et al., 2015: 49). For /ɔ̃/, F1 values were due to lip rounding, pharyngeal constriction and tongue height, while F2 was due to tongue backing, lip rouding, and velic lowering (Carignan, 2014: 31; Carignan et al., 2015: 49). The overall effect of articulatory gestures in addition to VP coupling appears to be that they enhance the effect of nasalization on F1 and F2 (Carignan, 2014: 31-32; Carignan et al., 2015: 49), in that they involve a general decrease in F2, an increase in F1 for /ɛ̃/ and /ɔ̃/, and an F1 decrease for /ɑ̃/.

The acoustic consequences of nasalization that result in the F1 and F2 values for /ɛ̃/, /ɑ̃/, and /ɔ̃/, as well as the enhancement of these acoustic consequences using other articulatory gestures, resembles the counter-clockwise chain shift for /ɛ̃/ and /ɑ̃/ schematized in Figure 2: an increase in F1 (lowering) and a decrease in F2 (backing) for /ɛ̃/; a decrease in both F2 and F1 (backing and raising) for /ɑ̃/ (Carignan, 2018a: 2598). Nasalization results in an increase in F1 for /ɔ̃/, or vowel lowering, which is not consistent with the systemic shift outlined in Figure 2 (Carignan, 2014 24). Carignan (2018b: 23-24) notes, however, that it is reasonable to question whether the acoustic consequences of nasalization, and associated articulatory gestures, might be perceived as changes in vowel quality, perhaps initiating the systemic chain shift. This argument is advanced within the framework of Ohala's (1989) 'hidden variation theory', sometimes referred to as the 'listener oriented approach to sound change': 'sound change is seen to take place when the listener reinterprets secondary acoustic cues that are present in the signal as important for parsing and producing the segment' (Mooney and Hawkey, 2019: 289). In the case of the nasal vowels, the acoustic effects of nasalization may have been misinterpreted as a systemic shift in vowel quality, which was perhaps 'triggered by the inherent consequence of VP coupling on the acoustic realization of /ɛ̃/' (Carignan, 2014: 31). If this is the case, we can note additionally that lingual and pharyngeal articulatory configurations may also contribute to the percept of shifting vowel quality and thus be involved (Carignan et al., 2015: 47). Since the raising of /ɔ̃/ is not consistent with the acoustic effects of nasalization, Carignan (2014: 31, 2015: 36) argues that this may simply be a functional reaction of the raising of /ɑ̃/ towards /ɔ̃/. In sum, Carignan (2018a: 2598) has argued convincingly that psycho-acoustic pressure on the vowel space as a consequence of nasalization and its associated articulatory gestures may have acted as a trigger for the initial shift in vowel quality, potentially influencing subsequent shifts in the nasal vowel system in Parisian French.

4. METHODOLOGY

This section outlines the methodological approach adopted for the study of the Parisian nasal vowel chain shift, including participant sampling, corpus construction, variable circumscription, data processing, and data analysis.

Table 1. Participants: sex, age, and self-identified sexuality

Speaker	Sex	Age	Sexuality
A	F	28	Bisexual
B	F	35	Lesbian
C	F	28	Lesbian
D	F	36	Straight
E	F	39	Straight
F	F	27	Straight
G	M	33	Gay
H	M	29	Gay
I	M	32	Gay
J	M	32	Straight
K	M	21	Straight
L	M	33	Straight

4.1. Participant Sampling

The primary method of recruiting participants was using the 'friend-of-a-friend' technique, also known as 'snowball' sampling (Milroy and Gordon, 2003: 32). This involved using the researcher's own networks of friends in Paris and subsequently asking participants to suggest other friends that might be willing to be involved. The participants in this study are profiled in Table 1: there are twelve participants in total, equally distributed by sex [male; female] and sexuality [straight; queer]. The categories of 'queer' and 'straight' were used primarily for the practical purpose of recruiting speakers. The use of these etic categories is not essentialist in intention and I acknowledge the inevitable variability within these categories. Indeed, Speaker A, for example, self-identifies as 'bisexual'. For the purpose of this study, the queer-straight binary distinction is a necessary first step in moving away from a focus on normative heterosexuality in language variation and change studies.

The ethnicity and socio-economic class of all speakers in this study is broadly 'white middle class'. Socio-economic class was, however, not measured explicitly; it was not self-reported and was simply intuited by the author. In western countries, predominantly white speakers in the lower middle class have been consistently shown to lead mainstream language change (see Labov, 2001). It is worth noting that Labov's initial findings were based on a formalized measurement of class in North America and that these categories do not necessarily map onto the socio-economic sub-divisions proposed by the *Institut National de la Statistique et des Études Économiques* (INSEE) (Pooley, 2000). In any case, the ethnicity and socio-economic status of participants in this study have been held constant in the sample frame in order to minimize the influence on speech production of other social factors, which may interact with sex and sexuality; future studies will integrate ethnic minorities and a larger socio-economic sample. The sampling method targeted participants that were 20-40 years old, with the aim of avoiding the

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transition from adolescence to adulthood, a period of linguistic development that is characterized by high levels of linguistic variation and change in the direction of more standard linguistic forms (Cukor-Avila and Bailey, 2013). The researcher was also in this age group, facilitating the friend-of-a-friend recruitment technique and having the added benefit of reducing potential socio-situational variation in the speech of participants in response to the researcher's relative age.

4.2. Linguistic variables and corpus construction

The primary aim of this study is to examine evidence for participation in the Parisian counter-clockwise nasal vowel chain shift: /ɛ̃/ → /ɑ̃/ → /ɔ̃/ → [õ]. A precursor to this shift, however, is checking that the participants involved also demonstrate evidence in their speech for the well-established merger of /ɛ̃/ and /œ̃/ to /ɛ̃/, since /œ̃/ has not been shown to participate in the chain shift as an independent phoneme. As such, this study aimed to examine: (i) evidence for the well-established merger of /ɛ̃/ and /œ̃/; (ii) evidence for the linguistic change in the formant values (F1, F2) of the three Parisian nasal vowel phonemes /ɛ̃/, /ɑ̃/, and /ɔ̃/.

Informants in this study took part in (i) a reading passage task, and (ii) a wordlist task. The reading passage was adapted from Hansen (1998: 155), including words containing the four standard French nasal vowel phonemes (/ɛ̃/, /œ̃/, /ɑ̃/ and /ɔ̃/). In the reading passage, presented in Appendix 1, the words have been emboldened and italicized, and the phoneme of interest is noted in brackets after each word; this formatting was, of course, removed when presented to participants. The text contained 28 nasal vowel tokens, distributed as follows: 6 tokens of /ɛ̃/; 2 tokens of /œ̃/; 11 tokens of /ɑ̃/; 9 tokens of /ɔ̃/. For /ɛ̃/, /ɑ̃/ and /ɔ̃/, tokens occurred in open final syllables (_#), closed final syllables (_C#), and open medial syllables (_σC). /œ̃/ only occurred in open final syllables in the text.

The wordlist task included 95 words presented in the carrier phrase 'Dites MOT pour moi'; the voiceless plosives preceding ([t]) and following ([p]) the target word assisted in the accurate segmentation of the vowel produced when it occurred at a word boundary. The wordlist used included all four standard French nasal vowel phonemes in three syllable types: (i) open final syllables (_#); (ii) closed final syllables (_C#); open medial syllables (_σC). The full wordlist can be consulted in Appendix 1; this was presented to participants in pseudo-randomized order, by aligning the words with a series of random numbers in Excel, using the =RAND() function, and then by sorting the list in numberical order. The distribution of the vowel tokens by syllable type in the reading passage and wordlist are presented in Table 2. A total of 123 words were included in both tasks; both tasks were included in the analysis and no distinction was made between data from the reading passage or wordlist in the statistical analyses outlined in Section 4.4. The use of two tasks simply aimed to maximize the number of tokens in the study and, as both tasks elicit read speech, their use is not intended to be a proxy for style.

4.3. Acoustic analysis

The reading and wordlist tasks were recorded in person using a sampling rate of 44.1 kHz and a 16-bit PCM sample size. The analysis began by manually labelling

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Table 2. Distribution of phonemes in the reading passage and wordlist tasks

Phoneme	Syllable	Reading passage	Wordlist	Total
/ɛ̃/	_#	3	11	14
	_C#	2	8	10
	_σC	1	10	11
/œ̃/	_#	2	10	12
	_C#	0	5	5
	_σC	0	5	5
/ɑ̃/	_#	7	10	17
	_C#	2	7	9
	_σC	2	10	12
/ɔ̃/	_#	6	9	15
	_C#	1	5	6
	_σC	2	5	7
Total		28	95	123

1476 tokens of the nasal vowels for vowel onset and offset in Praat (Boersma, 2001; Boersma and Weenink, 2012) text grids, across the twelve speakers selected for analysis, before measuring manually the first two formant frequencies, F1 and F2 at the vowel midpoint. These formants were estimated in Praat using the LPC (Linear Predictive Coding) algorithm, with a maximum of 4,000 Hz for male speakers and 4,500 Hz for female speakers. These formant ceilings are lower than the usual formant ceilings of 5000 Hz and 5500 Hz in order to increase the sensitivity of the LPC algorithm; this adjustment was necessary as the automatic detection of F1 and F2 for nasal vowels can be particularly problematic for back vowels, where the values for F1 and F2 are close together. Carignan (2014: 26, 2018b: 22) notes that adjusting the formant ceiling in this way for nasal vowels avoids multiple LPC estimate errors. For this reason, all values were extracted manually at the midpoint, therefore ensuring that the measurements taken were for estimations of the correct formant frequencies; outliers were double-checked against the spectrogram for the token in question. In total, 15 tokens were excluded from the analysis as it was not possible to reliably read the formant estimations, either due to low amplitude in the signal or extraneous noise, leaving 1461 tokens of the nasal vowels in total. In some instances, and in particular where the nasal vowels preceded a plosive consonant, a co-articulatory nasal consonant of short duration and low amplitude was produced during the vowel-plosive transition; these consonants were always excluded from the vowel offset label.

4.4. Statistical analysis

Before analysing evidence for the nasal vowel chain shift, the /ɛ̃/~/œ̃/ merger was first investigated. This involved submitting raw data (F1 and F2 in Hz) for both

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vowels to statistical analysis for each of the twelve speakers individually, in order to examine the degree of vowel overlap between the traditional phonemic categories of /ɛ̃/ and /œ̃/. Many methods have been proposed to examine overlap in the study of vowel splits and mergers; see Nycz and Hall-Lew (2013) for discussion of Euclidean distance, mixed model regression, spectral overlap, and the Pillai-Bartlett trace. Following Nycz (2013), the 'mixed model regression' technique was used in the present study: for each vowel pair analysed, and for each speaker, a mixed-effects regression analysis was undertaken in the R environment using the Rbrul text-based interface (Johnson, 2008, 2009). The models were constructed as follows: F1 or F2 as the dependent variable; the lexical item in which the vowel occurred was included as a random effect, 'word'; phonological environment (preceding and following) and the historically appropriate 'phoneme' were included as fixed effects. These analyses aimed explicitly to assess the extent to which 'phoneme' may predict formant values after phonological context has been taken into account, thus establishing concrete evidence for or against the /ɛ̃/∼/œ̃/ merger for individual speakers.

Subsequently, the F1 and F2 data for all speakers were normalized using the Lobanov (1971) normalization method to enable reliable statistical comparison which takes account of anatomical differences which may be related to speaker sex and age. Following normalization, the full normalized data set was submitted to statistical analysis in Rbrul. The statistical modelling technique used was mixed-effects linear regression for continuous variables which included F1 or F2 as the dependent variable, 'speaker' and 'word' as random effects to take account of variation introduced by inter-speaker differences and differing lexical items, as well as a variety of fixed-effect predictors, depending on the hypothesis being tested: phoneme, syllable type, preceding phoneme, following phoneme, speaker sex (M or F), speaker sexuality (straight or queer), and speaker year of birth. The 'syllable type' factor group contained the following factors: (i) open final syllables (_#); (ii) closed final syllables (_C#); open medial syllables (_σC). The factors of the 'preceding phoneme' and 'following phoneme' factor groups are not evenly distributed in terms of context; these factor groups have been included, however, in the statistical models in Section 5, as they may account for some of the variation observed. This will ensure that any significant results reported for the other independent variables are reliable predictors over and above the variation that is accounted for by the preceding or following phoneme. When preceding and/or following phoneme are themselves returned as significant by the modelling process, we must treat these effects with caution as the factors are not evenly distributed in such a way that we can reliably investigate the influence of preceding or following phoneme on vowel quality. The number of tokens per cell (or factor) is thus much more evenly distributed for 'syllable type' than for the phonological context factor groups.

It must also be noted that 'syllable type' cannot be included in regression models alongside 'preceding phoneme' and 'following phoneme' as, due to the nature of the reading and wordlist tasks, syllable type is at least partially multicollinear with phonological environment; they are correlated with each other. For example, final open syllables (_#) always correspond to following phoneme /p/, from the word *pour* in the carrier phrase and word initial tokens always correspond to preceding phoneme /t/, from the word *dites* in the carrier phrase. Additionally, certain syllabic contexts co-occur, to some extent, with particular combinations of preceding and

Table 3. Token counts for French nasal vowels by 'sex' and 'sexuality'

Nasal vowel	/ɛ̃/		/œ̃/		/ɑ̃/		/ɔ̃/		Total
Speaker sex	M	F	M	F	M	F	M	F	
Straight	102	102	66	66	111	110	87	87	731
Queer	102	102	66	66	110	110	87	87	730
Total	204	204	132	132	221	220	174	174	1461

following phonemes, as a result of the restricted range of lexical items included in the reading passage and wordlist tasks. For example, for the word *sainte*, the syllable type _C# has preceding /s/ and following /t/ for all speakers. Interdependencies such as these between independent variables should never be considered together (Tagliamonte and Baayen, 2012: 24–25) because unsolvable computational problems often arise resulting in various kinds of error messages from the variable rule programme. As such, separate models using 'syllable type' on one hand, and preceding and following phonological environment on the other, were performed; the models that accounted for the most variance in the data set are reported in Section 5. For all statistical tests, two alpha levels for statistical significance were used in the regression analyses: significant ($p < .05$); highly significant ($p < .01$).

5. RESULTS

The sociolinguistic distribution, by sex and sexuality, of the vowel tokens extracted for analysis are presented in Table 3; in total, 1461 tokens of the nasal vowels were submitted to acoustic analysis. The normalized F1 and F2 z-score data for all speakers is presented in Figure 3; raw Hz means and standard deviations, distinguished by speaker sex and sexuality, can additionally be consulted in Figure A1 in Appendix 1.

This section first examines evidence in the raw (Hz) data for the merger of the front unrounded and rounded nasal vowels, /ɛ̃/ and /œ̃/, to /ɛ̃/, before investigating evidence for ongoing sound change in the nasal vowel system as part of a counter-clockwise nasal vowel chain shift in Parisian French: /ɛ̃/ → /ɑ̃/ → /ɔ̃/ → [õ].

5.1. Front nasal vowel merger /ɛ̃/~/œ̃/

Table 4 presents the results of the mixed-model regression vowel overlap analysis of the raw (Hz) data for F1 and F2, performed for individual speakers on the /ɛ̃/ and /œ̃/ vowels. Non-significant *p*-values indicate that there is no significant difference in the phonetic realisation of /ɛ̃/ and /œ̃/, and that they are thus represented by a merged phonetic and phonological category, /ɛ̃/. This is the case for both formants for all queer female speakers (A, B, and C), all straight female speakers (D, E, and F), for two queer male speakers (G and I), and for two straight male speakers (J and L); ten of the twelve speakers in the sample therefore show no evidence for the phonetic separation of /ɛ̃/ and /œ̃/.

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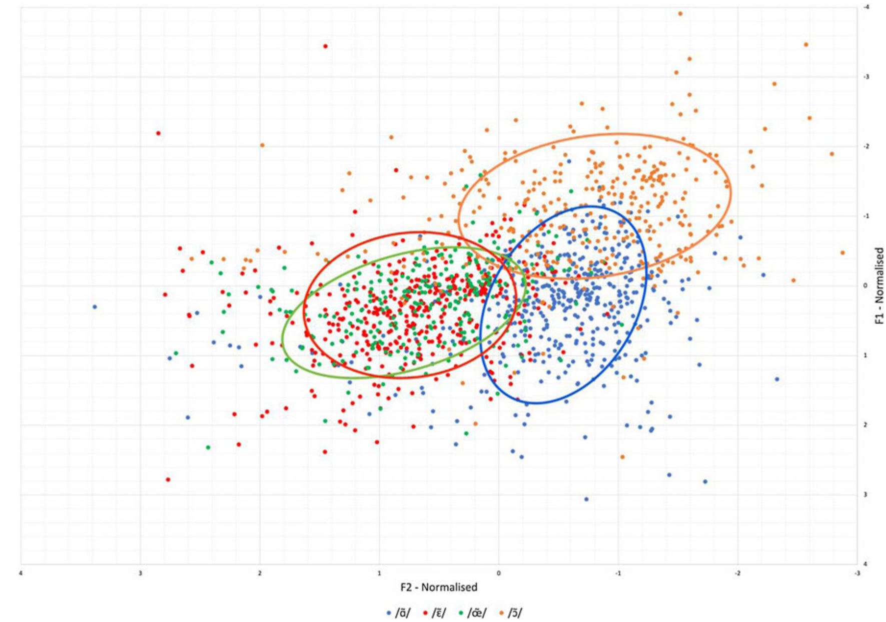

Figure 3. All speakers: normalized F1 and F2 z-scores for all nasal vowels, with 95% confidence intervals.

One queer male speaker (H) has F1 values for /ɛ̃/ and /œ̃/ that are returned by the regression analysis as significantly different ($p = .02$). Another straight male speaker (K) has both F1 and F2 values for /ɛ̃/ and /œ̃/ that are significantly different ($p = .02$ for F1; $p = .01$ for F2). For Speaker H, the mean F1 difference is 8 Hz; for Speaker K the mean F1 difference is 185 Hz and the mean F2 difference is 20 Hz. Labov (2001: 415) suggests that hearers can distinguish phonetic differences as small as 75-100 Hz on the F2 dimension, but that below 200 Hz, tokens are usually perceived as the same (Labov, 2001: 378). Rosner and Pickering (1994: 55) propose a method for establishing 'just noticeable differences' phonetically, suggesting a Weber fraction of greater than .05 as the maximal baseline for a noticeable phonetic difference. Weber's Law states that the size of the just noticeable difference is a constant proportion of the original stimulus size and Weber fractions are used to numerically represent this relationship. The Weber fraction (Δ) is $(F_a - F_b)/F_b$, where F = formant value; this fraction indicates likely false positive results, where the regression analysis has returned a significant *p*-value for an /ɛ̃/~/œ̃/ phonetic distinction, but where the mean phonetic difference is not actually noticeable. For Speaker H, $\Delta = .02$ for F1 and, for Speaker K, $\Delta = .32$ for F1 and $\Delta = .02$ for F2. The mean difference of 8 Hz for Speaker H's F1 values for /ɛ̃/ and /œ̃/ is therefore unlikely to be a noticeable difference, indicating that they too seem to have a merged phonetic and phonological category for /ɛ̃/ and /œ̃/. Equally, the 20 Hz difference on the F2 dimension for Speaker K is below the threshold for being a just noticeable difference. Speaker K's mean F1 difference, between /ɛ̃/ and /œ̃/, of 185 Hz is associated with a Weber fraction value of .32, indicating that this significant difference is indeed noticeable. For Speaker K, they produce /ɛ̃/ vowels with

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Table 4. Individual speakers (raw data): Vowel overlap results for front nasal vowels (F1 and F2), with Weber fractions (Δ)

Speaker	Sex	Sexuality	Mean F1 difference /ɛ̃/~/œ̃/	*p*-value	Δ	Mean F2 difference /ɛ̃/~/œ̃/	*p*-value	Δ
A	F	Queer	27 Hz	.96	.04	26 Hz	.05	.02
B	F	Queer	9 Hz	.66	.01	7 Hz	.05	.01
C	F	Queer	7 Hz	.41	.01	80 Hz	.79	.07
D	F	Straight	34 Hz	.96	.06	7 Hz	.20	.01
E	F	Straight	68 Hz	.37	.11	45 Hz	.62	.04
F	F	Straight	49 Hz	.50	.07	31 Hz	.60	.02
G	M	Queer	8 Hz	.40	.01	61 Hz	.41	.05
H	M	Queer	8 Hz	**.02**	.02	2 Hz	.53	.00
I	M	Queer	27 Hz	.10	.05	83 Hz	.18	.07
J	M	Straight	4 Hz	.50	.01	30 Hz	.94	.02
K	M	Straight	185 Hz	**.02**	.32	20 Hz	**.01**	.02
L	M	Straight	1 Hz	.43	.00	25 Hz	.84	.02

significantly higher F1 values than for /œ̃/, indicating that /ɛ̃/ is significantly lower in the acoustic vowel space than /œ̃/.

The Weber fraction analysis thus detected false positive *p*-values for Speaker H (F1) and Speaker K (F2). It is also necessary to examine any potentially false negative *p*-values, or phonetic differences that are returned as non-significant by the regression analysis but for which the mean Hz difference is related to a Weber fraction greater than .05. A Weber fraction greater than .05 indicates that the mean difference for /ɛ̃/ and /œ̃/ between F1 or F2 is likely to be perceptible or, at least, that it is above the maximum threshold for just noticeable differences. That said, while a mean difference between /ɛ̃/ and /œ̃/ may be noticeable, a non-significant *p*-value associated with this mean difference indicates that the observed mean difference is likely due to chance. There are three mean F1 differences and two mean F2 differences in Table 4 for which $\Delta > .05$, and for which $p > .05$: Speaker D (F1: $\Delta = .06$; $p = .1$), Speaker E (F1: $\Delta = .11$; $p = .4$), Speaker F (F1: $\Delta = .07$; $p = .5$), Speaker C, (F2: $\Delta = .07$; $p = .8$), Speaker I (F2: $\Delta = .07$; $p = .2$). For these five speakers, the Weber fractions indicate that the mean difference can technically be heard, but the associated *p*-values do not indicate that this noticeable difference is predictable, given the data observed. In the cases above, where false positives were detected for Speakers H and K, the mean difference was not due to chance, but it was also not great enough to be perceived.

In sum, the mixed-model regression analysis of vowel overlap and the establishment of Weber fractions for just noticeable differences suggests that, with the exception of F1 for Speaker K, a straight male speaker, all other speakers (11/12) show evidence for the merger of /ɛ̃/ and /œ̃/ to /ɛ̃/, indicating that their phonological inventory is characteristic of the typical three-term Parisian nasal

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vowel system: /ɛ̃/, /ɑ̃/ and /ɔ̃/. For Speaker K, the youngest of the straight male speakers at 21 years of age, /ɛ̃/ is realised phonetically as significantly lower than /œ̃/ in the acoustic vowel space. This speaker is originally from Metz, Moselle, which is in the supralocal area as defined by Pooley (2006: 385), though it borders an area where supralocal 'divergent forms' occur variably (2006: 385) and, because of his age, his period of residence is Paris is reduced, perhaps explaining his resistance to this widespread supralocal merger on the F1 dimension.

5.2. Counter-clockwise nasal vowel chain shift

The results presented in Section 5.1 indicate that, across the sample, the phonological inventory of the speakers involves phonetic distinctions between three, not four, nasal vowel phonemes: /ɛ̃/, /ɑ̃/ and /ɔ̃/. This section considers evidence for progression of the counter-clockwise nasal vowel shift in Parisian French by examining F1 and F2 data for all three vowels, noting that the original data set has been recoded such that /ɛ̃/ now represents a merged phoneme, containing all data originally coded separately for /ɛ̃/ and /œ̃/. This includes /ɛ̃/ data for Speaker K (see Section 5.1).

As discussed in Section 3, the nasal vowel chain shift in Parisian French involves the lowering and backing of /ɛ̃/, the backing and raising of /ɑ̃/, and the raising of /ɔ̃/, such that: /ɛ̃/ → /ɑ̃/ → /ɔ̃/ → [õ]. In acoustic terms, the following diagnostics for the progression of these systematic linguistic changes are as follows:

(i) /ɛ̃/-lowering: higher F1 values;
(ii) /ɛ̃/-backing: lower F2 values;
(iii) /ɑ̃/-raising: lower F1 values;
(iv) /ɑ̃/-backing: lower F2 values;
(v) /ɔ̃/-raising: lower F1 values.

These diagnostics imply that lowering and backing for a given vowel are completely distinct processes, but this is not necessarily the case. Before examining evidence for the diagnostics (i) – (v), it is first necessary to investigate Hansen's claim that the change in progress is more advanced in final (stressed) syllables (2001: 45). For all three nasal vowels, mixed-effect regression models were performed of F1 and F2 (separately) as the dependent variable, 'speaker' and 'word' as random effects, and the following fixed effects: 'speaker sex', 'speaker sexuality', 'speaker year of birth', and 'syllable type'. For all regression models, syllable type was returned as a non-significant predictor of F1 and F2 ($p > .05$), indicating that there is no significant distinction in formant values between tokens in final, stressed position (both open and closed), and those in medial position. As syllable type and phonological environment are partially multicollinear (see Section 4.4), the remainder of the mixed-effects regression models presented in this section exclude 'syllable type' as an independent variable and instead include 'preceding phonological environment' and 'following phonological environment' in the analyses.

Beginning with F1 values for /ɛ̃/, in order to investigate evidence for (i) /ɛ̃/-lowering, normalized data for all speakers was submitted to mixed-effect regression analysis, the results of which are presented in Table 5. F1 was included as the

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Table 5. All speakers (normalized data): Regression analysis of F1 values for /ɛ̃/ (merged), with 'speaker' and 'word' as random effects

Dependent variable = F1 (/ɛ̃/) N = 672 Grand mean = 0.337		R^2: 0.115 Degrees of freedom: 25		
Factor group	Factor	Coefficient	N	*p*-value
Speaker sex	Female	+0.121	336	.04
	Male	–0.121	336	

Note: Non-significant factor groups were: preceding phoneme (*p* = .08), speaker sexuality (*p* = .09), speaker year of birth (*p* = .34), and following phoneme (*p* = 1.0).

dependent variable, 'speaker' and 'word' as random effects, and the following fixed-effect independent variables: 'speaker sex' [male; female], 'speaker sexuality' [straight; queer], 'speaker year of birth' [continuous], 'preceding phoneme' [various], and 'following phoneme' [various]. The aim of this model, and indeed the subsequent models, is to ascertain the extent to which the social factors of sex and sexuality can predict the formant values observed when phonological context (preceding and following phonemes) has been taken into account. As such, significant results for 'preceding phoneme' and 'following phoneme' will be reported, when relevant, but will not form part of the main argument.

The regression analysis of F1 values for /ɛ̃/ returned speaker sex as a significant predictor (see Table 5). Female speakers, both straight and queer, are shown to have significantly higher F1 values than male speakers, both straight and queer. Therefore, female speakers demonstrate more evidence for (i) /ɛ̃/-lowering than males speakers, and thus more evidence for progression of this sound change. Considering the data for male and female speakers separately, no significant predictors were returned for male speakers but, for female speakers, preceding phoneme was a significant predictor (*p* = .01), such that the progression of the sound change was shown to be more probable following /s/, /v/, /l/, and /p/.

The /ɛ̃/ regression analysis of F2 values returned sex, sexuality, and year of birth as non-significant, indicating that none of the social factors considered were predictors of (ii) /ɛ̃/-backing. Phonological environment was, however, shown to have a significant effect of (ii) /ɛ̃/-backing. For following phoneme (*p* = .00), lower F2 values were realized before labials (/m/ and /p/) and apical consonants (/t/, /z/, /d/), and before a pause (_#), and for preceding phoneme (*p* = .00), lower F2 values were realized following labials (/f/, /v/, /m/, /p/), apicals (/ʒ/, /t/, /s/), and /ʁ/.

Table 6 considers evidence for (iii) /ɑ̃/-raising. F1 values for /ɑ̃/ are shown to be significant predicted by speaker sex, with male speakers having significantly higher F1 values than female speakers. Lower F1 values indicate /ɑ̃/ vowels that are more close or higher in the vowel space, thus showing that female speakers demonstrate more evidence for the sound change.

Considering the /ɑ̃/ data for male and female speakers separately, year of birth was returned as a significant predictor of F1 (see Table 7), such that the higher the year of birth, the lower the F1 value. For every year increase, F1 values reduce by 0.044. This is a relatively small effect but it suggests that, for male speakers (both

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Table 6. All speakers (normalized data): Regression analysis of F1 values for /ɑ̃/, with 'speaker' and 'word' as random effects

Dependent variable = F1 (/ɑ̃/) N = 441 Grand mean = 0.309		R^2: 0.121 Degrees of freedom: 27		
Factor group	Factor	Coefficient	N	*p*-value
Speaker sex	Male	+0.182	221	.01
	Female	–0.182	220	

Note: Non-significant factor groups were: speaker year of birth (p = .11). preceding phoneme (p = .14), following phoneme (p = .15), and speaker sexuality (p = .36).

Table 7. Male speakers (normalized data): Regression analysis of F1 values for /ɑ̃/, with 'speaker' and 'word' as random effects

Dependent variable = F1 (/ɑ̃/) N = 221 Grand mean = 0.462		R^2: 0.178 Degrees of freedom: 26		
Factor group	Factor	Coefficient	N	*p*-value
Speaker birth year	continuous +1	–0.044	221	.04

Note: Non-significant factor groups were: following phoneme (p = .14), preceding phoneme (p = .69), and speaker sexuality (p = .73).

straight and queer), younger speakers show more evidence for the ongoing sound change (iii) /ɑ̃/-raising. For female speakers, sex, sexuality, and year of birth were returned as non-significant predictors of F1, indicating that none of the social factors considered were predictors of (iii) /ɑ̃/-raising. /ɑ̃/-raising was, however, shown to be favoured, for female speakers, when the vowel precedes /s/ and /b/ (p = .04) and when the vowel follows /m/, /d/, /ʃ/, /ʁ/, /l/, and /j/ (p = .02).

The /ɑ̃/ regression model for F2 is presented in Table 8; this analysis shows that (iv) /ɑ̃/-backing is significantly favoured by sex, sexuality, preceding phoneme, and following phoneme. Female speakers have significantly higher F2 values than male speakers and queer speakers have significantly higher F2 values than straight speakers, but the magnitude of the effect is small in both cases, showing very weak effects. In order to probe deeper into the sex and sexuality effects, female and male speakers were considered separately, as were straight and queer speakers. When female speakers' F2 values were modelled separately, speaker sexuality was returned as a significant result (p = .01), such that queer women (+0.129) had higher F2 values than straight women (–0.129). When queer speaker's F2 values were modelled separately, speaker sex was returned as a significant result (p = .01), such that queer women (+0.118) had higher F2 values than queer men (0.118). The models considering only male speakers and only straight speakers did not show any equivalent effects. In sum, since /ɑ̃/-backing involves F2-lowering, straight women and queer men showed more robust evidence for the ongoing change than queer women. Additionally, the /ɑ̃/ regression model for F2 showed that the /ɑ̃/-backing

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Table 8. All speakers (normalized data): Regression analysis of F2 values for /ɑ̃/, with 'speaker' and 'word' as random effects

Dependent variable = F2 (/ɑ̃/) N = 441 Grand mean = −0.0507		R^2: 0.097 Degrees of freedom: 27		
Factor group	Factor	Coefficient	N	*p*-value
Preceding phoneme	/n/	+0.457	12	.02
	/ʃ/	+0.321	24	
	/j/	+0.273	12	
	/b/	+0.144	11	
	/t/	+0.105	144	
	/d/	+0.057	12	
	/l/	+0.036	70	
	/f/	−0.068	12	
	/s/	−0.110	24	
	/m/	−0.214	24	
	/v/	−0.260	12	
	/ʁ/	−0.290	48	
	/p/	−0.451	36	
Following phoneme	/k/	+0.466	12	.03
	/p/	+0.335	89	
	_#	+0.257	29	
	/t/	+0.236	42	
	/ʒ/	+0.163	6	
	/d/	+0.080	12	
	/g/	−0.039	6	
	/b/	−0.106	12	
	/s/	−1.392	12	
Speaker sex	Female	+0.071	220	.04
	Male	−0.071	221	
Speaker sexuality	Queer	+0.063	220	.045
	Straight	−0.063	221	
Non-significant factor groups were: speaker year of birth (*p* = .80).				

change is significantly favoured by preceding /n/, /ʃ/, /j/, /b/, /t/, /d/, and /l/ and by following /k/, /p/, pauses (_#), /t/, /ʒ/, and /d/.

For the back rounded nasal vowel /ɔ̃/, the regression model for F1 is presented in Table 9, where speaker sexuality and following phoneme are returned as significant

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Table 9. All speakers (normalized data): Regression analysis of F1 values for /ɔ̃/, with 'speaker' and 'word' as random effects

Dependent variable = F1 (/ɔ̃/) N = 348 Grand mean = −1.043		R^2: 0.394 Degrees of freedom: 21		
Factor group	Factor	Coefficient	N	*p*-value
Following phoneme	/p/	+0.224	132	.00
	/d/	+0.206	36	
	/g/	+0.203	12	
	/b/	+0.147	36	
	/s/	+0.006	12	
	/ʒ/	−0.343	36	
	_#	−0.443	60	
	/t/	−1.031	24	
Speaker sexuality	Straight	+0.243	174	.01
	Queer	−0.243	174	

Note: Non-significant factor groups were: preceding phoneme ($p = .06$), speaker year of birth ($p = .72$), and speaker sex ($p = .95$).

predictors of F1; lower F1 values are indicative of (v) /ɔ̃/-raising. Regarding sexuality, straight speakers (male and female) are shown to have much higher F1 values than queer speakers (male and female), and the magnitude of this effect is substantial (±0.243). Queer speakers are shown, therefore, to exhibit more advanced variants of this change, /ɔ̃/-raising, in their speech. Additionally, higher vowels are favoured by certain plosive consonants (/p/, /d/, /g/, and /b/). The analysis of F2 values for /ɔ̃/ revealed there to be no effect of social factors on vowel pronunciation.

To revisit the diagnostics (i) – (v) for the counter-clockwise nasal vowel chain shift in Parisian French, we can summarize the findings in Section 5 as follows:

(i) /ɛ̃/-lowering change is led by both straight and queer female speakers;
(ii) /ɛ̃/-backing change is favoured in certain phonological environments;
(iii) /ɑ̃/-raising change is led by both straight and queer female speakers and by younger male speakers;
(iv) /ɑ̃/-backing change is led by straight women and queer men;
(v) /ɔ̃/-raising change is led by queer women and queer men.

6. DISCUSSION

The Parisian nasal vowel shift involves the counter-clockwise rotation of three vowels. This rotation is systemic and functional in nature in that the movement of one vowel encourages the movement of the other vowels in the chain. In a push

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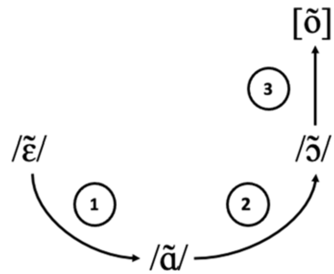

Figure 4. Parisian nasal vowel chain shift (push chain).

chain shift, the first stage of the change involves the encroachment of the first vowel to move on the phonetic space of the second vowel, which then moves away to preserve phonemic contrasts in the vocalic system, and so on. In a pull chain shift, the movement of the first vowel in the chain creates an open space in the system, which the second vowel then occupies.

Figure 4 presents a schematic model of the Parisian nasal vowel shift as a push chain: stage 1 involves the lowering and backing of /ɛ̃/; stage 2 involves the backing and raising of /ɑ̃/; stage 3 involves the raising of /ɔ̃/. In this scenario, the first stage of the change, is led by female speakers (both straight and queer): this is primarily true for /ɛ̃/-lowering, with backing favoured by specific phonological environments. This finding aligns with Labov's principle of linguistic change which accounts for the behaviour of women in situations of change from below: women have been show repeatedly to be more progressive and innovative than men when sound changes are internally motivated. The second stage of the chain shift is also led by female speakers (both straight and queer), but younger male speakers (of both sexualities) may also be involved. The backing of /ɑ̃/ (stage 2) has been shown to be led primarily by straight women and queer men. Labov's data-driven principles that account for the linguistic behaviour of women often emphasize that women are prestige-oriented in their linguistic choices, in particular in situations of stable sociolinguistic variation and change from above. The pervasive nature of this behaviour has, over time, led to a situation where the use of a certain linguistic variants by women can cause the feature to become imbued with prestige, simply because women have chosen to use it (Milroy et al., 1994: 351; Cheshire, 2002: 429-430). It may be the case, therefore, that younger male speakers and queer men orient to this covert prestige in stage 2, adopting the /ɑ̃/-raising and /ɑ̃/-backing changes independently of the systemic rotation. The adoption of individual elements of a chain shift in a somewhat off-the-shelf fashion has, for example, been noted in Michigan for the Northern Cities Shift (NCS) and constitutes a 'disconnection of [the] components' (Wagner et al., 2016: 177) of the systemic rotation of the vowels. The final stage of the change, which involves the raising of /ɔ̃/, is led by queer speakers, both men and women. In the push chain scenario, participation in stage 3 demonstrates linguistic behaviour that is particularly progressive in nature, indicating that queer men and queer women are spearheading the final stage of the systemic change. In sum, the findings considered here permit the tentative advancement of the following testable data-driven principles:

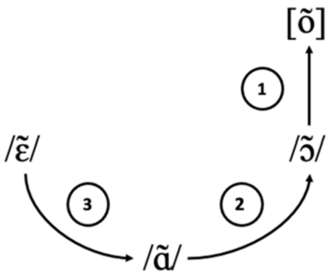

Figure 5. Parisian nasal vowel chain shift (pull chain).

1. In situations of change from below, queer women pattern with straight women in using a higher frequency of innovative forms than men.
2. In situations of change from below, when queer women pattern with men, it is with queer, not straight, men.
3. In situations of change from below, queer men and women appear to be particularly progressive in the final stages of the change, using a higher frequency of innovative variants than straight men and women.

Figure 5 presents a schematic representation of the Parisian nasal vowel shift as a pull chain: stage 1 involves the raising of /ɔ̃/; stage 2 involves the backing and raising of /ɑ̃/, to fill the space previously occupied by /ɔ̃/; stage 3 involves the lowering and backing of /ɛ̃/, to fill the space formerly occupied by /ɑ̃/. This chain shift is widely considered to be a push chain, especially since the raising of /ɔ̃/ is not consistent with the acoustic effects of nasalization, Carignan (2014: 31, 2015: 36); as such, there is no acoustic motivation for stage 1 of the pull chain. Additionally, the account of a push chain identified above is more probable given the information we already have on the progressive behaviour of women in situations of language change. Nonetheless, in a pull chain scenario, queer people (both men and women) would be seen to initiate the systemic change, demonstrating innovation in the raising of /ɔ̃/ to [õ] at stage 1. As a functional reaction to the raising of /ɔ̃/, /ɑ̃/ backs and raises into the free phonetic space created: stage 2 of the change would involve backing by straight women and queer men, and raising of the vowel would be led led by women (straight and queer) and younger men. The actors involved in stage 1, queer men and women, would also therefore be shown to be progressive in actioning the direct response to the movement of /ɔ̃/: queer men favouring the backing of /ɑ̃/ and queer women favouring the raising of /ɑ̃/. Straight women are, however, shown to lead both backing and raising of /ɑ̃/ at stage 2. If this was a pull chain, the behaviour of straight women may be a response to the innovation demonstrated by queer speakers at stage 1, though we may also expect them to adopt the stage 1 change at a higher rate, the raising of /ɔ̃/. The final stage of the change in the pull chain scenario would be led by women (both straight and queer). In this scenario, we might wonder why straight women would follow the example of queer people of both sexes? The pull-chain scenario would, at the very least, presuppose that straight women have enough contact with queer people to acquire the change. This makes the pull chain scenario less likely when compared with the linguistic behaviour identified above for the push chain, in addition to the potential

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'trigger' for the systemic change identified by Carignan, (2014: 31), notably the effect of VP coupling on the acoustic realization of /ɛ̃/.

What is clear from this data overall, is that women are always involved in all stages of the change. Straight and queer women pattern together at stages 1 and 2 in the push chain scenario: this behaviour strongly refutes any dated anecdotal arguments which suppose, for example, that lesbians' linguistic behaviour approximates opposite sex norms, notably that of straight men. When the linguistic behaviour of queer women does pattern with men, it is with gay men. Together these queer allies unite, either to push the final stage of the systemic change forward (in the push chain scenario) or potentially as innovators (in the less likely pull chain scenario).

7. CONCLUSION

This study constitutes the first step in a research project which aims to provide a data-driven account of the way sexual minorities engage in mainstream language change. Analysing self-identified heterosexual speakers alongside their queer counterparts had the dual aim of documenting the progression of the Parisian nasal vowel chain shift, while also providing a baseline against which to compare evidence for the relevant changes in the speech of the queer participants. The sample considered in this article confirms established theoretical constructs in variationist sociolinguistics regarding the linguistic behaviour of women in situations of language change: women are instrumental in driving forward the changes from below considered here. The nuance afforded by the sampling technique adopted in this study, however, is that we can begin to look within the category of 'woman', at least in terms of how these women self-identify regarding their sexuality. Queer women and straight women demonstrate, on the whole, very similar linguistic behaviour; this refutes, to some extent, Pierrehumbert et al.'s (2004) suggestion that lesbians may demonstrate resistance to ongoing sound change. This similarity in the speech of queer and straight women may be due to the fact that queer women 'are more likely to identify *with* than against their gender group' (Cameron and Kulick, 2003: 96), whereas as hegemonic masculinity tends to represent a norm that gay men identify against (Cameron and Kulick, 2003: 96). Indeed, the gay men in this study sometimes pattern with straight women, during the intermediate stages of the systemic change, and sometimes pattern with queer women, in the final stages of the push chain. This confirms Munson et al.'s conjecture that gay men participate 'in ongoing sound change more readily than straight men' (2007: 430). What is striking from the overall results presented here is that straight men, at least in this small sample, are the most conservative of the groups considered in terms of driving this change from below forward. The frequent observation that men are more conservative and conforming in situations of change from below (e.g., Labov, 2001: 93) appears only to apply to straight-identified men.

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REFERENCES

Armstrong, N. and Low, J. (2008). *C'est encore plus jeuli, le Mareuc*: Some Evidence for the Spread of /ɔ/-Fronting in French. *Transactions of the Philological Society*, **106**: 1–24.

Armstrong, N. and Pooley, T. (2010). *Social and Linguistic Change in European French*. Basingstoke: Palgrave Macmillan.

Boersma, P. (2001). Praat: a System for doing Phonetics by Computer. *Glot International*, 5.9/10: 341–345.

Boersma, P. and Weenink, D. (2012). Praat: doing phonetics by computer. URL: http://www.praat.org/, retrieved September 2022, Version 6.1.09.

Cameron, D. and Kulick, D. (2003). *Language and Sexuality*. Cambridge: Cambridge University Press.

Carignan, C. (2011). Oral articulation of nasal vowels in French. In: W. S. Lee and E. Zee (eds), *Proceedings of the International Congress of Phonetic Sciences XVII*. Hong Kong: City University of Hong Kong, pp. 408–411.

Carignan, C. (2013). When nasal is more than nasal: the oral articulation of nasals vowels in two dialects of French. Unpublished doctoral thesis: University of Illinois at Urbana-Champaign.

Carignan, C. (2014). An acoustic and articulatory examination of the 'oral' in 'nasal': The oral articulatios of French nasal vowels are not arbitrary. *Journal of Phonetics*, **46**: 23–33.

Carignan, C. (2018a). Using ultrasound and nasalance to separate oral and nasal contributions to formant frequencies of nasalised vowels. *Journal of the Acoustical Society of America*, **143**: 2588–2601.

Carignan, C. (2018b). An examination of oral articulation of vowel nasality in the light of the independent effects of nasalization on vowel quality. In: Vietti, A., Spreafico, L., Mereu, D., and V. Galatà (eds.), *Studi AISV IV: Speech in the Natural Context*. Milan, Italy: Associazione Italiana Scienze della Voce, pp. 19–40.

Carignan, C., Shosted, R., Fu, M., Liang, Z.-P. and Sutton, B. (2013). The role of the tongue and pharynx in enhancement of vowel nasalization: A real-time MRI investigation of French nasal vowels. *Proceedings of INTERSPEECH 2013*: 3042–3046.

Carignan, C., Shosted, R., Fu, M., Liang, Z-P. and Sutton, B. (2015). A real-time MRI investigation of the role of lingual and pharyngeal articulation in the production of the nasal vowel system in French. *Journal of Phonetics*, **50**: 34–51.

Cheshire, J. (2002). Sex and gender in variationist research. In: Chambers, J., Trudgill, P. and N. Schilling-Estes (eds), *The Handbook of Language Variation and Change*. Oxford: Blackwell, pp. 423–443.

Cukor-Avila, P. and Bailey, G. (2013). Real time and apparent time. In: Chambers, J.K. and N. Schilling (eds), *The Handbook of Language Variation and Change*. Oxford: Blackwell, pp. 239–262.

De Mareüil, P. B., Adda-Decker, M. and Woehrling, C. (2007). Analysis of Oral and Nasal Vowel Realisation in Northern and Southern French Varieties *16th International Congress of Phonetic Sciences*, 2221–2224.

Delais-Roussarie, É and Durand, J. (2003). *Corpus et variation en phonologie du français: méthodes et analyses*. Toulouse: Presses Universitaires du Mirail.

Delvaux, V. (2009). Perception du contraste de nasalité vocalique en français. *Journal of French Language Studies*, **19**: 25–29.

Delvaux, V., Demolin, D., Harmegnies, B. and Soquet, A. (2008). The aerodynamics of nasalization in French. *Journal of Phonetics*, **36**: 576–606.

Delvaux, V., Demolin, D., Soquet, A. and Kingston, J. (2004). La perception des voyelles nasales du français. *XXVèmes Journées d'etude sur la parole*, 157–160.

Delvaux, V., Metens, T. and Soquet, A. (2002) French nasal vowels: Acoustic and articulatory properties. *Proceedings of the seventh international conference on spoken language processing*, 1: 53–56.

Durand, J. (1988). Phénomènes de nasalité en français du midi. Phonologie de dépendance et sous-spécification. *Recherches Linguistiques*, **17**: 29–54.

Durand, J. (2009). Essai de panorama critique des accents du midi. In L. Baronian and F. Martineau (eds), *Le français, d'un continent à l'autre: Mélanges offerts à Yves Charles Morin*. Québec: Presses de l'Université Laval, pp. 123–170.

Durand, J. and Eychenne, J. (2011). La phonologie des voyelles nasales: typologie, universaux et acquisition. Journées IPFC & PFC-EF.

Eckert, P. (2008). Variation and the indexical field. Journal of sociolinguistics, 12/4: 453–476.

Fónagy, I. (1989). Le français change de visage? *Revue Romane*, 24.2: 232.

https://doi.org/10.1017/S0959269523000157 Published online by Cambridge University Press

Gauchat, L. (1905). *L'unité phonétique dans la patois d'une commune*. Niemeyer.
Hansen, A. B. (1998). *Les voyelles nasales du français parisien moderne*. Copenhagen: Mueum Tusculanum Press.
Hansen, A. B. (2001). Les changements actuels des voyelles nasales du français parisien: Confusions ou changement en chaîne ?. *La linguistique*, **37**: 33–48.
Hawkey, J. (2016). Developing discussion of language change into a three-dimensional model of linguistic phenomena. Language and Linguistics Compass, 10/4: 176–190.
Johnson, D. E. (2009). Getting off the Goldvarb Standard: Introducing Rbrul for Mixed-Effects Variable Rule Analysis. *Language and Linguistics Compass*, **3.1**: 359–383.
Johnson, Daniel. E. (2008). Rbrul. URL: http://www.ling.upenn.edu/~johnson4/Rbrul.R, retrieved September 2022).
Labov, W. (1990). The intersection of sex and social class in the course of linguistic change. *Language Variation and Change*, **2**: 205–254.
Labov, W. (2001). *Principles of linguistic change Volume 2: Social factors*. Oxford: Blackwell.
Léon, P. R. (1983). Dynamique des changements phonétiques dans le français de France et du Canada. *La Linguistique*, 19.1: 13–28.
Lobanov, B. M. (1971). Classification of Russian Vowels Spoken by Different Speakers. *Journal of the Acoustical Society of America*, **49**: 606–608.
Longchamp, F. (1979). Analyse acoustique des voyelles nasales françaises. Verbum: Revue de Linguistique, 2/9: 9–54.
Maeda, S. (1982). Acoustic correlates of vowel nasalization: A simulation study. *Journal of the Acoustical Society of America*, **72**: 102.
Maeda, S. (1990). Compensatory articulation during speech: Evidence from the analysis and synthesis of vocal-tract shapes using an articulatory model. In W. J. Hardcastle and A. Marchal (eds), *Speech production and speech modelling*. Dordrecht: Kluwer Academic, pp. 131–149.
Maeda, S. (1993). Acoustics of vowel nasalization and articulatory shifts in French nasal vowels. In M. K. Huffman and R. A. Krakow (eds), *Nasals, Nasalization, and the Velum*. San Diego: Academic Press, pp. 147–170.
Malderez, I. (1991). Neutralisation des voyelles nasales chez les enfants d'Île-de-France. *Actes du XIIe ICPhS, Aix-en-Provence*, p. 174–177.
Martinet, A. (1958). C'est jeuli, le Mareuc!. *Romance Philology*, **11**: 345–355.
Mettas, O. (1973). Les réalisations vocaliques d'un sociolecte parisien. *Travaux de l'Institut de phonétique de Strasbourg*, **5**: 1–11.
Milroy, J., Milroy, L., Hartley, S. and Walshaw, D. (1994). Glottal stops and Tyneside glottalization: Competing patterns of variation and change in British English. *Language Variation and Change*, **6**: 327–358.
Milroy, L. and Gordon, M. (2003). *Sociolinguistics: Method and Interpretation*. Oxford: Blackwell.
Montagu, J. (2004). Les cibles articulatoires 'sous-jacentes' aux voyelles nasales en français parisien: indices perceptifs des changements. *Actes des VIIèmes RJC ED268*, 47–50.
Montagu, J. (2007). Analyse acoustique et perceptive des voyelles nasales et nasalisées du français parisien. Unpublished doctoral thesis: Université Paris III.
Mooney, D. (2016a). 'C'est jeuli, la Gasceugne!' L'antériorisation du phonème /ɔ/ dans le français régional du Béarn. French Studies, 70/1: 61–81.
Mooney, D. (2016b). Transmission and diffusion: Linguistic change in the regional French of Béarn. *Journal of French Language Studies*, **26**: 327–352.
Mooney, D. and Hawkey, J. (2019). The variable palatal lateral in Occitan and Catalan: linguistic transfer or regular sound change? *Journal of French Language Studies*, **29**: 281–303.
Munson, B. and Babel, M. (2007). Loose Lips and Silver Tongues, or, Projecting Sexual Orientation Through Speech. Language and Linguistics Compass, 1/5: 416–449.
Munson, B., McDonald, E. C., DeBoe, N. L. and White, A. R. (2006). The acoustic and perceptual bases of judgments of women and men's sexual orientation from read speech. *Journal of Phonetics*, **34**: 202–240.
Nycz, J. (2013). New contrast acquisition: methodological issues and theoretical implications. *English Language and Linguistics*, **17**: 325–357.

Nycz, J. and Hall-Lew, L. (2013). Best practices in measuring vowel merger. *The Journal of the Acoustical Society of America*, **134**: 4198–4198.

Ohala, John. 1989. Sound change is drawn from a pool of synchronic variation. In: *Language Change: Contribution to the study of its causes*, ed. by Leiv Breivik and Jahr Ernst, Berlin: De Gruyter, pp. 173–198.

Pierrehumbert, J., Bent, T., Munson, B., Bradlow, A. R. and Bailey, J. M. (2004). The influence of sexual orientation on vowel production. *Journal of the Acoustical Society of America*, **116**: 1905–1908.

Podesva, R. J. and Kajino, S. (2014). Sociophonetics, Gender, and Sexuality. In: Ehrlich, S., Meyerhoff, M. and J. Holmes (eds), *The Handbook of Language, Gender, and Sexuality*, Oxford: Wiley-Blackwell, pp. 103–122.

Pooley, T. (2006). On the Geographical Spread of Oïl French in France. *Journal of French Language Studies*, **16**: 357–90.

Queen, R. (2007). Sociolinguistic Horizons: Language and Sexuality. Language and Linguistic Compass, 1/4: 314–330.

Queen, R. (2013). Gender, Sex, Sexuality, and Sexual Identities. In: J.K. Chambers and N. Schilling (eds), *The Handbook of Language Variation and Change*. Oxford: Wiley-Blackwell, pp. 368–387.

Rosner, B. S. and Pickering, B. (1994). *Vowel Perception and Production*. Oxford: Oxford University Press.

Smyth, R. and Rogers, H. (2002). Phonetics, Gender, and Sexual Orientation. Actes de l'ACL.

Tagliamonte, S. A. and Baayenm R. H. (2012). Models, Forests and Trees of York English: *Was/were* Variation as a Case Study for Statistical Practice. *Language Variation and Change*, **24**:2: 135–178.

Teston, B. and Demolin, D. (1997). Aspects dynamiques et articulatoires des voyelles nasales du français. *Travaux de l'Institut Phonétique d'Aix*, **18**: 47–59.

Wagner, S. E., Mason, A., Nesbitt, M., Pevan, E. and Savage, M. (2016). Reversal and re-organization of the Northern Cities Shift in Michigan. *University of Pennsylvania Working Papers in Linguistics*, **22**: 172–179.

Waksler, R. (2001). Pitch range and women's sexual orientation. *Word*, **52**: 69–77.

Walter, H. (1994). Variétés actuelles des voyelles nasales du français, Diachronie et variation linguistique. In: R. van Deyck (ed.), *Communication and Cognition*, p. 223–236.

Woehrling, C. and Boula de Mareüil, P. (2006) Identification d'accents régionaux en français: perception et catégorisation. *Bulletin PFC*, **6**: 89–103.

Appendix 1

(i) Reading passage task:
Allez, mais vous ***mentez*** (/ɑ̃/)! Vous ne faites pas assez d'exercices. Sans ***attendre*** (/ɑ̃/) que le remords vous ***ronge*** (/ɔ̃/), mettez ce bonnet ***brun*** (/œ̃/) de laine sur vos cheveux ***blonds*** (/ɔ̃/). En route ! Et essayez d'***atteindre*** (/ɛ̃/) ce petit ***pont*** (/ɔ̃/). ***Pincez*** (/ɛ̃/) bien les lèvres qu'aucune ***plainte*** (/ɛ̃/) de douleur ne s'échappe ; faites les ***plein*** (/ɛ̃/) : respirez à ***fond*** (/ɔ̃/). ***Épongez*** (/ɔ̃/) votre ***front*** (/ɔ̃/). Plus vous ***montez*** (/ɔ̃/), plus la ***plante*** (/ɑ̃/) de vos pieds devient le ***plomb*** (/ɔ̃/). ***Pensez*** (/ɑ̃/) bien que la marche, c'est ***commun*** (/œ̃/) ! Beaucoup le pratiquent. ***Maintenant*** (/ɑ̃/), plus ***rien*** (/ɛ̃/) ne vous arrête. Et c'est en ***riant*** (/ɑ̃/) que vous arrivez au sommet, sans trop savoir ***comment*** (/ɑ̃/), et fière comme un ***paon*** (/ɑ̃/). C'est un succès ***franc*** (/ɑ̃/). ***Maintenons*** (/ɔ̃/) ce ***plan*** (/ɑ̃/). Continuez ces activités physiques durant quelques semaines et cela deviendra un ***brin*** (/ɛ̃/) moins difficile. Vous ne vous ferez plus de cheveux ***blancs*** (/ɑ̃/).

(ii) Wordlist task:

Phoneme	/ɛ̃/		
Syllable type	_#	_C#	_σC
Lexical items	brin	quinze	symbole
	certain	cinq	sympathique
	matin	sainte	syndicat
	copain	empreinte	impossible
	vin	simple	intéressant
	pain	plainte	pincer
	faim	feindre	agenda
	thym	atteindre	ainsi
	enfin		vaincu
	saint		peinture
	vin (repetition)		

Phoneme	/œ̃/		
Syllable type	_#	_C#	_σC
Lexical items	un	humble	lundi
	quelqu'un	emprunte	emprunter
	aucun	défunte	remprunter
	chacun	emprunte (repetition)	emprunteur
	brun	humble (repetition)	untel
	parfum		
	à jeûn		
	commun		
	opportun		
	défunt		

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Phoneme	/ɑ̃/		
Syllable type	_#	_C#	_σC
Lexical items	cent	entre	embarras
	sang	ample	chanter
	dans	attendre	champignon
	temps	plante	ranger
	blanc	ancre	tremper
	paon	temple	entrer
	banc	angle	emporter
	franc		lentement
	vent		ambassade
	enfant		penser

Phoneme	/ɔ̃/		
Syllable type	_#	_C#	_σC
Lexical items	dont	ronde	tomber
	bon	ombre	tromper
	blond	onde	ronger
	long	bombe	(nous) montons
	son	ongle	tondeuse
	thon		
	plomb		
	pont		
	front		

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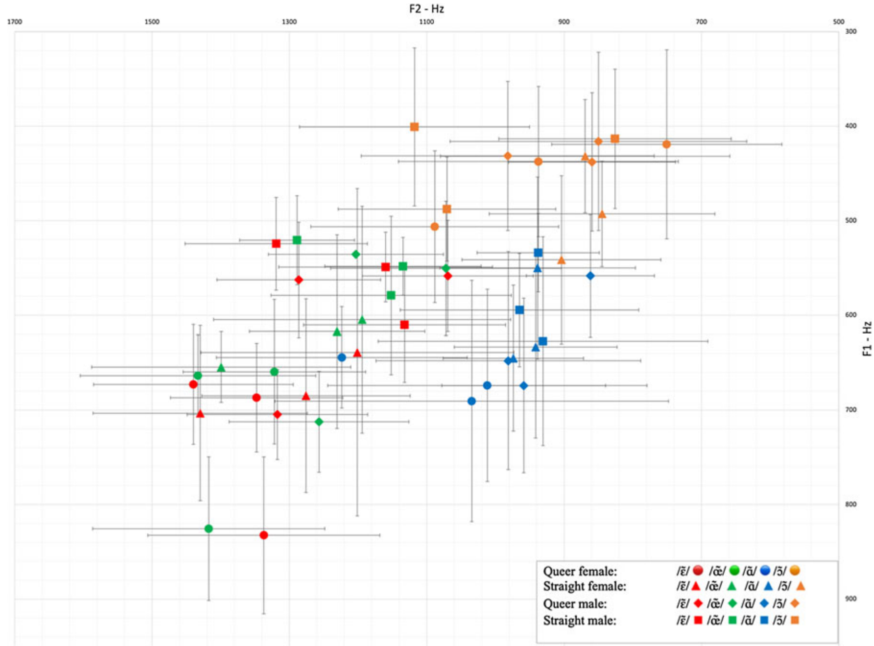

Figure A1. All speakers: raw Hz F1 and F2 means and standard deviations by speaker sex and speaker sexuality.

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