The role of F0 and Vowel Formant Dispersion in cis-gender female-male flirting interactions

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Abstract

This study explores variation in the fundamental frequency (F0) and Vowel Formant Dispersion (VFD) in cis-gender, heterosexual men (n=4) and women (n=4) within flirting interactions (compared to non-flirting interactions) on the American reality show 'Married at First Sight'. Results show that women of this study produce a rise in mean F0 while in flirting interactions and men project larger vocal tract sizes (lower VFD). Our findings suggest that women may perform greater degrees of stereotypical hyper-femininity via F0 variation when aiming to appear more attractive to a desired male partner – at least for the speakers of the current dataset. As for the men, two speakers exhibit lower F0 when in the flirting context (possibly signalling notions of hyper-masculinity) where the other two raise F0 (possibly accommodating to their romantic partner). VFD shows similarly diverse results, with all men possibly using it to signal hyper-masculinity and only two women hyper-femininity. These results suggest that speakers of this study combine features associated with stereotypically hyper-gendered speech production with aspects of vocal accommodation to their partner in their flirting strategies.

Introduction

This study investigates the role of F0 and Vowel Formant Dispersion (VFD) in heterosexual flirting interactions. In this we argue that speakers may engage in flirting acts by drawing from and performing sociocultural expectations of hegemonic masculinity/femininity as a way of signalling interest and sexual desire. Furthermore, we suggest that when such flirting strategies are not employed, speakers may instead rely on acts of accommodation (Lawson & Giles 1973) to signal interest in their romantic partner.

Speakers may perform more stereotypical gender presentations out of a desire to have their identities endorsed by the listener (Milani 2017), a desire which is perhaps most patent in a flirting interaction. Therefore, a cis-gender heterosexual individual may be likely to perform hegemonic and stereotypical gender presentations when aiming to flirt. This may be accomplished through an individual's voice (in addition to other semiotic practices), as a way to indicate desire.

Studies have shown that women with a high F0 are initially considered more attractive by heterosexual male listeners (Buckert, et al. 2010; Puts, et al. 2011). Inverse findings have been shown in regard to male vocal attractiveness, wherein those with lower F0 productions are perceived as more attractive by heterosexual female listeners (Riding, Lonsdale, & Brown 2006; Xu, et al. 2013).

However, vocal attractiveness is only one aspect of human attraction. In more long-term relationships, the importance of vocal signalling of femininity decreases, suggesting that hyper-feminine gender presentation is less important than other factors (Puts et al. 2013). Furthermore, in studies where male subjects were in direct contact with their desired partner, these show that the importance of F0 decreases when deciding the level of attractiveness (Anolli &

Ciceri, 2002; Ranganath, Jurafsky, & McFarland 2013). This suggests that vocal productions of hegemonic gender and hyper-feminisation or masculinity are most important at the early stages of a relationship. We therefore might expect women to perform some form of hyper-femininity when flirting, raising their F0, while men may conform to notions of hegemonic masculinity by producing lower F0 as one of the many semiotic resources for signalling desire. This is particularly true for the current dataset as all speakers are on a reality dating show whose main objective is to find love. Love may nevertheless come in diverse forms, and in order to create a desired connection with their partner, speakers may employ different communicative strategies in order to best form and nurture the desired connection.

VFD is less studied within the literature on vocal attractiveness than F0 is, where VFD acts as a correlate of a speaker's projected body size (Babel, McGuire, & King 2014; Xu et al. 2013). VFD may therefore indicate fitness of a mate and is rife with potential to signal willingness to engage in a 'mating context' (*e.g.*, Puts, et al. 2011) through the act of flirting.

Our research questions therefore explore whether male and female speakers employ aspects of F0 variation and VFD as a strategy to signal desire in flirting interactions, and to what extent these are employed in comparable ways within and across individuals. Furthermore, we explore if and how these flirting strategies are used differently by male and female speakers. In doing so, we present a study of vocal attractiveness in speech production with a focus on the relationship between two vocal attractiveness traits.

Methodology

Data for the present study comes from eight contestants on the American reality television show *Married at First Sight*, Season 9 (2019). In the show, a number of singles are chosen and matched by a group of experts. These singles proceed to get married on the show, prior to having met each other or having any previous knowledge of their match. Their aim is then to attempt to fall in love and build a lasting relationship over the course of eight weeks.

The speech data comes from four male and four female contestants. Our corpus is derived from 'talking head' segments where the contestant is alone speaking to a camera (non-flirting context), and romantic situations with their matched partner (flirting context). The non-flirting context used in this study occurs before they have met their match where the flirting context contains data collected from so-called "date nights".

Speakers

All speakers of the study are heterosexual cis-gender singles of different races (though no paired couples are mixed-race), and ages (27-35 years old at the time of filming). Speakers are grouped with their corresponding partner (§2.3, Table 1; wherein C# refers to the couple numbering, and M/F corresponds to the male and female contestant of that couple). C1 and C2 are Black individuals, and C3 and C4 are White individuals. C3-4 further differed by showing more overtly sexualised flirting than C1-2. While the context of being more 'overtly sexualised' may be rather subjective, it is clear from the interactions that C1-2 were more practical in their attempts to get to know their partner, whereas C3-4 had very strong sexual overtones and engaged in more openly sexual conversational topics.

F0 and Vowel Formant Dispersion

All vowels in the recordings were manually identified and segmented in Praat (Boersma & Weenink 2021). In total, we analysed 19 minutes of speech with an average of 55 seconds for each speaker in their 'talking head' segment, and an average of 1m 50s for each couple

during their flirting interactions. Each speaker had between 275 and 464 vowel tokens with an average of 406 tokens per speaker (Table 1). In total, 3250 vowels were analysed across all eight speakers, with 1361 tokens in the non-flirting context (average 170) and 1889 tokens in the flirting context (average 236).

Formant measures were extracted at the temporal midpoint of each vowel. F0 was set with a minimum pitch parameter of 50Hz, and a maximum of 600Hz for both males and females. This was done as instances of periodic creak and falsetto occurred in both the female and the male data. The results presented here are based on raw F0 values for two reasons. Firstly, these do not differ from the results available for the ST normalisation. Secondly, this is also in line with some other studies in the area of vocal attractiveness (Farley & Lafayette 2013; Fraccaro, et al. 2011). VFD analysis was conducted via F1, F2, F3, and F4 values which were also extracted at the temporal midpoint of each vowel token. Vowel normalisation was not conducted as VFD analysis relies on raw Hz values. The flirting and the non-flirting contexts are segmentally comparable.

Speaker	Flirt	Non-flirt	Total
C1:F	327	137	464
C1:M	324	137	461
C2:F	119	213	332
C2:M	289	187	476
C3:F	131	144	275
C3:M	156	192	348
C4:F	258	176	434
C4:M	285	175	460

Table 1: Number of tokens per speaker.

Analysis

The statistical analysis was conducted via Linear Mixed Effects Models in R (R Core Team 2021), using the lme4 (Bates, et al. 2014), the lmerTest (Kuznetsova 2015), and the effects packages (Fox, et al 2017). The initial models for analysis included predictors for Sex (female or male), context (flirt or non-flirt), vowel (18 levels), and couple (C1, C2, C3, C4) with a sex*context interaction and F0 or VFD as a dependent variable. Individual models were then contrasted through backward stepwise ANOVA tests by taking out an independent variable one at a time.

Due to the size of the dataset, race was not included within the statistical modelling as a discussion of potential implications of differences in race is outwith the scope of the present paper. Impressionistically, within our dataset, there are no obvious overall trends regarding flirting strategies and race *per se*, and F0/VFD variation – though the male speakers do show race-specific patterns briefly discussed below, which we attribute to the difference in approaches to flirting strategies being more or less overtly sexualised as opposed to differences in race *per se*.

Results

The mixed effects analysis reveals that across all speakers, a higher F0 is realised in the flirting context in contrast to the non-flirting one (χ^2 (4) = 22.96, p < 0.001), as shown in Fig. 1.

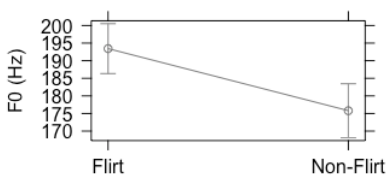

Figure 1: F0 (Hz) by speaking context for the model: F0 ~ Context * Sex + Vowel + Couple + (1|Speaker).

Overall, female speakers have higher maximum and mean F0 values in the flirting context than in the non-flirting context. Their F0 minimum is lower in the flirting context. This means that they also display a larger F0 range in the flirting context. In contrast, male speakers have lower maximum F0 values and a smaller range in the flirting context. All

of these differences are nonetheless rather small in magnitude, and the interaction between sex and context is not significant (χ^2 (1) = 2.14, p = 0.14). Fig. 2 shows the overall F0 change for all speakers across the two contexts by sex.

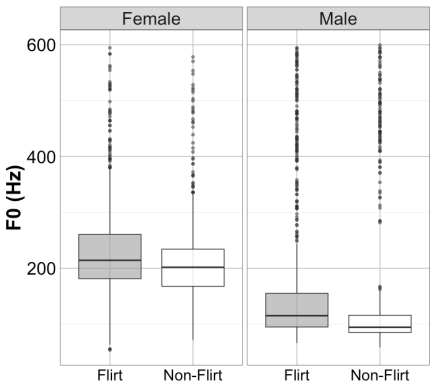

Figure 2: Comparable F0 change for all speakers by context.

While there is an overall rise in average F0 for the male speakers in the flirting context compared to the non-flirting context, as shown in Table 2 there appears to be an interesting disconnect not represented within the statistical models. Two speakers (C1:M and C2:M) follow the same patterns as the female speakers with a rise in F0 within the flirting context. The other two speakers (C3:M and C4:M) lower their F0 in the flirting context, which falls in line with previous research on male vocal attractiveness (Riding, Lonsdale, & Brown 2006; Xu, et al. 2013). Interestingly, this difference correlates with speaker race with the Black male speakers raising their F0 in flirting interactions, while the White male speakers lower their F0. Though this finding correlates with differences in race, we do not suggest that it is in fact motivated by racial differences; instead, it seems more likely that this finding is an artefact of the overall tone of the conversation given that C3-4 are more overtly sexual in contrast to C1-2.

Speaker	Flirt	Non-Flirt
C1:F	230	218
C2:F	285	191
C3:F	241	238
C4:F	211	217
C1:M	149	133
C2:M	177	117
C3:M	126	154
C4:M	163	173

Table 2: Mean F0 for each speaker by context. All values represented in Hz.

The females also offer interesting individual-specific variation. C1:F and C3:F show little visual change across the two conditions. C4:F has a higher mean in the non-flirting situation, but a larger range in the flirting situation. Finally, C2:F has a larger range and higher mean F0 value in the flirting context.

Looking at the individual couples provides an interesting insight as well. Couples 1, 3, and 4 show extremely low-magnitude change across the two conditions. However, both the female and the male speakers show a comparable magnitude of change by context, both increasing their F0 in the flirting context. C2 stands out: both speakers shift, but they do so in the same direction, and more so than the other couples (Fig. 3).

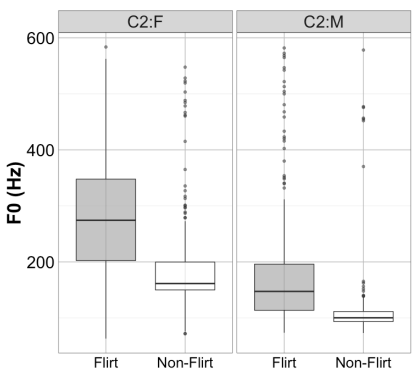

Figure 3: Comparable F0 change by context in Couple 2.

In terms of VFD, higher maximum VFD values correspond to smaller vocal tract size where lower VFD values indicate more expansive usage of the vowel space. The mixed effects analysis shows that across all speakers, VFD is lower in the flirting context (χ^2 (1) = 8.79, $p < 0.01$), which means that speakers generally project a larger size of the vocal tract when flirting, as shown in Fig. 4.

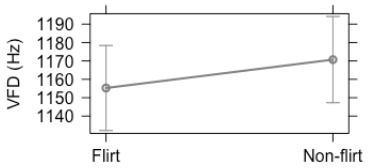

Figure 4 VFD (Hz) by speaking context for the model: VFD ~ Context * Sex + Vowel + Couple + (1|Speaker).

This effect is nevertheless driven primarily by the male speakers. Overall, females project a smaller vocal tract size (higher VFD) than males in general, although including the variable of sex does not improve the model fit (χ^2 (1) = 1.02, $p > 0.3$). The male speakers show larger and more consistent differences across the conditions, and both groups also display higher VFD range values in the flirting context.

As shown in Table 3, here too we find couple-specific patterns. The male speakers all consistently lower their VFD in the flirting context. Surprisingly, two females show the same tendency (C1:F and C3:F), albeit with a very small magnitude of the effect. On the other hand, and as expected, C2:F and C4:F project a *smaller* vocal tract in the flirting context (i.e. higher VFD). Thus, the male speakers are consistent in that they all lower their VFD in the flirting context, and they also do so with a larger magnitude of the effect than is the case for the female speakers (irrespective of the directionality of the effect in these female speakers).

Speaker	Flirt	Non-Flirt
C1:F	1100	1119
C2:F	1153	1114
C3:F	1207	1219
C4:F	1164	1160
C1:M	1209	1220
C2:M	1161	1190
C3:M	1113	1170
C4:M	1157	1197

Table 3: VFD for each speaker by speaking context. All values represented in Hz.

Discussion

Despite the limitations on the size of our dataset, the results presented here provide interesting insights into flirting strategies that may be employed by speakers. The speakers of the current study have a vested interest in making things work with their romantic partner. While in everyday interactions, individuals may flirt casually, and decide if they would like to continue seeing the person (with the option of leaving the relationship as they see fit before any commitment to the new partner is solidified), the individuals in the present study are quite literally "Married at First Sight", creating an incentive for any romantic (i.e., flirtatious) interactions to succeed.

Our results may indicate two potential flirting strategies, neither of which is mutually exclusive within an interaction. The first is that individuals may employ speech acts of hegemonic/hyper-masculinity or femininity as a way to signal willingness to engage in romantic interactions. In such interaction we find that speakers are engaging in hyper-gendered productions, which corresponds to features which are interpreted as more attractive to the opposite sex (e.g. Anolli & Ciceri, 2002; Ranganath, Jurafsky, & McFarland 2013). Overall, for the speakers of the present study, productions of hyper-femininity more consistently rely on F0 where productions of hyper-masculinity more consistently rely on VFD. Our results show that three

of the four female speakers raise their F0 in flirting interactions, which is one potential method to exhibit more stereotypically hyper-feminine productions. Two male speakers also lower F0 in the flirting interaction. The overall results for F0 fall in line with research suggesting greater degrees of attractiveness for females with higher F0 and males with lower F0 productions. Furthermore, all male speakers project a lower VFD value within the flirting context, which meshes well with the expectation that larger vocal tract size will be projected in such situations.

The two male speakers who do not lower their F0 are perhaps engaging with what we suggest is the second potential flirting strategy - accommodation. This would make sense as a potential flirting tactic given that accommodation is one known method employed in attempts to gain approval between interlocutors (e.g. Giles & Powesland 1975). We suggest that the two male speakers who do not lower their F0 are converging their speech to their romantic partner as a way of quickly accommodating to their new spouse as well as the newlywed situation they now find themselves in. This accommodation is most evident in C2, who shows the greatest change between flirting and non-flirting contexts. While two females raise their VFD values and project a smaller-sized vocal tract, the other two female speakers nevertheless do the opposite. In doing so, the female speakers with lower VFD values may be accommodating to their partner in ways they do not for F0, albeit to a lesser extent.

Our results suggest that both strategies are used by both genders to some extent. In this, speakers do not restrict themselves to one flirting strategy, with some speakers employing a combination of the two strategies within the same interaction using different vocal cues in their attempts to create a bond with their romantic partner. Of these two romance strategies, accommodation tends to emerge more frequently as a possible tactic amongst couples in more romantically-presented interactions, where more sexually-presented interactions seem to result in more productions of hyper-masculinity/femininity.

While there is no doubt that further strategies beyond those suggested here may be employed to signal romantic desire, our results show two of the potential ways in which a speaker may indicate romantic and/or sexual attraction. By utilising aspects of both accommodation and productions associated with stereotypical masculinity/femininity speakers may get the best of both worlds. On one hand they tap into notions of stereotypically attractive (fe)male voices, and on the other they can accommodate to reinforce a budding mutual kinship. These findings further highlight the usefulness of analysing more than one vocal attractiveness trait within the same speech sample.

Conclusions

Vocal attractiveness is an important aspect of the human experience. While studies of human attraction have been explored in terms of visual and olfactory attractiveness (*e.g.* Fugère, Leszczynski, & Cousins 2015), this paper has explored potential vocal strategies for ways that humans may indicate their attraction to a romantic partner. In this, we show that regardless of the flirting strategy, F0 and VFD variation is a potential resource which can be employed when engaging in flirting interactions. Furthermore, within our dataset, it seems that men rely on VFD more uniformly and women rely on F0 more uniformly, although both strategies are used by both men and women to some extent. In this, something interesting is observed for males with F0 and for females with VFD, wherein speakers may be using secondary vocal cues to accommodate to their partners. We suggest that vocal convergence to a romantic partner, *and*

performances of stereotypically performative gender (and therefore divergence) which fall in line with the sociocultural expectations of attractive female/male voices may both act as potential strategies either on their own or in combination when conveying sexual attraction and may therefore be employed in attempts to endear oneself to their partner. Romantic and sexual interactions thus represent an interesting case where both accommodation and non-accommodation can happen simultaneously between two interlocutors.

References

Anolli, L. & Ciceri, R. (2002). Analysis of the vocal profiles of male seduction: From exhibition to self-disclosure. *The Journal of General Psychology* 129, 2, 149–169.

Babel, M., McGuire, G. & King, J. (2014). Towards a more nuanced view of vocal attractiveness. *PloS One* 9, 2, e88616.

Bates, D., Maechler, M., Bolker, B. & Walker, S. (2014). lme4: Linear mixed-effects models using Eigen and S4. R package version 1.1-7, http://CRAN.R-project.org/package=lme4.

Boersma, P. & Weenink, D. (2021). Praat: Doing phonetics by computer. https://www.fon.hum.uva.nl/praat/

Bruckert, L., Bestelmeyer, P., Latinus, M., Rouger, J., Charest, I., Rousselet, G.A., Kawahara, H. & Belin, P. (2010). Vocal attractiveness increases by averaging. *Current Biology* 20, 116–120.

Farley, S.D. & Lafayette, J.N. (2013). People will know when we are in love: Evidence of differences between vocal samples directed toward lovers and friends. *Journal of Nonverbal Behavior* 37, 3, 123–138.

Fox, J., Weisberg, S., Friendly, M., Hong, J., Andersen, R., Firth, D., Taylor, S. & R Core Team. (2017). Package "effects". Effect Displays for Linear, and Other Models. Version 4.0-0, https://cran.r-project.org/web/packages/effects/effects.pdf.

Fraccaro, P.J., Jones, B.C., Vukovic, J., Smith, F.G., Watkins, C.D., Feinberg, D.R., Little, A.C. & DeBruine, L.M. (2011). Experimental evidence that women speak in a higher voice pitch to men they find attractive. *Journal of Evolutionary Psychology* 9, 1, 57–67.

Fugère, M.A., Leszczynski, J.P. & Cousins, A.J. (2015). *The Social Psychology of Attraction and Romantic Relationships*. New York: Palgrave.

Giles, H. & Coupland, N. (1991). *Language: Contexts and Consequences*. Keynes: Open University Press

Kuznetsova, A. (2015). lmerTest: Tests in Linear Mixed Effects Models. Version 2.0-25, http://cran.r-project.org/web/packages/lmerTest/index.html.

Lawson, E.D. & Giles, H. (1973). British semantic differential responses to world powers. *European Journal of Social Psychology* 3, 233–240; reprinted in *Peace Research Reviews* 6, 25–38.

Milani, T.M. (2017). Language and sexuality. In: Garcia O. and Flores, N. (eds.). *The Oxford Handbook of Language and Societ*y. Oxford University Press, 411–417.

Puts, D.A., Barndt, J.L., Welling, L.L.M., Dawood, K. & Burriss, R.P. (2011). Intrasexual competition among women: Vocal femininity affects perceptions of attractiveness and flirtatiousness. *Personality and Individual Differences* 50, 1, 111–115.

Ranganath, R., Jurafsky, D. & McFarland, D.A. (2013). Detecting friendly, flirtatious, awkward, and assertive speech in speed-dates. *Computer Speech & Language 27*, 89–115.

Riding, D., Lonsdale, D. & Brown, B. (2006). The effects of average fundamental frequency and variance of fundamental frequency on male vocal attractiveness to women. *Journal of Nonverbal Behavior* 30, 55–61.

R Core Team. (2021). R: A language and environment for statistical computing http://www.R-project.org/, http://www.rstudio.com.

Xu, Y., Lee, A., Wu, W., Liu, X. & Birkholz, P. (2013). Human vocal attractiveness as signalled by body size projection. *PloS one* 8, 4, e62397.