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Integrating cues of social interest and voice pitch in men's preferences for women's voices

Benedict C. Jones[1,*], David R. Feinberg[2], Lisa M. DeBruine[1], Anthony C. Little[3] and Jovana Vukovic[1]

[1]*School of Psychology, University of Aberdeen, Aberdeen AB24 2UB, UK*
[2]*Department of Psychology, Neuroscience and Behaviour, McMaster University, Hamilton, Ontario, Canada L8S 4L8*
[3]*Department of Psychology, University of Stirling, Stirling FK9 4LA, UK*
**Author for correspondence (ben.jones@abdn.ac.uk).*

Most previous studies of vocal attractiveness have focused on preferences for physical characteristics of voices such as pitch. Here we examine the content of vocalizations in interaction with such physical traits, finding that vocal cues of social interest modulate the strength of men's preferences for raised pitch in women's voices. Men showed stronger preferences for raised pitch when judging the voices of women who appeared interested in the listener than when judging the voices of women who appeared relatively disinterested in the listener. These findings show that voice preferences are not determined solely by physical properties of voices and that men integrate information about voice pitch and the degree of social interest expressed by women when forming voice preferences. Women's preferences for raised pitch in women's voices were not modulated by cues of social interest, suggesting that the integration of cues of social interest and voice pitch when men judge the attractiveness of women's voices may reflect adaptations that promote efficient allocation of men's mating effort.

Keywords: mate preference; cue integration; mating effort

1. INTRODUCTION

Mating effort is a finite resource. Consequently, humans may possess adaptations for allocating mating effort efficiently (i.e. the effort is directed primarily at individuals displaying cues that attraction may be reciprocated; Mishra *et al.* 2007). Indeed, research on human face preferences has presented neurobiological and behavioural evidence for the existence of such adaptations (Kampe *et al.* 2001; O'Doherty *et al.* 2003; Jones *et al.* 2006).

The neuroimaging studies have shown that the reward value of physically attractive faces (i.e. the extent to which attractive faces elicit greater activity in reward systems than relatively unattractive faces do) is modulated by the degree of social interest the target individual demonstrates for the viewer. O'Doherty *et al.* (2003) found that the reward value of attractive faces is greater when faces are shown with perceiver-directed smiles than when faces are shown with relatively negative expressions. Similarly, Kampe *et al.* (2001) found that direct gaze increases the reward value of attractive faces but decreases the reward value of relatively unattractive faces. The behavioural studies have also shown that preferences for physical attractiveness are modulated by cues of social interest. Jones *et al.* (2006) found that preferences for physically attractive faces are stronger when judging faces that are smiling at the viewer than when judging faces that are smiling away from the viewer. Collectively, these findings reveal integrative mechanisms that would promote allocation of mating effort to the most attractive individuals who appear likely to reciprocate (i.e. mechanisms that promote efficient allocation of mating effort).

Several studies have demonstrated the importance of voice pitch in judgments of women's attractiveness. For example, Collins & Missing (2003) reported a positive association between measured voice pitch and men's attractiveness ratings of women's voices. Feinberg *et al.* (in press) found that increasing women's voice pitch alone is sufficient to increase vocal attractiveness, demonstrating that voice pitch is an auditory cue to women's vocal attractiveness. Furthermore, Feinberg *et al.* (in press) demonstrated that men's preferences for raised pitch in women's voices are not artefacts of preferences for average (i.e. typical) female voice pitch; increasing voice pitch by 20 Hz increased women's vocal attractiveness when the pitch of the unmanipulated voices was lower than, equivalent to and higher than the average voice pitch for adult women. Male preferences for high pitch in women's voices may occur because voice pitch is positively associated with youth and fertility in women (Collins & Missing 2003; Feinberg *et al.* in press). Although evidence from studies of facial attractiveness suggests the existence of integrative mechanisms that will promote efficient allocation of mating effort, we know of no studies that have tested for complementary integrative effects in the domain of voice preferences.

Here we tested whether vocal cues associated with social interest modulate the strength of men's preferences for raised pitch in women's voices. We predicted that men would show stronger preferences for raised pitch in women's voices when female speakers demonstrated positive social interest in the listener (i.e. were saying 'I really like you') than when female speakers appeared disinterested in the listener (i.e. were saying 'I don't really like you'). To control for possible effects of differences in the length of utterance, speech rate, baseline (i.e. unmanipulated) voice pitch and variability in voice pitch between the interested and disinterested conditions, we also compared men's preferences for raised voice pitch in interested and disinterested voices when these voices had been reversed. If stronger attraction to raised voice pitch in the interested than the disinterested conditions reflects integration of voice pitch and vocal cues associated with social interest rather than these other factors that are not affected by reversal, there should be no difference in the strength of men's preferences for raised voice pitch between the interested and the disinterested conditions when the voice recordings are reversed.

We also tested women's preferences for raised pitch in female voices under the same conditions. If

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Table 1. Descriptive statistics for manipulated voices used in our study. (Voices were raised or lowered in pitch by ±0.5 ERB. Note that variation in the standard deviations of the mean average pitches for raised and lowered voices measured in Hz is expected given the logarithmic relationship between ERB and Hz.)

speech content	pitch manipulation	mean average pitch (Hz)	standard deviation of average pitch (Hz)	mean average pitch (ERB)	standard deviation of average pitch (ERB)
I really like you	raised	223.2	12.4	5.8	0.2
I really like you	lowered	177.6	11.6	4.8	0.2
I don't really like you	raised	211.9	9.6	5.6	0.1
I don't really like you	lowered	164.4	4.6	4.6	0.1

integration of cues of social interest and female voice pitch reflects mechanisms for efficient allocation of mating effort, cues of social interest may not modulate women's preferences for female voice pitch.

2. MATERIAL AND METHODS

(a) *Stimuli*

First, we recorded four women (mean age = 25.75 years; s.d. = 4.65 years) speaking the phrases 'I really like you' and 'I don't really like you' using an Audio-Technica AT 4041 microphone. Voices were recorded in a quiet room using WavePad recording software in mono at a sampling rate of 44.1 kHz at 16 bit amplitude quantization. These four female speakers were selected at random from consenting staff and students between the ages of 20 and 30 in our Psychology Department. Next, we manufactured two versions of each voice recording: one with raised voice pitch and the other with lowered voice pitch.

Voices were raised and lowered in pitch using the pitch-synchronous overlap-add (PSOLA) algorithm in Praat (Boersma & Weenink 2007) to ±0.5 equivalent rectangular bandwidths (ERBs) of the original frequency. The PSOLA method has been used successfully in other voice attractiveness studies (e.g. Feinberg *et al.* 2005, in press). While the PSOLA method alters voice pitch, other aspects of the voice are unaffected (e.g. Feinberg *et al.* 2005, in press). The manipulation performed here is roughly equivalent to ±20 Hz in this particular sample (table 1), but takes into account the fact that pitch perception is on a logarithmic scale in comparison with the natural frequencies (i.e. Hz; Stevens 1998). The ERB scale was used here owing to its better resolution at human average speaking frequencies than the tonotopic Bark, semitone or Mel scales (Stevens 1998). A manipulation roughly equivalent to 20 Hz was used because it has previously been shown to be sufficient to alter men's attractiveness ratings of women's voices in prior studies (Feinberg *et al.* in press). After manipulation, amplitudes were scaled to 70 dB for constant presentation volume. Finally, we manufactured reversed versions of these pitch-manipulated voices by reversing each recording using WavePad audio software.

This process created 16 pairs of voices in total (each pair consisting of raised and lowered pitch versions of the same recording): four pairs of voices saying 'I really like you', four pairs of voices saying 'I don't really like you', four pairs of reversed voices saying 'I really like you' and four pairs of reversed voices saying 'I don't really like you'.

(b) *Procedure*

Thirty men (mean age = 26.41 years; s.d. = 5.78 years) and thirty women (mean age = 21.89 years; s.d. = 6.06 years) were played these pairs of voices in a fully randomized order and were asked to choose the voice in each pair that was the more attractive. The order in which the voice recordings in each pair were played was also fully randomized. The study was run online. Internet-based studies of female voice attractiveness have revealed preferences that are consistent with findings from laboratory studies (Feinberg *et al.* in press). Since participants were judging the attractiveness of the pitch manipulation, rather than the individual speakers, the relatively low number of speakers used to generate our stimuli is unlikely to affect our results (e.g. Feinberg *et al.* 2005, in press).

(c) *Initial processing of data*

For each participant, we calculated the proportion of trials on which the voice with raised pitch was chosen as the more attractive. Scores for each of the four conditions ('I really like you' played forwards, 'I really like you' played backwards, 'I don't really like you' played forwards and 'I don't really like you' played backwards) were calculated separately. As some measures were not normally distributed, responses were analysed using non-parametric tests.

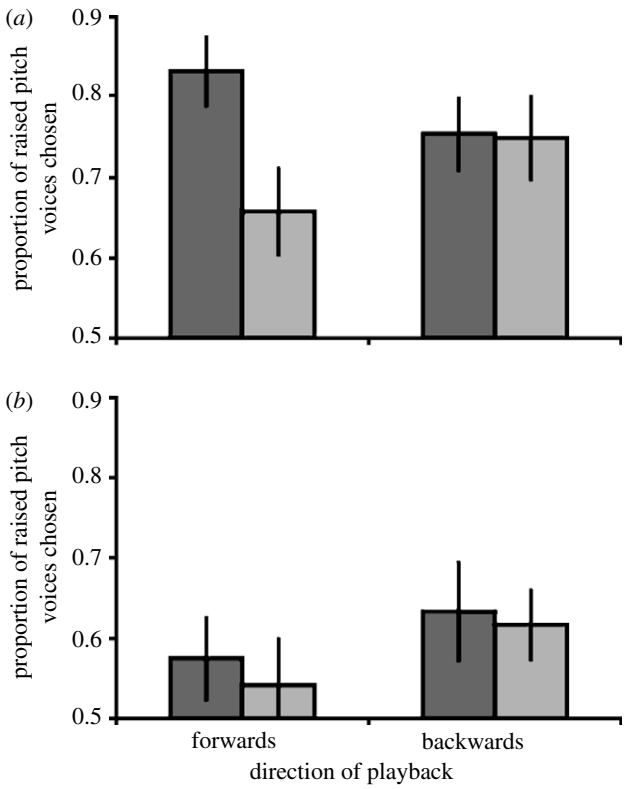

Figure 1. (*a*) Men showed significantly stronger preferences for raised pitch in women's voices that appeared interested (black bars) in the listener than in disinterested (grey bars) women's voices when voices were played forwards, but not when voices were reversed. (*b*) By contrast, women did not integrate cues of social interest and voice pitch. Black bars, interested and grey bars, disinterested.

3. RESULTS

(a) *Men's preferences*

A Friedman test for multiple related samples revealed a significant effect of condition ($\chi^2_3 = 10.69$, $p = 0.014$; figure 1*a*). Wilcoxon signed-rank tests for related scores demonstrated that men's preferences for raised pitch were stronger in the interested condition ('I really like you') than in the disinterested condition ('I don't really like you') when the voice recordings were played forwards ($Z = 2.84$, $p = 0.005$), but not when they were reversed ($Z = 0.45$, $p = 0.651$). The *difference* between preferences for voices with raised pitch in the positive and negative interest conditions

(i.e. the proportion of trials on which the raised pitch voice was chosen in the positive interest condition minus the corresponding score for the negative interest condition) was significantly greater when voices were played forwards than when reversed (Wilcoxon signed-rank tests for related scores: $Z=2.30$, $p=0.022$). This latter finding confirms that the effect of vocal cues of interest on pitch preferences was significantly greater when voices were played forwards than when reversed. Wilcoxon signed-rank tests showed that the raised pitch voices were chosen as the more attractive significantly more often than would be expected by chance (i.e. 0.5) in each condition (all $Z>2.60$, all $p<0.010$).

(b) *Women's preferences*

Corresponding analyses were carried out for women's voice preferences. There was no significant effect of condition ($\chi^2_3=1.00$, $p=0.801$; figure 1*b*). Wilcoxon signed-rank tests for related scores showed no significant differences between the positive and the negative interest voices in either the forward ($Z=0.78$, $p=0.438$) or backward ($Z=0.25$, $p=0.803$) condition. Wilcoxon signed-rank tests showed that the raised pitch voices were chosen as the more attractive significantly more often than would be expected by chance (i.e. 0.5) in the reversed playback conditions (all $Z>2.01$, all $p<0.045$) but not in the forward playback conditions (all $Z<1.41$, all $p>0.16$).

4. DISCUSSION

Consistent with previous studies of men's preferences for women's voices (Collins & Missing 2003; Feinberg *et al.* in press), men preferred women's voices with raised pitch to those with lowered pitch. Such preferences may be adaptive, since voice pitch is thought to be positively associated with women's youth and fertility (Collins & Missing 2003; Feinberg *et al.* in press). Additionally, we found that men's preferences for raised pitch in women's voices were stronger when the speakers appeared to be interested in the listener (i.e. were saying 'I really like you') than when they appeared relatively disinterested in the listener (i.e. were saying 'I don't really like you'). Modulation of the strength of men's preferences for raised pitch in women's voices according to the valence of the utterance was only observed when the recordings were played forwards and did not occur when the recordings had been reversed. This latter finding suggests that the effect of positive interest on the strength of men's preferences for raised pitch in women's voices is not an artefact of possible effects of differences in the length of utterance, speech rate, baseline voice pitch or variability in voice pitch between the interested and disinterested conditions, since these vocal characteristics are not affected by reversal.

As mating effort is a finite resource, the need to allocate it in an efficient manner is likely to have applied selection pressure on the evolution of mate preferences (Mishra *et al.* 2007). Indeed, our findings for modulation of the strength of men's preferences for raised voice pitch according to the valence of the utterance may reflect adaptations to promote efficient allocation of mating effort. Consistent with this interpretation, cues of social interest did not modulate women's preferences for raised pitch in women's voices. Previous studies of men's voice preferences have emphasized the importance of physical characteristics of women's voices (Collins & Missing 2003; Feinberg *et al.* in press). By contrast, here we show that the extent to which men prefer attractive physical characteristics in women's voices can be modulated by cues of social interest, emphasizing the complex integrative processes that underpin voice preferences and adding a new layer of complexity to our understanding of female vocal attractiveness.

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