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Low vocal pitch preference drives first impressions of trustworthiness and dominance in non-contextual scenarios.

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Abstract:

Vocal pitch has been found to influence judgements of perceived trustworthiness and dominance from a novel voice. However, the majority of findings arise from using only male voices, and in context-specific scenarios. The present study explores the influence of average vocal pitch on first-impression judgements of perceived trustworthiness and dominance across genders using non-contextual stimuli. Pairs of high- and low-pitched temporally-reversed recordings of male and female vocal utterances were presented in a two-alternative forced-choice task. Results revealed a tendency to select the low-pitched voice over the high-pitched voice as more trustworthy and more dominant. This preference for low-pitched voices was significant in both genders in regard to trustworthiness, but for male voices only in regards to dominance. It is proposed that an overall preference for low-pitched voices is a default prior in humans when lacking other information. However, we suggest that the relationship between vocal pitch and perceived personality may be sensitive to contextual influences, to the manner of task utilised, and to the availability of semantic information in speech. The present study confirms the important role of vocal pitch in the formation of first-impression personality judgements.

Keywords: social perception; social interaction; vocal pitch; dominance; trustworthiness; first impressions

1 **Low vocal pitch preference drives first impressions of trustworthiness and dominance in non-**
2 **contextual scenarios.**

3 When forming first impressions of others' personalities in everyday social life, people take into
4 account information from multiple senses: they see a 'trustworthy' face, hear a 'trustworthy'
5 voice, and feel a 'trustworthy' handshake. Such judgements are often formed rapidly in order
6 to direct a decision about the appropriate course of action towards the person in question, and,
7 together with the face, the human voice is one of the most important providers of information
8 utilized when forming these first impressions. Indeed, Belin and colleagues (2011) propose that
9 the human voice acts as an 'auditory face', allowing for the extraction of paralinguistic socially
10 relevant information, including information about personality (Belin, Bestelmeyer, Latinus, &
11 Watson, 2011). Recent work has highlighted such personality judgements, with McAleer,
12 Todorov and Belin (2014) showing that people can establish first-impression judgements from
13 voices after listening to only sub-second extracts.

14 Within first-impression personality judgements, studies using both faces or voices have
15 indicated that trustworthiness and dominance are the most prominent of perceived traits (e.g.
16 McAleer et al., 2014; Oosterhof & Todorov, 2008; Sutherland et al., 2013). Oosterhof and
17 Todorov (2008) proposed that, in the case of trustworthiness, adaptive mechanisms for
18 detecting brief facial cues to the intent to cause harm, and to a person's ability to cause harm,
19 in the case of dominance, are over-generalised to a static personality trait due to the detection
20 of threat being crucial for survival. Thus, the over-generalisation of subtle facial cues leads to
21 very rapid, but not necessarily accurate, first-impression judgements of trustworthiness (i.e.

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1 whether a person should be approached or avoided) and dominance (i.e. whether a person is
2 physically weak or strong) (McArthur & Baron, 1983; Oosterhof & Todorov, 2008; Secord, 1958;
3 Zebrowitz & Montepare, 2008). For similar purposes, a recent study by McAleer and colleagues
4 (2014) suggested a parallel functionality of personality judgements in voices, and showed that,
5 as with faces, numerous vocal personality traits can be represented in a two-dimensional 'social
6 voice space' in which valence (i.e. trustworthiness and likeability) forms the primary dimension
7 and dominance forms the second dimension.

8 Estimates of dominance and trustworthiness from the voice are found to be influenced by
9 differences in vocal acoustics between individuals (e.g. Apicella & Feinberg, 2009; Ferdenzi et
10 al, 2013; McAleer et al., 2014; Scherer, 1972; Zuckerman & Driver, 1989). One key acoustical
11 feature studied is the fundamental frequency of the voice (f_0), i.e. the rate of vocal fold
12 vibration (Fitch, 2000) otherwise called 'pitch'. Previously, variations in vocal pitch between
13 individuals have been shown to be negatively related to androgen levels (Dabbs Jr. & Mallinger,
14 1999; Evans, Neave, Wakelin, & Hamilton, 2008; Newman, Butler, Hammond, & Gray, 2000),
15 and as such, dominance has been consistently associated with low vocal pitch in men (Feinberg
16 et al., 2006; Jones, Feinberg, DeBruine, Little, & Vukovic, 2010; Klofstad, Anderson, & Peters,
17 2012; McAleer et al., 2014; Ohala, 1982; Puts, Gaulin, & Verdolini, 2006; Puts, Hodges,
18 Cárdenas, & Gaulin, 2007; Tigue, Borak, O'Connor, Schandl, & Feinberg, 2012; Vukovic et al.,
19 2011; Watkins et al., 2010; Wolff & Puts, 2010). However, in contrast, the relationship between
20 vocal pitch and dominance in women has received less attention in the literature. Looking at
21 what exists shows contradiction, with Ohala (1982) proposing that dominance is associated
22 with low vocal pitch regardless of gender, yet Jones and colleagues (2010) as well as Borkowska

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1 and Pawlowski (2011) found that low-pitched female voices were perceived as more dominant
2 compared with high-pitched voices. Different again, McAleer et al. (2014) found that
3 dominance was more associated with high vocal pitch in females, with all studies employing
4 varying techniques and scenarios.

5 In regards to perceived trustworthiness, few studies have explored the effect of vocal pitch on
6 this trait, and similar to female dominance, findings are largely inconsistent. In male voices,
7 two studies exploring the effect of vocal pitch on election voting and personality traits found
8 contradictory results; Tigue and colleagues (2012) found that low-pitched candidates were
9 perceived as more trustworthy, whereas Klofstad and colleagues (2012) found no significant
10 preference in pitch in regard to trustworthiness. Vukovic and colleagues (2011), in a study
11 exploring the effect of male vocal pitch on women's personality judgements and on the
12 preference for short and long term relationships, also showed no significant preference in pitch
13 when judging trustworthiness, whereas McAleer and colleagues (2014) found high-pitched
14 male voices to be rated more trustworthy, in a non-contextual scenario. For female voices,
15 Klofstad and colleagues (2012) found that low-pitched candidates were judged as more
16 trustworthy, whilst McAleer and colleagues (2014), again in a non-contextual scenario where
17 participants just heard the word 'hello' spoken, trustworthiness in the female voices was found
18 to be influenced by the movement of pitch more so than the average pitch value.

19 As mentioned, one source of variability between the studies is the utterance. The majority of
20 studies exploring judgements of personality in voices have done so within specific contexts,
21 such as the election of political leaders (Klofstad et al., 2012; Tigue et al., 2012) and relationship

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1 preferences (Vukovic et al., 2011), utilising content-relevant voice stimuli, or conversely with
2 short non-socially relevant stimuli such as vowel sounds (e.g. Jones et al., 2010). Thus, given
3 that it has been demonstrated that preferences for low or high vocal pitch are moderated by
4 social context (Jones, Feinberg, DeBruine, Little, & Vukovic, 2008; Vukovic et al., 2008) the
5 generalisability of these findings across different or ambiguous contexts becomes limited.
6 Moreover, the majority of studies exploring vocal pitch in relation to both dominance and
7 trustworthiness have focused on male voices and therefore, it is unclear whether these findings
8 can also be generalised to female voices.

9 Thus, the aim of the present study was to explore the effect of vocal pitch on first-impression
10 judgements of dominance and trustworthiness in male and female voices using non-contextual,
11 yet social relevant, stimuli. High and low-pitched versions of male and female voice recordings
12 of the word “hello” (McAleer et al., 2014) were created by raising and lowering the
13 fundamental frequency by 20 Hz (Klofstad et al., 2012). The resulting voice samples were
14 individually temporally-reversed so as to minimise possible influences of semantic content on
15 participants’ preferences, but to maintain acoustical information and to enable listeners to
16 recognise them as voices (Fleming, Giordano, Caldara and Belin, 2014). It has been
17 demonstrated that although reversed speech stimuli are unintelligible they activate the same
18 brain regions as natural speech (Binder et al., 2000). It is proposed that the use of reversed
19 words as stimuli maintains the social nature of language, in contrast to the use of vowel sounds,
20 and, at the same time, the use of sub-second voice recordings ensures that the time duration is
21 sufficient to produce first-impression judgements (McAleer et al., 2014). In short, the stimuli

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1 are socially relevant in that people perceive them as words, though they may not understand
2 what is being said.

3 Based on the perceived association between low fundamental frequency and aggressive
4 potential in men (Bartholomew & Collias, 1962; Puts et al., 2012) and with characteristics of
5 social dominance such as assertiveness, charisma, and leadership skills in both men and women
6 (Bolinger, 1964; Borkowska & Pawlowski, 2011; Ohala, 1983; Puts et al., 2007), it was predicted
7 that low-pitched male and female voices would be perceived as more dominant, compared
8 with the high-pitched voices. Secondly, in accordance with McAleer and colleagues (2014) that
9 high vocal pitch is associated with higher perceived trustworthiness in male voices, it was
10 expected that high-pitched male voices will be perceived as more trustworthy, compared with
11 the low-pitched voices. Finally, in line with Klofstad and colleagues (2012) it was expected that
12 the low-pitched female voices will be perceived as more trustworthy, compared with their high-
13 pitched counterparts.

14 **Methods**

15 **Ethics Statement**

16 All procedures for this experiment were approved by the University of Glasgow ethics
17 committee for the School of Psychology, in accordance with the 1964 Declaration of Helsinki.
18 Before taking part in the experiment, participants provided written consent for their
19 participation after reading a form reminding them of their freedom to withdraw at any point,
20 and of the anonymity and confidentiality of the provided data.

1 **Participants**

2 40 postgraduate students (13 male; average age: 24 ± 3 years) from the University of Glasgow
3 took part in the experiment. All participants except three were right handed. No monetary
4 incentive was given for taking part.

5 **Stimuli and Apparatus**

6 The voice recordings used in this experiment were obtained from an existing sample of 64 voice
7 recordings of the word 'hello', with pre-determined ratings of dominance and trustworthiness
8 (McAleer et al., 2014). 20 (10 female and 10 male) voice recordings were selected from the
9 middle range of the ratings for dominance, and 20 (10 female and 10 male) voice recordings
10 were selected from the middle range of ratings for trustworthiness. This selective method was
11 used in order to minimise the possibility of the original voices containing characteristics,
12 besides vocal pitch, that rendered them as extremely dominant/trustworthy, or extremely non-
13 dominant/untrustworthy. The PRAAT phonetic analysis programme (v. 5.1.25; Boersma &
14 Weenink, 2010) was used to create a high- and a low-pitched version of each recording by
15 altering the frequency ± 20 Hz. A difference of 40Hz between voices has been shown to be
16 large enough to cause significant differences in perceptual judgments of vocal personality traits
17 (e.g. Borkowska & Pawlowski, 2011; Feinberg et al., 2005). All voice samples were then
18 temporally-reversed to minimise semantic content but to maintain acoustical information and
19 to enable listeners to recognise them as voices (Fleming, Giordano, Caldara and Belin, 2014).
20 The average duration of the stimuli across the whole experiment was approximately 400 msec.
21 A total of 40 pairs of voice samples (80 individual samples) were created using this process: high

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1 and low pitch for 10 male and 10 female from the trustworthiness scale; high and low pitch
2 samples for 10 male and 10 female from the dominance scale. The experiment was presented
3 on E-Prime v2.0 software running on Dell Inspiron One 2320 (Intel Core i5) PCs.

4 **Procedure**

5 The experiment took place in the experimental laboratories at the University of Glasgow.
6 Participants were required to complete a two-alternative forced-choice task during which they
7 listened to pairs of voices comprising high- and low-pitched versions of the original recordings.
8 The sound samples were presented through headphones (participant's own) connected to a
9 computer with the sound set at a comfortable, constant volume (~80dB). This type of task has
10 been used successfully in the past to measure the effect of vocal pitch on personality
11 judgements (e.g. Feinberg et al., 2005). The fact that choices are made within pairs of versions
12 of the same voice, as opposed to different voices, eliminates the possibility that other
13 characteristics besides vocal pitch cause participants to choose one voice over the other.

14 At the beginning of the experiment participants were informed, via on-screen instructions, that
15 they would hear pairs of voices in two blocks, by trait, and would be asked to make a decision
16 regarding each pair. Participants were told that there was no time limit to their decision but
17 were encouraged to answer with their first impression. After each pair of voices the question
18 'Which voice did you perceive as more {dominant} {trustworthy}' was displayed on the screen.
19 Pressing the 's' key would mean that they perceived voice 1 as being most
20 dominant/trustworthy, whereas the 'k' key represented voice 2. The definitions of dominance

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1 and trustworthiness used in the instructions were 'Dominance means having power and
2 influence over others' and 'Trustworthiness means able to be relied on as honest or truthful'.

3 The order of the dominance and trustworthiness blocks was counterbalanced across
4 participants as well as the order in which the voice trials were presented within the block. Male
5 and female trials were presented randomly within the same block, as opposed to being
6 presented in different blocks, so as to avoid block-order effects caused by the gender of the
7 voice. Finally, the order of the high- and low-pitched versions of the recordings within each
8 trial was counterbalanced by including two trials of each pair in a block, with the high- and low-
9 pitched versions in a different order. Therefore, within each block, the 20 pairs of voice
10 samples were presented twice. The voices within each pair were played consecutively with a
11 one second pause between the first voice and the second voice, and participants proceeded to
12 the next trial by pressing 'space'. The experiment lasted approximately 14 minutes.

13 **Data analysis**

14 Individual participants were used as the unit of analysis. To perform the analyses, each
15 participant's choices were coded as 1 if the low-pitched voice was selected and as 0 if the high-
16 pitched voice was selected. The average of each participant's choices, separately for each
17 block, represents the proportion of trials in which the low-pitched voice was chosen over the
18 high-pitched voice as more dominant or trustworthy. One-sample t-tests were used to
19 compare the proportion of trials in which the low-pitched voices were chosen as more
20 dominant/trustworthy with a chance level of 0.5, which represents no preference for either
21 low- or high-pitched voices. In cases where the data was not normally distributed, one-sample

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1 Wilcoxon signed-rank tests were used for the same purpose. The gender of the participants
2 was not included in the analysis of the data due to the much smaller number of male (N=13)
3 compared to female (N=27) participants. All analyses were considered as two-tailed and tested
4 at alpha = 0.05.

5 **Results**

6 **Dominance:** The results showed that when judging vocal dominance the low-pitched voices
7 were selected more often compared with the high-pitched voices, both for male and for female
8 voices (Figure 1). As shown in Table 1, participants selected the female low-pitched voices in
9 55% of the trials ($SD=0.21$), and the male low-pitched voices in 62% of the trials ($SD=0.21$), on
10 average. A one-sample Wilcoxon signed-rank test (chance level = 0.5) revealed that the low-
11 pitched male voices were chosen significantly more often than the chance level ($Z=3.04$,
12 $p<.002$). However, this preference for female low-pitched voices was not significantly higher
13 than what would be expected by chance ($t(39)=1.37$, $p<.178$).

14 **INSERT FIGURE 1 ABOUT HERE**

15 **INSERT TABLE 1 ABOUT HERE**

16 **Trustworthiness:** Similar to dominance, when judging vocal trustworthiness the low-pitched
17 voices were selected more often compared with the high-pitched voices, both for male and for
18 female voices (Figure 1). Participants selected the female low-pitched voices in 61% of the
19 trials ($SD=0.17$) and the male low-pitched voices in 59% of the trials ($SD=0.22$), on average
20 (Table 1). A one-sample t-test (chance level = 0.5) revealed that the preference for low-pitched

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1 male voices was significantly higher than chance ($t(39)=2.57, p<.014$). Similarly, a one-sample
2 Wilcoxon signed-rank test showed that the preference for low-pitched female voices was also
3 significantly higher than chance ($Z=-3.55, p<.001$).

4 **Analysis by voice gender:** A two-way ANOVA was used to explore a possible interaction
5 between the trait examined and speaker gender. A significant interaction between the two
6 variables was found ($F(1,39)=4.53, p<.04, partial-eta=0.104$) which was driven by the
7 preference for low-pitched voices in the dominance trials being stronger in response to male
8 speakers (62%) compared with female speakers (55%), but the preference for low-pitched
9 voices in the trustworthiness trials being stronger in response to female speakers (61%)
10 compared with male speakers (59%) (See Figure 1).

11 **Analysis by order preference:** In order to examine whether there was a tendency to select the
12 first or the second voice, regardless of vocal pitch level, the proportion of trials in which
13 participants selected the first voice over the second voice was calculated (Figure 2). In the
14 dominance block the first voice was selected on 54% of the female voice trials ($SD=0.07$) and on
15 51% of the male voice trials ($SD=0.14$), on average. In the trustworthiness block the first voice
16 was selected on 53% of the female voice trials ($SD=0.15$) and on 51% of the male voice trials
17 ($SD=0.11$), on average. One-sample t-tests (chance level = 0.5) revealed that the first voice was
18 selected significantly more often than chance only when judging the female speakers in the
19 dominance block ($t(9)=5.24, p<.001$).

20 **INSERT FIGURE 2 ABOUT HERE**

1 **Analysis by block-order:** To test for block-order effects, the proportion of trials in which the
2 low-pitched voices were selected over the high-pitched voices, for the dominance and
3 trustworthiness traits, was calculated separately both for participants who completed the
4 dominance block first (N=20), and for participants who completed the trustworthiness block
5 first (N=20). The preference for low-pitched voices in the dominance block was 60% for
6 participants who completed that block first ($SD=0.17$) and 57% for participants who completed
7 that block second ($SD=0.21$). The preference for low-pitched voices in the trustworthiness
8 block was 61% when that block was completed first ($SD=0.18$) and 60% when that block was
9 completed second ($SD=0.17$). Independent t-tests showed that these differences were non-
10 significant (all $p>0.05$).

11 **Discussion**

12 The results revealed a tendency to select the low-pitched voices as more dominant and more
13 trustworthy compared with the high-pitched voices. The preference for low-pitched voices was
14 significant for voices of both genders when judging vocal trustworthiness but for male voices
15 only when judging vocal dominance. The strength of the preference was characterised by an
16 interaction between the trait being judged and the gender of the voice; the preference was
17 stronger for male voices, compared with female voices, in regard to dominance, but stronger
18 for female voices, compared with male voices, in regard to trustworthiness.

19 That low-pitched male voices were judged as more dominant than high-pitched male voices is
20 consistent with previous studies (Feinberg et al., 2006; Jones et al., 2010; McAleer et al., 2014;
21 Puts et al., 2006; Puts et al., 2007; Tigue et al., 2012; Vukovic et al., 2011; Watkins et al., 2010;

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1 Wolff & Puts, 2010). One explanation for the link between low male vocal pitch and dominance
2 is evident in the theoretical proposition that low pitch is misattributed to large body size and
3 physical strength (Feinberg, Jones, Little, Burt, & Perrett, 2005; Fitch, 1997). These
4 characteristics may signal aggression potential and have been previously correlated to physical
5 dominance (Bartholomew & Collias, 1962; Puts et al., 2007; Puts et al., 2012). Furthermore,
6 there is a perceived connection between low-pitched voices and assertiveness, charisma, and
7 leadership skills, which are thought to be characteristics of social dominance (Ohala, 1983; Puts
8 et al., 2007).

9 In regards to female voices, although low-pitched voices were more often judged as being more
10 dominant, compared with high-pitched voices, the results showed that this preference was not
11 significant. This finding is in contrast to Borkowska and Pawlowski (2011) and Jones and
12 colleagues (2010), who did find an overall significant preference for low-pitched voices, and
13 conversely in contrast to McAleer et al. (2014), who found that dominance was more
14 associated with high vocal pitch in females. It has been proposed by Borkowska and Pawlowski
15 (2011) that perceived female dominance is more closely related to social dominance, i.e.
16 characteristics such as assertiveness, charisma, and leadership skills (Bolinger, 1964; Ohala,
17 1983; Puts et al., 2007), than physical dominance, i.e. aggressive potential (Bartholomew &
18 Collias, 1962; Puts et al., 2007; Puts et al., 2012). It is notable that Puts and colleagues (2007)
19 found that the manipulation of pitch in male voices had a stronger influence on the judgement
20 of physical dominance than it did on the judgement of social dominance. It is proposed that
21 the fact that female dominance is more closely associated with social than physical dominance
22 could result in the influence of vocal pitch on judgements of dominance being weaker for

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1 female voices compared with male voices. This suggestion is in line with the finding by McAleer
2 and colleagues (2014) that the variance in the perception of dominance from female voices is
3 not well explained by vocal pitch. Our result of no preference can be elucidated by the
4 preference towards selecting the first voice out of the female voice pairs when judging
5 dominance, suggesting that responses were not being driven exclusively by vocal pitch.

6 Switching attention to trustworthiness, to our knowledge, the present study is the first to use a
7 two-alternative forced-choice task to explore the influence of vocal pitch level on judgments of
8 trustworthiness using non-contextual socially relevant stimuli that are perceived as speech. In
9 contrast to our hypothesis, low-pitched male voices were perceived as more trustworthy
10 compared with high-pitched voices. This supports Tigue and colleagues (2012) using contextual
11 stimuli, but is against McAleer et al (2014), using non-contextual 'Hellos', where the higher-
12 pitched male voices were rated as more trustworthy. Similarly, for female voices, in line with
13 Klofstad et al (2012) who used the 2AFC, the results of the present study showed that low-
14 pitched female voices were perceived as more trustworthy compared with high-pitched female
15 voices; yet McAleer and colleagues (2014), found that intonation and not vocal pitch explained
16 the variance of trustworthiness in female voices.

17 One possible explanation for the alternative findings is that the type of task used in the
18 experiment influences the relationship between vocal pitch level and trustworthiness
19 judgements. McAleer and colleagues (2014) used a Likert task in which the degree of
20 trustworthiness of the voices was rated individually, whereas the present study and others used
21 a 2AFC where preference is asked between pairs of stimuli. It is possible that the preference

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1 for low-pitched voices reflects a general bias towards the lower pitch that is driven when the
2 task specifically asks you to compare two sounds. Previous research has shown that additional
3 stimuli in the immediate environment would alter percepts of personality traits for a target
4 stimulus (Little, Burriss, Jones, DeBruine & Caldwell, 2008; Re, Lefevre, DeBruine, Jones &
5 Perrett, 2014); potentially explaining differences in studies using tasks with diverse cognitive
6 demands. However, although studies using the 2AFC task frequently find preferences for low-
7 pitched voices, there have been exceptions to this tendency (Apicella & Feinberg, 2009;
8 Feinberg, DeBruine, Jones, & Perrett, 2008; Tigue et al., 2012). An alternative explanation is
9 that the relationship between vocal pitch and trustworthiness is non-linear. Specifically, it is
10 possible that high-pitched male voices are perceived as more trustworthy up to a certain pitch
11 level above which they start to appear untrustworthy. A number of studies have revealed a link
12 between deception and high vocal pitch (Apple, Streeter, & Krauss, 1979; Ekman, Friesen, &
13 Scherer, 1976; Ekman, O'Sullivan, Friesen, & Scherer, 1991; Sporer & Schwandt, 2006; Lakhani
14 & Taylor, 2003; Streeter, Krauss, Geller, Olson, & Apple, 1977; Taylor & Hick, 2007; Villar,
15 Arciuli, & Paterson, 2013; Zuckerman, Koestner, & Driver, 1981). It is possible that the
16 manipulated high-pitched male voices used in this study were higher than the optimal high-
17 pitch level. As a consequence, when compared with the low-pitched voices, the high-pitched
18 voices would be perceived as deceptive and less trustworthy compared with their low-pitched
19 counterparts. Borkowska & Pawlowski (2011) have reported a similar, non-linear, relationship
20 between vocal pitch and attractiveness in female voices. Both explanations leave route for
21 further investigation that cannot be answered with the current data.

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1 Finally, specifically on male trustworthiness, Klofstad et al (2012) found no significant influence
2 of vocal pitch on trustworthiness judgements, yet the current study showed low-pitched male
3 voices were perceived as more trustworthy. Both studies used a similar 2AFC task, which would
4 negate a task effect; however, in contrast to this study, they used contextual stimuli based on
5 elections. It is proposed that context, in conjunction with additional stimuli in the environment,
6 may influence the signals used to make a judgement of trustworthiness from voices (Jones et
7 al., 2008; Vukovic et al., 2008), resulting in variations in the strength of the influence of auditory
8 cues such as pitch or formant dispersion depending on how and what you are judging. For
9 instance, the use of reversed speech in the current study may have the effect of strengthening
10 the use of vocal pitch as a cue to trustworthiness. Studies exploring the influence of vocal pitch
11 level on perceiving deception in voices have shown that removing speech content and semantic
12 meaning caused a positive correlation between pitch level and deception, which were
13 otherwise uncorrelated (Ekman et al., 1976; Streeter et al., 1977). Thus it is suggested that
14 context and situation (task) of a judgement may influence the percept of certain personality
15 traits to a greater extent than has previously been considered.

16 **General conclusions**

17 The aim of the present study was to explore the influence of vocal pitch level on first-
18 impression judgements of dominance and trustworthiness across genders using non-contextual
19 stimuli. The removal of context through the reversed speech revealed a general preference for
20 low-pitched voices, irrespective of personality trait. The strength of the preference for low-
21 pitched voices as more dominant differed depending on the gender on the voices; the

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1 preference for low-pitched male voices was much stronger compared with the preference for
2 low-pitched female voices, which failed to reach significance. The strength of the preference
3 for low-pitched voices as more trustworthy was on a similar level for voices of both genders.

4 It is proposed that the perception of low-pitched voices as more dominant and trustworthy
5 when making first-impression judgements based on voice is a default situation. However, due
6 to the largely inconsistent findings between studies, it is speculated that the relationship
7 between vocal pitch level and the judgement of trustworthiness may be sensitive to contextual
8 influences, to the type of task used in the study, and to the availability of semantic information
9 in speech. The findings of the present study highlight the important role of vocal pitch level in
10 the formation of first-impression personality judgements based on voice and may have practical
11 future applications in vocal human-computer interaction (HCI), voice-driven technologies, and
12 robotics.

13 **{Word Count: 4210}**

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TABLE1:

Trait	Voice Gender			
	Female		Male	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Dominance	0.55	0.21	0.62	0.21
Trustworthiness	0.61	0.17	0.59	0.22

Notes: M=mean, SD=standard deviation

Table 1: Proportions of trials in which low-pitched voices were selected as more dominant or trustworthy for female and male voice trials. A mean value of 1 would indicate a 100% preference for low-pitched voices; 0.5 would indicate no preference for either low- or high-pitched voices; 0 would indicate 100% preference for high-pitched voices.

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1 **Figure Legends:**

2

3 Figure 1: The proportion of female voice trials (dark grey) and male voice trials (light grey) in
4 which the low-pitch version was selected, for both the dominance (left) and trustworthiness
5 (right) traits. A mean value of 1 would indicate a 100% preference for low-pitched voices; 0.5
6 would indicate no preference for either low- or high-pitched voices; 0 would indicate 100%
7 preference for high-pitched voices. Vertical axis is truncated between 0.6 & 0.65 for clarity.
8 Error bars show standard error.

9

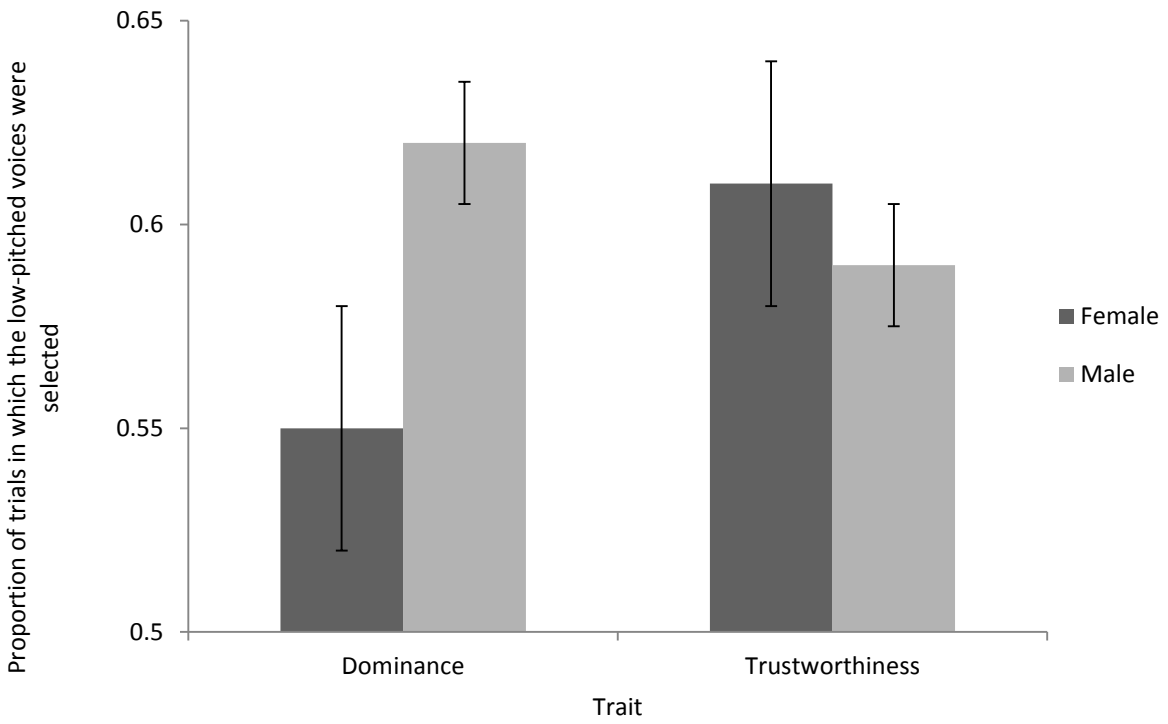
10 Figure 2: The proportion of female (left) and male (right) voice trials in which the low-pitch
11 voice (dark grey) was selected, and the proportion of female and male voice trials in which the
12 1st (light grey) and 2nd voice (mid grey) was selected, for the dominance (top graph) and
13 trustworthiness (bottom graph) traits. A mean value of 1 would indicate a 100% preference for
14 low-pitched voices; 0.5 would indicate no preference for either low- or high-pitched voices; 0
15 would indicate 100% preference for high-pitched voices. Vertical axis is truncated between 0.6
16 & 0.65 for clarity. Error bars show standard error.

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FIGURE1:



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FIGURE2:

