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Abstract

Voice pitch may not only influence the listeners but also the speakers themselves. Based on the theories of embodied cognition and previous research on power, we tested whether lowering their pitch leads people to feel more powerful and think more abstractly. In three experiments, participants received instructions to read a text out loud with either a lower or a higher voice than usual. Subsequently, feelings of power (Experiments 1 and 2) and abstract thinking (Experiment 3) were assessed. Participants who lowered their voice pitch perceived themselves more as possessing more powerful traits (Experiments 1 and 2) and had a higher level of abstract thinking (Experiment 3) compared to participants who raised their voice pitch.

Keywords

voice, pitch, abstract thinking, embodiment, power, dominance, vocal feedback

Speakers influence listeners not only with their words, but also with their voice itself. The nonverbal characteristics of a voice (pitch, rate, volume, and quality) can be used to emphasize words, hold attention, express confidence, and subtly communicate one's feelings about a certain issue. Interestingly, these characteristics may also affect the speakers themselves. Producing sound patterns associated with joy, love, sadness, anger, and fear can lead to corresponding emotional experiences (i.e., vocal feedback effects; Hatfield, Hsee, Costello, Weisman, & Denney, 1995). For instance, when producing sounds of laughter, participants felt happier than when producing other emotional sounds.

The idea that a speaker's voice influences his or her own feelings is supported by theories of embodied cognition. These theories propose that bodily states—postures, movements, facial, and vocal expressions—play a role in affective and cognitive states via re-enactment of the information associated with that state (e.g., Niedenthal, 2007). In the current article, we identify an as yet unexplored embodied cognition effect: the impact of voice pitch on a speaker's feeling and thinking. One of the most salient features of the human voice is voice pitch, which essentially refers to voice height.¹ We argue that voice pitch can affect the extent to which a speaker feels powerful and thinks abstractly.

The Association Between Pitch, Power, and Thinking

Lay people associate a low voice with more power (e.g., Carney, Hall, & Smith LeBeau, 2005; Hall, Coates, & Smith

LeBeau, 2005). Accordingly, research has shown that people judge a person whose voice pitch was lowered as more powerful than the same person whose pitch was raised (Puts, Gaulin, & Verdolini, 2006; Puts, Hodges, Cardenas, & Gaulin, 2007). A person's level of power also actually affects their pitch, though the data on this are limited (Hall et al., 2005). In a dating-game scenario, men lowered their voice pitch when addressing a supposedly less dominant competitor, and raised their pitch when addressing a more dominant competitor (Puts et al., 2006). Additionally, Van Dijk et al. (2011) found that participants lowered their pitch when placed in a high-power role.

As low pitch and high power are so strongly associated, we argue, in line with the theories of embodied cognition, that lowering the voice pitch should elicit these concepts of power and thus influence one's power-related states. Thus, we first of all expect that lowering their pitch will lead speakers to feel more

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powerful compared to raising their pitch. Previous research (Smith & Trope, 2006) also demonstrated that the experience of power promotes abstract thinking. Therefore, we also expect that lowering pitch will enhance abstract thinking compared to raising pitch. Furthermore, we included a control condition in most of our experiments to explore the direction of the effect.

Apart from being the first to show that a speaker's tone of voice may affect his or her feeling and thinking, findings such as these would add to the literature on the embodiment of power, showing that power is embodied in vocal expressions and not just bodily expressions (i.e., power poses and fist clenching; Carney, Cuddy, & Yap, 2010; Huang, Galinsky, Gruenfeld, & Guillory, 2011; Schubert & Koole, 2009).

We tested our hypothesis by instructing participants to read a text silently or to read it out loud with either a lowered or raised voice pitch. In an ostensibly unrelated part of the experiment, participants' power-related states were measured. More specifically, we measured whether the lowering of one's voice pitch leads participants to feel more powerful (Experiments 1 and 2) and whether it influences their cognitive style so they think more abstractly (Experiment 3). Additionally, in Experiment 2 we tested whether feelings of power are indeed affected by producing the lowered or raised voice pitch oneself, as compared to merely listening to a lowered or raised voice pitch.

Experiment 1

Method

Participants and design. Participants were 81 (55 female, 26 male) students at Leiden University ($M_{\text{age}} = 19.61$; range: 17–28 years). They were randomly assigned to one of three voice pitch conditions (lowered vs. raised vs. control [no speaking]) and were paid € 4 for taking part in the experiment.

Procedure. Participants were told that we were interested in the effects of an extra task on the processing of a text. They were instructed to read a text out loud with a pitch either three tones higher than their usual pitch or three tones lower than their usual pitch. In the control (no speaking) condition, participants received no special voice instructions and were asked to read the text silently. The instructions to lower or raise the voice were found to be effective in a pilot study,² which also ruled out possible load or mood effects caused by differences in the instructions. All participants read a neutral text about the characteristics of the earth, which took approximately 3 min. Afterward, they answered filler questions about the text, namely how informative and succinct it was (1 = *not at all* to 7 = *very much*). We did not expect the voice instructions to affect responses to these questions.

To avoid possible demand effects, we presented the second part of the experiment, in which we measured participants' feelings of power, as unrelated to the first. Participants' feelings of power were measured as in previous studies (Smith, Wigboldus, & Dijksterhuis, 2008; Tiedens & Jimenez, 2003). Participants rated themselves on several trait pairs using 7-

point bipolar scales (e.g., To what extent would you say you are boring versus fun?). Seven trait pairs related to power were embedded in the list (submissive–dominant, passive–active, unassertive–assertive, timid–firm, uncertain–certain, insecure–confident, dependent–independent; $\alpha = .68$). In previous research, this measure has been shown to tap into participants' current feelings of power (e.g., Smith et al., 2008).

At the end of the experiment, we asked participants what they thought the experiment was about. None of them reported anything related to the actual goals of our study. Afterward they were thanked, debriefed, and paid.

Results and Discussion³

Feelings of power. A one-way analysis of variance (ANOVA) on participants' feelings of power showed a significant effect of voice pitch, $F(2, 71) = 8.71, p < .001, \eta_p^2 = .20$. Participants who lowered their voice pitch perceived themselves more as possessing more powerful traits ($M = 5.33, SD = .61$) than participants who raised their pitch ($M = 4.86, SD = .67, p = .01$). Moreover, participants who lowered their pitch perceived themselves more as possessing more powerful traits than control participants ($M = 4.52, SD = .71, p < .001$). The pitch-raised and control conditions differed marginally, $p = .09$.

Ratings of text. Two separate analyses with voice pitch as the independent variable and the text ratings as dependent variables showed no effects of pitch, $F_s < 1.04, p_s > .36, \eta_p^2_s < .03$.

These results provide the first evidence that voice pitch influences power. More specifically, producing a lowered voice pitch led to stronger feelings of power compared to either producing a raised voice pitch or not speaking out loud. Importantly, voice pitch influenced power-related ratings only and not ratings of the text itself.

Experiment 2

Experiment 1 demonstrated that lowering the voice pitch led to stronger feelings of power. However, it is unclear whether these results are caused by the actual production of a lowered or raised voice pitch, or by merely being primed with a lowered or raised voice pitch. After all, when reading the text out loud, participants both produced a particularly pitched voice and heard that voice. To disentangle the effects of these two mechanisms, we conducted Experiment 2. Here half of our participants produced either a lowered or raised voice pitch, and the other half listened to a recording of someone else's lowered or raised voice pitch. If our effects are dependent on actual voice production and not mere priming, as would be predicted by theories of embodied cognition, then the listening-only group should show no effect of voice pitch on their feelings of power.

Method

Participants and design. Participants were 44 male students at Tilburg University ($M_{\text{age}} = 24.89$; range: 17–56 years). They were randomly assigned to one of the conditions of a 2 (Voice

Pitch: lowered vs. raised) \times 2 (Activity: producing vs. listening) between participants design. They were paid € 4 for taking part in the experiment.

Procedure. The procedure was similar to the procedure of Experiment 1, except that we changed the extent to which the voice pitch was raised or lowered (now 1 semitone) and that we added listening conditions. We raised or lowered the voice pitch 1 semitone instead of the three full tones used in Study 1 as we needed to keep the voice feedback natural, which is especially important when listening to other people's voices. Our choice of 1 semitone was based on previous research by Puts, Gaulin, and Verdolini (2006). They raised or lowered a person's voice pitch with 1 semitone and showed that participants who listened to these voices rated the speaker as more dominant when the voice was lowered 1 semitone relative to when it was raised 1 semitone.

In the listening conditions, participants listened to an audio-fragment of a same-sex (male) voice which had been either lowered or raised 1 semitone. This audio-fragment was created by asking a male person to read a text (the same as in Experiment 1) out loud in his normal tone of voice. His normal voice pitch was 150.81 Hz, which falls within the normal range for male voices. Using the program Audacity, this pitch was lowered and raised 1 semitone (based on Puts et al., 2006). The audio clips are presented at <http://www.youtube.com/watch?v=Bajt0eQUsd8> (raised pitch) and <http://www.youtube.com/watch?v=TjplMEqizWw> (lowered pitch). In the producing conditions, participants were instructed to read the same text out loud with a pitch 1 semitone lower or higher than their usual pitch. Importantly, a pilot study showed that the lowered or raised voices were indeed perceived and categorized as such, both in the listening and producing conditions.⁴

After producing or listening to a lowered or raised voice pitch, participants' feelings of power were measured as in Experiment 1 ($\alpha = .82$). Again, none of the participants reported anything related to the actual goals of our study when asked what they thought were the goals of the experiment. Afterward they were thanked, debriefed, and paid.

Results and Discussion

A 2 (Voice Pitch: lowered vs. raised) \times 2 (Activity: producing vs. listening) ANOVA on participants' feelings of power was conducted. The analysis showed a significant main effect of voice pitch, $F(1, 40) = 10.50, p = .002, \eta_p^2 = .21$, indicating that participants who produced or listened to a lowered voice pitch perceived themselves more as possessing more powerful traits ($M = 5.31, SD = .49$) than participants who produced or listened to a raised voice pitch ($M = 4.63, SD = .95$). Furthermore, a significant main effect of activity, $F(1, 40) = 5.01, p = .03, \eta_p^2 = .11$, indicated that participants who merely listened to a voice perceived themselves more as possessing more powerful traits ($M = 5.21, SD = .69$) than participants who produced a voice ($M = 4.69, SD = .90$). This effect may be due to

participants feeling insecure about having to read difficult words out loud.

Importantly, both main effects were qualified by a significant interaction, $F(1, 40) = 8.91, p = .005, \eta_p^2 = .18$. Voice pitch affected participants' feelings of power only when they produced the lowered or raised pitch themselves, $F(1, 40) = 20.68, p < .001$: Participants who produced a lowered pitch perceived themselves more as possessing more powerful traits ($M = 5.39, SD = .46$) than participants who produced a raised pitch ($M = 4.12, SD = .76$). Voice pitch did not affect participants' feelings of power when listening to a lowered or raised pitch ($M = 5.23, SD = .53$ and $M = 5.18, SD = .85$), $F < 1, ns$.

These results replicate the findings of Experiment 1, showing that producing a lower-pitched voice led to stronger feelings of power compared to producing a higher-pitched voice. Moreover, the present results showed that the effects only occur when producing the voice pitch oneself, not when listening to a same-sex lowered or heightened voice pitch. Thus, it seems that the effects on feelings of power are due to the production of voice pitch and cannot be explained by mere priming effects.

Experiment 3

Can lowering the pitch of one's voice evoke abstract thinking? Smith and Trope (2006) demonstrated that high-power people think more abstractly than low-power people. They argued that because power makes people feel more psychologically distant, it leads them to think more abstractly. Thus, high-power people focus more on important, central aspects and are better at detecting relationships between aspects compared to low-power people. Since lowering the voice increased feelings of power in Experiments 1 and 2, we also expect it to lead people to think more abstractly.

Method

Participants and design. Participants were 42 (26 female, 16 male) students at Utrecht University ($M_{age} = 21.50$; range: 17–27 years). They were randomly assigned to one of three voice pitch conditions (lowered vs. raised vs. control) and were paid € 4 for taking part in the experiment.

Procedure. The first part of the experiment, in which vocal expression was manipulated, was the same as in Experiment 1: Participants were instructed to read a text silently or to read it out loud with either a lowered or raised voice pitch. In the second part, participant's level of abstract thinking was measured using a variation of the Deese-Roediger-McDermott false recognition paradigm (Deese, 1959; Roediger & McDermott, 1995; cf. Smith & Trope, 2006). First, participants were presented with 100 words one at a time for 2 s each and were asked to try to remember each word. Each word belonged to 1 of 10 categories, with 10 words to each category. The words were presented in random order.

After several filler questions, participants did a recognition test consisting of 75 words: 40 old words that were presented

previously in the study list and 35 new words. For each word, participants indicated by pressing one of two keys whether the word was previously presented or not. Of the 35 new words, 10 were critical lures, meaning they were not previously presented but were strong associates of the categories. We counted the number of errors participants made with these 10 critical lures. When thinking more abstractly, one will more easily remember the broad categories to which the words belonged than the exact words that were presented. Therefore, participants who think more abstractly will more often erroneously indicate that the 10 critical lures were presented previously (for more detailed information, see Smith & Trope, 2006).

Finally, participants were asked whether they knew what the experiment was about. None of them reported anything related to the actual goals of our study.

Results and Discussion

Abstract thinking. A one-way ANOVA on participants' level of abstract thinking (i.e., number of false alarms to the critical lures) showed a significant effect of vocal expression, $F(2, 39) = 4.57, p = .02, \eta_p^2 = .19$. Participants who lowered the pitch of their voice showed more abstract thinking ($M = 4.07, SD = 1.21$) than participants who raised their pitch ($M = 3.00, SD = 1.18$), $p = .02$. Also, participants who lowered their pitch thought more abstractly compared to control participants ($M = 2.86, SD = 1.10$), $p = .01$. The pitch-raised and control conditions did not differ significantly, $p = .75$. Thus, lowering the voice led to more abstract thinking than raising the voice or not speaking out loud.⁵

General Discussion

In three experiments we provide evidence for an embodied cognition account of voice pitch effects. Whereas previous research merely focused on the influence of voice pitch on how a speaker is perceived by others, the current research shows that voice pitch also influences the speaker. When speaking with a lowered voice pitch individuals not only feel more powerful, but they also think more abstractly. Furthermore, the results of Experiment 2 showed that these effects cannot be explained by mere priming: Being exposed to a lowered or raised voice pitch did not influence participants' feelings of power. Only when producing the lowered pitch oneself did feelings of power increase. Our findings confirm previous findings that low pitch and high power are related. Furthermore, we extend both the embodiment and the power literatures and suggest that voice pitch embodies power. The present results imply that when one needs to be powerful (for instance, when being placed in a high-power role or when trying to persuade others), lowering one's voice is sufficient to feel and think like a powerful person and may help to get the job done.

Experiments 1 and 3, which included a control condition, showed that raising the voice pitch did not lead to less power-related feelings and thoughts compared to the control

condition. Even more so, in Experiment 1 there was a trend for participants to feel more powerful when they changed their voice pitch (lowered or raised) compared to when they did not speak out loud at all. It is conceivable that the act of changing one's voice pitch gives people a greater sense of control, influencing power-related feelings and thoughts. After all, action is also associated with power (Galinsky, Gruenfeld, & Magee, 2003; Magee, 2009), and changing one's voice pitch is much more active than reading silently. Another explanation is that producing and listening to one's own changed voice pitch could lead people to feel more distance from the self. As psychological distance is associated with feeling powerful (Lammers, Galinsky, Gordijn, & Otten, in press; Smith & Trope, 2006), this could explain the obtained effect. However, although it is possible that changing one's voice pitch (or talking out loud) may sometimes lead to more power-related feelings and thoughts, the trend obtained in Experiment 1 was not replicated. In Experiment 3, raising the voice pitch did not lead participants to think more powerfully than not speaking at all. Relatedly, in Experiment 2, participants who changed their voice pitch even felt less powerful than participants who listened to someone else's voice. Importantly, our findings do consistently show that lowering one's voice pitch leads to more power-related feelings and thoughts compared to raising one's voice pitch.

It is important to note that, in line with prior embodiment research, we took the necessary precautions to ensure that our participants did not connect the embodiment manipulation to our main measures of interest. Apart from the disconnection in time (with the main measurements being taken some time after the induction of voice pitch), we presented the manipulation of voice pitch and subsequent measurements as being part of separate studies. Not only do these embodied effects of voice pitch appear to take place beyond awareness, but they also carry over across situations and over time.

An interesting and challenging question for future research is what occurs when someone is aware of "the power of pitch." For example, would it be possible to deliberately increase one's feelings of power by choosing to lower the pitch of one's voice? If so, this would add a simple and generally available instrument to your strategic arsenal: your own voice. The lowering of your own voice could then be used not only to influence others (cf. Puts et al., 2006, 2007) but also to influence yourself.

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Notes

1. More specifically, pitch is influenced by fundamental and formant frequencies: It is related to vocal fold length, the tension on the vocal folds, and the length of vocal tract (Puts et al., 2006).
2. In a pilot study, we tested whether these instructions to lower or raise the voice indeed affected voice pitch accordingly. Participants were 54 (37 female and 17 male) students of Leiden University ($M_{\text{age}} = 19.69$ years; range: 17–26 years). We asked participants to read a text out loud with either a pitch three tones lower than their usual pitch or three times higher than their usual pitch and recorded their voice while they read the text. Additionally, we tested whether the voice instructions caused variation in other variables (difficulty of the instructions and mood), which could possibly explain the results. After reading the text, participants rated the difficulty of the instructions on a 7-point scale (1 = *not at all* to 7 = *very much*). Mood was measured by 12 emotion items, on which participants indicated on 7-point scales how tense, enthusiastic, pleased, worried, irritated, angry, confused, cheerful, mad, dreary, happy, and sad they felt ($\alpha = .81$).

Voice pitch was estimated using the program PRAAT (Boersma & Weenink, 2010). Results showed that when instructed to lower their pitch, participants had lower pitch ($M = 168.76$, $SD = 33.79$) than when instructed to raise their pitch ($M = 224.98$, $SD = 67.68$), $F(1, 50) = 22.22$, $p < .001$, $\eta^2 = .31$. Although male participants had lower pitch ($M = 159.11$, $SD = 56.61$) than female participants ($M = 215.74$, $SD = 54.29$), $F(1, 50) = 25.51$, $p < .001$, $\eta^2 = .34$, both were equally successful at following the instructions. Thus, there was no interaction between participants' gender and voice instructions, $F < 1$. Furthermore, results showed no effects of voice instructions on difficulty ratings or on mood, $F_s < 1$.

3. Results of Experiments 1 and 3 showed no main effects of or interaction effects with the gender of the participant ($F_s < 1.02$, $p > .37$, $\eta^2 < .03$). Therefore, this variable was not included in the reported analyses.
4. In a pilot study, 55 male participants ($M_{\text{age}} = 28.42$ years; range: 18–56 years) were either asked to produce or listen to a voice that was lowered or raised 1 semitone (same design, instructions, and text as in Experiment 2). Then, participants were asked to rate the voice on two items. First, they indicated on a 7-point scale "To what extent was the voice you [produced/listened to] low-pitched versus high-pitched?" (1 = *very low*, 7 = *very high*). Second, they guessed the pitch of the voice they produced or listened to. They answered by sliding a bar on a scale from 50 to 250 Hz, which indicated that a men's normal voice pitch ranges from 100 to 150 Hz and a women's normal voice pitch from 170 to 220 Hz.

A 2 (Voice Pitch: lowered vs. raised) \times 2 (Activity: producing vs. listening) ANOVA on participants' ratings of the extent to which the voice pitch was low or high showed a significant main effect of voice pitch, $F(1, 51) = 27.80$, $p < .001$, $\eta^2 = .35$: Participants who produced or listened to a lowered voice perceived the voice pitch as lower ($M = 3.54$, $SD = 1.37$) than participants who produced or listened to a raised voice ($M = 5.15$, $SD = .82$). There was no main effect of activity, nor an interaction of voice pitch and activity, $F_s(1, 51) < 1.53$, $p_s > .22$.

A 2 (Voice Pitch: lowered vs. raised) \times 2 (Activity: producing vs. listening) ANOVA on participants' guess of the voice pitch (in Hertz) showed a significant main effect of voice pitch, $F(1, 51) = 13.86$, $p < .001$, $\eta^2 = .21$: Participants who produced or listened to a lowered voice perceived the voice pitch as lower ($M = 123.47$ Hz, $SD = 22.59$) than participants who produced or listened to a raised voice ($M = 147.74$ Hz, $SD = 24.32$). There was no main effect of activity, nor an interaction of voice pitch and activity, $F_s < 1$.

So in sum, these results showed that participants rated a lowered voice pitch as lower than a raised voice pitch. Furthermore, they did not differ in their perceptions when producing versus listening to a (lowered or raised) voice pitch.

5. Importantly, vocal expression did not affect performance in general: There was no effect of vocal expression on accurate recognition of old words, or on false recognition of new words that were not critical lures. $F_s < 1.33$, $p > .28$, $\eta^2 < .10$.

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