The Relationship between Vocal, Trait, and Physical Markers of Dominance

Tracy Celestin
~~Candidate~~ for the degree

Bachelor of Sciences

Submitted in partial fulfilment of the requirements for

Departmental Distinction in Psychology

Susan Hughes
Thesis Advisor: Susan M. Hughes, Ph.D.

Departmental Reader: Keith Feigenson, Ph.D.

College Reader: Stephen Mech, Ph.D.

F. Wilbur Gingrich Library
Special Collections Department
Albright College

Release of Senior Thesis

I hereby grant to the Special Collections Department of the F. Wilbur Gingrich Library at Albright College the nonexclusive right and privilege to reproduce, disseminate, or otherwise preserve the Senior Honors Thesis described below in any noncommercial manner that furthers the educational, research or public service purposes of Albright College. Copyright privileges remain with me, the author.

Title: The Relationship between Vocal, Trait, and Physical Markers of Dominance

Signature of Author: Tracy Celestin Date: 5-7-18

Printed Name of Author: Tracy Celestin

Street Address: 1673 Troy Ave

City, State, Zip Code: Brooklyn, NY, 11234

The Relationship between Vocal, Trait, and Physical Markers of Dominance

Tracy Celestin

Albright College

Abstract

In previous research, voice, SHR, height, and handgrip strength have all been linked to testosterone and dominance (Dabbs & Mallinger, 1999; Gallup, White, & Gallup Jr., 2007; Kasperk et. al, 1996; Marsh, Yu, Schechter, & Blair, 2009). The aim of this study was to examine whether there is a relationship between different physical, personality trait, and vocal markers of dominance. Participants were measured for several traits related to dominance that included handgrip strength, height, shoulder-to-hip ratio, waist-to-hip ratio, and participants completed personality inventories measuring dominance. Participants also provided voice samples that independent raters evaluated for vocal dominance and used to estimate speakers' height. Results showed that the taller a man was perceived to be, the more dominant other males rated his voice as sounding. Perceived vocal dominance was positively correlated to a female speaker's perceived height, but not their actual height. There were also several acoustic measures of the voices that related to markers of dominance for women. Further, social dominance orientation (SDO) positively correlated with women's' personality dominance score. These findings demonstrate that some, but not all features that signal dominance are related to one another.

The Relationship between Vocal, Trait, and Physical Markers of Dominance

Dominance can be defined as the potential to successfully acquire resources through force (physical or otherwise), threat of force, or through the perceived benefits of associating with prestigious (i.e. high-ranking) social partners (Watkins & Pisanski, 2016). Dominance may influence important social outcomes such as choice of leaders (Blaker et al., 2013). There tends to be a relationship between testosterone and dominance, which can be impactful in the context of competition, especially male-male competition (Swaddle & Reierson, 2002; Kasperk et. al, 1996; Dabbs & Mallinger, 1999; Evans, Neave, Wakelin, & Hamilton, 2008; Hodges-Simeon, Gaulin, & Puts, 2010). Even highly dominant women who were given testosterone had a desire to continue competing after winning a competitive task (Mehta et al., 2015). The trait of dominance also seems to play a role in mate selection. Women prefer dominant men, specifically for long-term dating, and women's preference for dominant men is greater when they are the most fertile during their menstrual cycle (Lukaszewski & Roney, 2008). Dominance msy be a beneficial trait for people to have.

Perceived Dominance

There are many features that contribute to our perception of dominance in others. For instance, men's faces that display the effects of high levels of testosterone (i.e., lower jaws, sharper brow ridges, and longer faces) were perceived as being more dominant, but they were not necessarily perceived as the most attractive (Swaddle & Reierson, 2002). Dominant faces may not always be perceived as being attractive. Kleisner, Kočnar, Rubešová, and Flegr (2010) found that men with brown eyes were perceived as more dominant than men with blue eyes presumably because brown eyes correlated with other features (e.g., larger chins, broader mouths, thicker eyebrows, and larger noses) that are associated with genes that code for the

production of testosterone (Kleisner, Kočnar, Rubešová, & Flegr, 2010). There are also age differences in the correlates of perceived dominance; younger children consider aggressive actions, like bullying, to signal dominance while older children consider socioeconomic status as a sign of dominance (Wright, Zakriski, & Fisher, 1996). Facial characteristics, like eye color, nose size, and brow ridges, can influence perceived dominance.

Self-perception of their own level of dominance also seems to influence perception of others' dominance. For example, men who perceive themselves as dominant prefer to hear jokes told by men with dominant-sounding, lower-pitched voices, and also tend to be friends with men who have dominant, lower-pitched voices (Cowan, Watkins, Fraccaro, Feinberg, & Little, 2016). Additionally, men with higher scores on a dominance questionnaire were less likely to attribute dominance to other men, and were less sensitive to facial cues of male dominance than were less dominant men (Watkins, Jones, & DeBruine, 2010). Similarly, taller men were less likely to attribute dominance to men with deeper voices and masculine facial features when compared to shorter men (Watkins et al., 2010). Similar to men, tall women with higher scores on a dominance scale do not judge other women with masculine faces to be dominant (Watkins, Quist, Smith, DeBruine, & Jones, 2012). Collectively, these studies demonstrate that an individuals' own dominance level can influence their perception of others' dominance. Individuals used their perception of their own dominance to assess how dominant another individual is.

Dominant Personality Traits

There are many positive traits that are associated with the personality trait of dominance. For instance, those who have very dominant personalities were also perceived as being competent individuals in a group setting (Anderson & Kiduff, 2009). Lord, De Vader, and

Alliger (1986) conducted a meta-analysis and found that the trait of dominance also influences perceptions of leadership capabilities and highly dominant individuals are seen as leaders. Kalma, Visser, and Peeters (1993) identified two types of dominance, sociable and aggressive dominance, as they relate to differences in leadership style. Kalma et al (1993) found that socially-dominant individuals use direct strategies, such as explicitly saying what they want, when trying to communicate their intentions while aggressively dominant individuals use indirect strategies, such as hinting, flattery, and deceit. The type of dominance that an individual has may contribute to perceptions of leadership and competence.

In addition to the positive qualities associated with the trait of dominance, there are several negative attributes that are associated with the trait. For instance, individuals who are socially dominant also tend to have cold, vindictive, and aggressive personality traits (Lippa & Arad, 1999). Zhang and Reid (2017) found that men with high trait dominance think about more aggressive words after listening to a low-pitched male voice who they perceived was a threat. Individuals with high trait dominance also make more risky decisions when dealing with money (Demaree, DeDonno, Burns, Feldman, & Everhart, 2009). Highly dominant individuals are perceived to be competent leaders, but they also have aggressive personality traits.

It may be the case that those who have personality traits related to dominance also have physical features that signal social dominance. For instance, men who considered themselves to be dominant and were perceived as dominant by other individuals have larger facial width-to-height ratios (fWHRs; Mileva, Cowan, Cobey, Knowles, & Little, 2014), which could be a result of higher testosterone levels (Lefevre, Lewis, Perrett, & Penke, 2013). Men with low second to fourth digit (2D:4D) ratios, which has been shown to indicate greater prenatal testosterone exposure, were perceived as dominant and masculine by women (Neave, Laing, Fink, &

Manning, 2003). Coy, Green, and Price (2014) presented women with avatars of men that showed their body measurements and found that men with lower waist-to-chest ratios (WCRs) were seen as physically dominant and fit and were perceived as being more capable of providing protection. The seminal work conducted by Seltzer (1946) showed that those who had certain body proportions (e.g., tall stature for body weight, broad shoulders relative to the circumference of the chest, heads large for size of chest, faces broad for width of chest, hands large for body weight, hips broad for width of chest, etc.) had a greater frequency of possessing dominant personality traits. Testosterone may be the link between each of these traits that signal dominance.

Height and Dominance

Height, in particular, is a prominent physical feature that has been linked to dominance. When individuals' heights were manipulated experimentally, people who appeared taller were perceived as more socially dominant (Marsh, Yu, Schechter, & Blair, 2009). Perhaps height and body mass appear to signal dominance because it can give the appearance of being formidable. Indeed, when walking down a narrow street, shorter individuals tended to move out of the way for taller individuals who were passing (Stulp, Buunk, Verhulst, & Pollet, 2015). Shorter men are more aware of dominance cues in other men when observing men's faces and listening to their voices (Watkins et al., 2010). Melamed (1992) measured participants' heights and assessed their personality through a personality inventory and found that taller individuals tended to have more dominant and assertive personality traits. Height may signal dominance cues in men and may affect perceptions of dominance.

Being taller and therefore seemingly more dominant can afford a person many benefits. Judge and Cable (2004) examined the relationship between height and career success and found

that taller individuals typically earn more money. They also found that the average CEO's of Fortune 500 companies are approximately 3 inches taller than the average American man who stands at 5-foot-9, and 30% of the CEO's are over 6-foot-2 as opposed to only 3.9% of the adult men in the US population who are that height (Gladwell, 2005). Persico, Postlewaite, and Silverman (2004) found that after controlling for a number of family characteristics that are generally correlated with both height and wages (e.g., parents' education, parents' occupation and number of siblings), white men in the United States earned a 1.8-percent increase in wages with every additional inch of height. Professional football referees tend to be taller than assistant referees yet are less experienced than their assistants, suggesting that height may play more of a role than experience in order to be promoted (Stulp, Buunk, Verhulst, & Pollet, 2010). Additionally, taller individuals are more likely to be perceived as being leaders than are shorter individuals (Blaker et al., 2013). Being taller may be linked to more success and earning ore money.

Height can also influence facial perceptions of dominance. Re, DeBruine, Jones and Perret (2013) used a computer graphic software program to combine participants' faces for each sex and transformed the averaged faces to appear taller, shorter, more masculine, or less masculine. They found that male and female faces that were manipulated to look taller and more masculine were perceived as being dominant. Another study by Re et al. (2012) presented their participants with 3-D faces of men and women and asked them to indicate the person's height and their leadership ability. Their findings revealed that the faces that were perceived to belong to taller and healthier individuals by participants were also perceived as faces belonging to competent leaders. Height may be linked to facial perceptions of dominance.

Shoulder-to-hip Ratio (SHR) and Dominance

Shoulder-to-hip ratio (SHR) is another physical feature that has been linked to dominance. Men perceive other men with high SHR as more dominant and men tend to pay more attention to the shoulders of potential rivals (Buunk & Dijkstra, 2005). Men are also more jealous of other men with high SHR and are more likely to view them as potential rivals (Dijkstra & Buunk, 2001). Likewise, Dijkstra and Buunk (2001) found that women with high SHR evoked more jealousy and were perceived as physically and socially dominant.

SHR is an important factor in men's attractiveness. Dixon, Halliwell, East, Wignarajah, and Mathew (2003) conducted a study where participants were presented with figures of men's backs and found that women were more attracted to the figure with a more muscular, mesomorphic physique. Individuals with mesomorphic somatotypes have large bones, broad shoulders, and broad hips (Sills, 1950). Likewise, when observing line drawings of men's physiques, both men and women thought men with broader shoulders and more muscular chests were more attractive (Horvath, 1981). Shoup and Gallup (2008) took pictures of their male participants' faces, measured their SHR, and presented their photos to female participants to rate for attractiveness. They found that women rated the faces of men with high SHRs as attractive, despite the fact that they only viewed the men from the neck up. Men with high SHRs also seem to have to have more sexual opportunity; high SHR men tend to engage in sexual intercourse at an early age, have more sexual partners in their lifetime, and have more affair partners (Hughes & Gallup, Jr., 2003; Gallup, White, & Gallup, Jr., 2007).

Handgrip Strength and Dominance

Handgrip strength (HGS) can be revealing of one's level of dominance. Men with high HGS values tend to have broader shoulders and are more aggressive than men with low HGS values (Gallup, White, & Gallup Jr. 2007). Gallup, O'Brien, and Wilson (2010) found that male

high school seniors with high HGS were perceived as more aggressive, dominant, and healthy than men with low HGS. Men with high HGS values were also more inclined to participate in aggressive activities after listening to a male with a lower-pitched voice perceived to be a potential threat (Zhang & Reid, 2017). High HGS may be associated with aggressive personality trait and behaviors.

Men typically tend to have higher HGS values than women and HGS values are higher for the dominant hand (Kamural, Ahmad, & Loh, 2006). Kamarul et al. (2006) also demonstrated that HGS values, in both the left and right hands, are greater for taller and heavier people. Likewise, Chandrasekaran, Ghosh, Prasad, Krishnan, and Chandrasharma, (2010) also showed that older, taller, and heavier individuals have greater HGS. Among Caucasian adults, HGS increases until 35 years old, then the values begin to decrease with age (Günther, Bürger, Rickert, Crispin, Schulz, 2008). HGS values may be linked to age, gender, height, and body mass index.

HGS correlates to the perception of one's facial dominance. Winghager, Schaefer, and Fink (2011) found that men who had greater HGS also had faces that were perceived by women as being more dominant and masculine. These men had facial features of heavier individuals such as a round face, curved jaw line, and wide eyebrows. Fink, Neave, and Seydel (2007) also found that women perceived the faces of men with high HGS as being masculine, attractive, and dominant. Greater HGS values may be linked to facial perceptions of dominance.

Weak HGS can indicate the presence of diseases, thus signaling signs of weakness and lower dominance. Matos, Tavares, and Amaral, (2007) showed that HGS can be used as a predictor of illness and nutritional deficits in hospitalized patients. Those with type 2 diabetes mellitus have weaker HGS than healthy individuals (Cetinus, Buvukhese, Uzel, Ekerbicer, &

Karaoguz, 2005), as do individuals with rheumatoid arthritis (Fraser, Vallow, Preston, & Cooper, 1999). Additionally, HGS can predict mortality rates (Rantanen et al., 2003). Snih, Markides, Ray, Ostir, and Goodwin (2002) showed that the mortality rate was higher in older Mexican Americans with weaker HGS. Weaker HGS may be linked to illnesses and mortality.

Voice and Dominance

Voice can also signal dominance. Low voice pitch is related to high levels of testosterone in men (Dabbs & Mallinger, 1999). A lower pitch (low fundamental frequency, F_0) is not only associated with higher testosterone levels, but also physical dominance in men (Evans, Neave, Wakelin, & Hamilton, 2008). Hughes, Harrison, and Gallup (2009) found that people are capable of accurately estimating men's SHRs simply from listening to their voices. This finding suggests that individuals may be able to assess physical features of dominance by hearing one's voice alone.

Men with masculine, low-pitched voices are seen as dominant and attractive by both men and women (Puts, Gaulin, & Verdolini, 2006; Collins, 2000). Men with voices that are perceived as threatening by other men are considered to also have threatening faces (Han et al., 2017). Hodges-Simeon, Gaulin, and Puts (2010) also assessed whether voice pitch influences perceptions of attractiveness and dominance and found that men associated a low male pitch to physical dominance. Indeed, Pisanski et al. (2014) showed that men and women with low F_0 were taller and heavier. When listening to male voice recording that were manipulated to sound higher or lower, individuals thought that voice recordings with low formant dispersion (D_f) belonged to physically dominant men (Puts, Hodges, Cárdenas, & Gaulin, 2007). D_f is associated with longer vocal tracts in men, which results from higher levels of testosterone during puberty (Fitch & Giedd, 1999). Also, men and women with voices that were manipulated to sound lower

were chosen as leaders (Klofstad et al., 2012; Watkins & Pisanski, 2016). CEOs with lower-pitched voices tended to oversee larger companies and received tenure for a longer period of time (Mayew et al., 2013; Watkins & Pisanski, 2016). Low-pitched voices and D_f may be associated with perceptions of dominance.

When both sexes were asked to deliberately portray a dominant-sounding voice, both sexes were capable of projecting a dominant voice compared to their normal speaking voice (Hughes, Mogilski, & Harrison, 2014). Both sexes raised their pitch and spoke louder in order to sound dominant and women had less vocal hoarseness. Men will manipulate their voices when competing with other men. For example, in the context of competing for a lunch date with a woman, men had lowered their voices when they were near another man who appeared to be more dominant (Puts, Gaulin, & Verdolini, 2006). Men who consider themselves to be very dominant tend to rate other men's voices as sounding less dominant (Wolff & Puts, 2010). Lowering one's voice may be used to portray dominance.

Women with low-pitched voices are also perceived as being more dominant than women with high-pitched voices (Borkowska & Pawlowski, 2011). There is a possibility that prenatal androgen exposure may influence the development of women's voices; women with lower second digit to fourth digit (2D:4D) ratios, which is an indirect measure of greater prenatal hormone exposure within each sex, have voices that are rated as sounding mature and dominant (Hughes, Pastizzo, Gallup, 2008). When examining the Hadza, an indigenous group of hunter-gathers, not only men, but also women with deeper voices are perceived as more capable of acquiring resources (Apicella & Feinberg, 2009; Watkins & Pisanski, 2016). The hunter-gathers' ability to successfully acquire resources relies on physical strength and a muscular physique, thus it seems that those with deeper voices had the strength to acquire such resources.

Current Study

This study examined whether there is a relationship between different markers of vocal, personality trait, and physical dominance. I hypothesized that participants with voices that are rated as sounding more dominant would also have physical features signaling dominance (e.g., taller height, larger shoulder-to-hip ratio, greater handgrip strength) than participants with less dominant-sounding voices. I also predicted that those with more dominant sounding voices and dominant physical features would have dominant personality traits as measured from a personality inventory. While I predicted that there would be a sex difference in these features of dominance, such that men's voices would be rated as more dominance, I hypothesized that within each sex, the relationship between these dominance markers would still exist.

In previous research, voice, SHR, height, and handgrip strength have all been linked to testosterone and dominance (Dabbs & Mallinger, 1999; Gallup, White, & Gallup Jr., 2007; Kasperk et. al, 1996; Marsh, Yu, Schechter, & Blair, 2009). This study attempted to bridge this gap in the literature by examining whether there is a relationship between each of these physical, trait, and vocal markers of dominance. To test these hypotheses, a sample of participants provided a voice sample (i.e., a number count recitation), and their height, shoulder width, waist width, and hip width were measured. These body measures served as physical markers of dominance. In addition, a measure of their handgrip strength was taken using a digital dynamometer and the participants were asked to complete a personality inventory scale that measured dominance. Participants rated the voices of previous participants for how dominant their voices sounded and were asked to estimate the speaker's height without being given any information about the speaker. The voice ratings were correlated with the speakers' personality

and physical measures taken to determine if there is a relationship between perceived vocal, trait, and physical markers of dominance.

Method

Participants

Speakers. There were 83 undergraduate students (51 women, 32 men) who provided voice samples and other measures used for analyses in this study. These participants were obtained from the Psychology Department Participant Pool at Albright College as well as acquaintances of the investigator to participate in this study. The mean age was 20 (*SD* = 1.45, range 18-25). Most participants were Caucasian (44.6%), followed by African American/Black (31.3%), Hispanic/Latino (18.1%), Asian (2.44%), and other (3.6%). Originally, there were ninety-one provided voice samples but eight had to be eliminated due to several reasons. For instance, nine participants indicated that English was not their native language, and two were eliminated because they had a discernable accent. All other participants providing voice samples did not have a discernable accent foreign to the Northeastern region of the United States.

Two other participants were eliminated because they indicated having auditory surgery, two speakers indicated that they had a cold or an illness at the time of the experiment and were also eliminated due to the possibility that their ailment would affect their voice. One speaker who indicated that they were a heavy smoker (i.e., smoked several packs a week) was also eliminated because their frequent smoking could have affected their speech.

Raters. There were 107 undergraduate students (64 women, 43 men) who served as raters of the vocal stimuli. All participants, except for the first seven participants, who provided voice samples as described above also served as raters. Nineteen additional raters were also used to provide ratings for the last few voices collected, and to rate any voice samples that had an

insufficient number of male and/or female raters. The mean age of the raters was 20 (*SD* = 1.45, range 18-25). The majority of participants reported being Caucasian (44.9%) followed by African American/Black (30.8%), Hispanic/Latino (17.8%), Asian (2.8%), and other (3.7%). Two raters were eliminated due to reports of having auditory impairments.

Participation in the study was completely voluntary, and participants could receive extra credit or credit in their psychology classes for their participation in this study at the discretion of their professors. All procedures were approved by the local Institutional Review Board.

Materials and Procedure

After giving informed consent, participants were asked to complete a demographic questionnaire that included questions asking their sex, age, native language, ethnicity, and items possibly affecting their speech, as reported above. Participants were then asked to complete two personality inventories that measured the trait of dominance. The first inventory included a 41-item test obtained from *Psychology Today* and included some self-assessment statements and some hypothetical questions where participants had to select the option that was most similar to how they would behave in that situation. The second inventory was the Social Dominance Orientation (SDO) Questionnaire (Pratto et al., 1994), a reliable measure to test for social dominance.

Then, the participants had their voices recorded while being asked to recite a number count from 1 to 10 at approximately one numeral per second. The voice sample was recorded using the Voice Recorder app, version 12.25.3321, by recorder and smart apps on a Samsung Galaxy J3 cellphone. Afterwards, the participants' handgrip strength was recorded in kilograms (kg) using the Camry Electronic Hand Dynamometer, EH101. The handgrip strength of the non-dominant hand was recorded first followed by the dominant hand. There was one participant who

indicated they had rheumatoid arthritis and this measure was subsequently eliminated from the data set for only this measure. There were 18 participants who indicated that they sustained some type of injury to their hand/wrist, but they were not eliminated because they reported that it would not affect their strength or that the injury occurred at least a year prior. Then, the width of the participants' waist (the smallest point between the rib cage and the hips), hips (the widest point between the waist and the thighs, and shoulders were taken using an anthropomorphic measuring tape. The heights of the participants were measured in centimeters (cm).

Lastly, participants were asked to listen to and rate a set of voice recordings of the previous participants counting from 1 to 10. Raters indicated whether they thought the voice belonged to a male or female speaker, rated how dominant they thought the speaker's voice was for their sex on 10-point scale (1 = not at all, 10 = very), and estimated the speaker's height in feet and inches. None of the participants incorrectly identified the sex of the speaker. Because the participants rated the voices of the previous participants, the first few raters did not rate any voices, and the first 25 participants rated fewer than 25 voices samples. Once we collected a sample of 25 voices from the first participants, subsequent participants each rated 25 voice samples. For the last set of voices, additional raters were obtained to rate those voices and to provide ratings for any voice sample that had an insufficient number of male or female raters. In total, each voice was rated by an average of 27 participants (*SD* = 2.80) An average of 11 males (*SD* = 1.10) and 14 females (*SD* = 3.02) rated each voice. At the conclusion of the study, participants were debriefed about the purpose of the study and were given an extra credit form to complete information in order to gain credit for their classes.

Acoustic Analyses

Voice acoustic measures were conducted using the Praat program, version 6.0.39. A voice report was obtained for each voice sample listing: mean pitch, pitch standard deviation (SD), shimmer, jitter, and noise-to-harmonics ratio (NHR) of each voice sample. Mean pitch indicates how high or low a voice sounds (Tusing & Dillard, 2000). Mean pitch is also referred to as fundamental frequency of a voice. Pitch SD measures how dispersed the pitch is (Hodges-Simeon, Gaulin, & Puts, 2010). Shimmer measures the changes in amplitude of the voice while jitter indicates the changes in frequency. Both jitter and shimmer contribute to perceptions of voice hoarseness and roughness (Dejonckereetal.,1996). Noise-to-harmonics ratio (NHR) measures the proportion of noise to harmonic sound in the voice and indicates voice quality (Ferrand, 2002).

Results

Table 1 reports sex differences in each of the measured traits signaling dominance. As shown in the table, men, compared to women, were significantly taller, $t(81) = 10.81$, $p < .001$, had greater average handgrip strength, $t(80) = 9.60$, $p < .001$, waist-to-hip ratio, $t(80) = 5.83$, $p < .001$, shoulder-to-hip ratio, $t(80) = 5.54$, $p < .001$, and noise-to-harmonics ratio, $t(81) = 3.80$, $p < .001$. Women had a higher mean pitch, $t(81) = -10.81$, $p < .001$, and pitch standard deviation, $t(81) = -3.39$, $p < .001$, than men. There were no sex differences found for vocal, jitter, shimmer, or scores on the personality dominance inventory and Social Dominance Orientation (SDO) inventory. A Bonferroni correction was applied to these results and only differences with *p*-values less than .005 were considered significant.

Because sex differences were found in most of the measured traits, analyses were conducted separately for each sex. Table 2 lists Pearson correlations for men between independent ratings for vocal dominance, independent estimates of speakers' height, speakers'

actual height, average handgrip strength (HGS), waist-to-hip ratio (WHR), shoulder-to-hip ratio (SHR), and scores on the dominance personality inventory and the Social Dominance Orientation (SDO) inventory, and the five acoustic measures taken [mean pitch, pitch standard deviation (SD), jitter, shimmer, noise-to-harmonics ratio (NHR)]. Due to the multiple comparisons being performed, a Bonferroni correction was also applied to these correlations (i.e., $p < .003$). There were several vocal traits that correlated with one another; mean pitch was positively correlated with pitch SD, $r(29) = .78$, $p < .001$, jitter, $r(29) = .75$, $p < .001$, shimmer, $r(29) = .57$, $p = .001$, and NHR, $r(29) = .59$, $p < .001$. Pitch SD was positively correlated with jitter, $r(29) = .85$, $p < .001$, shimmer, $r(29) = .80$, $p < .001$, and NHR, $r(29) = .76$, $p < .001$. Jitter was positively correlated with shimmer, $r(29) = .79$, $p < .001$, and NHR, $r(29) = .90$, $p < .001$. Shimmer and NHR were also significantly correlated with one another, $r(29) = .85$, $p < .001$. When only considering male raters, a Pearson correlation demonstrated that the taller a man was perceived to be, the more dominant other males rated his voice as sounding, $r(29) = .72$, $p < .001$.

A multiple regression analysis was conducted to assess the relationship between the traits that signal dominance among men. Measured height, average HGS, WHR, SHR, personality dominance score, and SDO score were used as predictors and the ratings for vocal dominance was the criterion. The regression analysis revealed that neither measured height (ß = .181), average HGS (ß = .150), WHR (ß = .058), SHR (ß = .343), personality dominance score (ß = -.070), SDO score (ß = -.325), nor pitch (ß = -.273) had uniquely predicted the voice dominance ratings, and the overall regression was not significant, $R^2 = .20$, $F(7, 21) = .759$, $p = .627$.

Table 3 displays Pearson correlations between traits that signal dominance in women. As shown in the table, pitch was negatively correlated with shimmer, $r(49) = -.48$, $p < .001$, and

NHR, $r(49) = -.45$, $p = .001$. Jitter was positively correlated with shimmer, $r(49) = .62$, $p < .001$, and NHR, $r(49) = .78$, $p < .001$. Shimmer was positively correlated with NHR, $r(49) = .79$, $p < .001$ and height. Pitch SD was positively correlated with jitter, $r(49) = .47$, $p = .001$, shimmer, $r(49) = .50$, $p < .001$, and NHR, $r(49) = .50$, $p < .001$.The more dominant a woman's voice was rated, the taller she was estimated as being when only hearing her voice. increased, the estimated height ratings increased, $r(49) = .74$, $p < .001$. Lastly, SDO score was positively correlated with personality dominance score, $r(49) = .61$, $p < .001$. When only considering ratings made by female raters, a Pearson correlation revealed that their perceived voice dominance ratings increased as their estimated height ratings increased, $r(49) = .76$, $p < .001$. When considering only ratings made by men, the taller a woman was, the more dominant her voice was perceived, $r(29) = .60$, $p < .001$.

A multiple regression analysis was conducted to assess the relationship between the traits that signal dominance among women. Measured height, average HGS, WHR, SHR, personality dominance score, and SDO score were used as predictors and ratings for voice dominance was the criterion. The regression analysis revealed that neither measured height (ß = -.076), average HGS (ß = -.008), WHR (ß = -.260), SHR (ß = .183), personality dominance score (ß = .017), SDO score (ß = .195), nor pitch (ß = -.275) had uniquely predicted voice dominance ratings, and the overall regression model was not significant, $R^2 = .17$, $F(7, 42) = 1.260$, $p = .293$.

Discussion

This study examined whether there was a relationship between different markers of vocal, personality trait, and physical dominance. First, I documented several sex differences in the measures taken. Men, compared to women, were taller, had higher average handgrip strength, waist-to-hip ratio, and shoulder-to-hip ratio. These findings are in line with previous studies,

especially those that have documented men's greater handgrip strength (Chandrasekaran, Ghosh, Prasad, Krishnan, & Chandrasharma, 2010; Kamural, Ahmad, & Loh, 2006), shoulder-to-hip ratio (Buunk & Dijkstra, 2005), waist-to-hip ratio (Chiappa & Singh, 2017), and height compared to women. Men's voices also showed a greater noise-to-harmonics ratio (i.e., voice quality). I also found that women had higher pitch and pitch standard deviation than men. This finding was supported by previous studies that indicate that women's pitch is approximately an octave higher than men's pitch (Latinus & Taylor, 2012).

For men, males who were perceived to be taller were perceived as having more dominant sounding voices only by male raters. This finding is in line with previous studies demonstrating that lower voices are perceived as being more dominant (Puts, Gaulin, & Verdolini, 2006; Puts, Hodges, Cardenas, & Gaulin, 2007) and associated with taller individuals (Pisanski et al., 2014). Perhaps men were able to use voice to estimate the height of participants because height in men is very important when it comes to women's choices in selecting mates. Swami et al. (2008) found that men prefer their partner to be shorter than them while women prefer their partner to be taller, and people prefer relationships where the man is taller than the woman. This preference is stronger for men than women (Stulp, Buunk, & Pollet, 2013; Swami et al., 2008). Pierce (1999) also found that women were more romantically attracted to taller men than shorter men. In heterosexual relationships, taller men do not feel as jealous as shorter men when another man expresses interest in their girlfriend (Buunk, Park, Zurriaga, Klavina, & Massar, 2008). On the other hand, taller women are more jealous than women who are average height when a rival expresses interest in their partner. Taller men also have more children than shorter men (Pisanski & Feinberg, 2013) and men without children were found to be shorter than men with at least one child (Pawlowski, Dunbar, & Lipowicz, 2000).

For women, their scores on the dominance personality trait inventory predicted their scores on the social dominance inventory. This finding supports previous investigations that have shown that those who score high on the personality trait of dominance are also perceived as being competent individuals in a group setting (Anderson & Kiduff, 2009) and are seen as leaders (Lord, De Vader, & Alliger, 1986). The results of this study have also demonstrated that some acoustic measures of women's voices signal dominance. I found that women who had voices perceived as sounding more dominant were perceived by others as being taller in height. Perhaps, these women had low-pitched voices. Women with low-pitched voices are perceived as leaders (Klofstad et al., 2012; Watkins & Pisanski, 2016) and are seen as more dominant than women with high-pitched voices (Borkowska & Pawlowski, 2011). Studies have documented that women with lower pitch are taller (Pisanski et al., 2014). Perhaps, women with voices that were perceived as dominant were believed t be taller because lower pitch in women has been associated to being taller.

I was unable to demonstrate significant relationships between perceived vocal dominance and other features signaling dominance, such as taller height, larger SHR, greater HGS, and higher dominance personality trait. It may be that the sample size was not large enough to detect significant relationships, as many of these correlations were in the predicted direction. It is also possible that perhaps testosterone is not what is driving the perception of vocal dominance as it is with the other traits measured. Indeed, no relationship was found between perceived vocal dominance and a lower voice pitch, and voice pitch is known to be influenced by testosterone (Dabbs & Mallinger, 1999). Also, the study was conducted in a setting where the participants may not have felt threatened or felt as if they were competing, thus vocal dominance was not portrayed. Perhaps a relationship between perceived vocal dominance and other features

signaling dominance could have been found if the participants were placed in a position where they felt threatened.

Limitations

There were several limitations and confounds that could have affected these results. First, while a sample of 31 men and 51 women used as stimuli was adequate, perhaps a larger sample size used as stimuli would provide more statistical power and would be more sensitive to detecting significant relationships. Second, the audio speakers that were used to play the voice samples were not of high quality and there were some technical difficulties experienced, which affected the playback volume for some voice samples. Third, the experiment was not conducted in the same room throughout the experiment and the acoustics of the room and extraneous background noise may have affected some ratings. Fourth, for some participants, the electric hand dynamometer would not record the handgrip strength value the first time, which provided the risk of fatigue effects. In order to control for fatigue effect, the participant's handgrip strength was recorded again after the other physical measures were recorded. Lastly, the participants' may have had a different understanding of what dominance meant when completing the personality inventories, as I noted that a few participants asked what the term dominance meant during the study.

Future Directions

Future investigations that continue this line of work could investigate whether people who are better at intentionally projecting a dominant voice may have other physical features that signal dominance. Future studies could also examine how mean pitch and pitch variation contribute to how accurately a person can portray a dominant voice and whether there is a relationship between perceived vocal dominance and pitch. Also, future investigators could

assess whether vocal dominance would be captured better if participants were put in a situation of competition or had felt threatened.

Conclusion

This study demonstrated that although some traits which signal dominance are related to one another, many of these markers are not. Results showed that the taller a man was perceived to be, the more dominant other males rated his voice as sounding. For females, perceived vocal dominance was positively correlated to the speaker's perceived height, but not their actual height. Further, females' social dominance orientation (SDO) was positively correlated with their personality dominance score. It appears that dominance traits related for women more than men. This could be due to the unequal representation of men in this study. These findings demonstrate that only some, but not all, features that signal dominance (e.g., height, shoulder-to-hip ratio, and low pitch) are related to one another within each sex.

References

Anderson, C., & Kilduff, G. J. (2009). Why do dominant personalities attain influence in face-to-face groups? The competence-signaling effects of trait dominance. *Journal of Personality and Social Psychology*, *96*(2), 491-503. doi:10.1037/a0014201

Apicella, C. L. & Feinberg, D. R. (2009). Voice pitch alters mate-choice relevant perception in hunter-gatherers. *Proceedings of the Royal Society of London B, 276*, 1077-1082.

Blaker, N. M., Rompa, I., Dessing, I. H., Vriend, A. F., Herschberg, C., & van Vugt, M. (2013). The height leadership advantage in men and women: Testing evolutionary psychology predictions about the perceptions of tall leaders. *Group Processes and Intergroup Relations*, *16*(1), 17-27. doi:10.1177/1368430212437211

Borkowska, B., & Pawlowski, B. (2011). Female voice frequency in the context of dominance and attractiveness perception. *Animal Behaviour*, *82*(1), 55-59. doi:10.1016/j.anbehav.2011.03.024

Buunk, B. P., & Dijkstra, P. (2005). A narrow waist versus broad shoulders: Sex and age differences in the jealousy-evoking characteristics of a rival's body build. *Personality and Individual Differences*, *39*(2), 379-389. doi:10.1016/j.paid.2005.01.020

Buunk, A. P., Park, J. H., Zurriaga, R., Klavina, L., & Massar, K. (2008). Height predicts jealousy differently for men and women. *Evolution and Human Behavior*, *29*(2), 133-139.

Cetinus, E., Buyukbese, M. A., Uzel, M., Ekerbicer, H., & Karaoguz, A. (2005). Hand grip strength in patients with type 2 diabetes mellitus. *Diabetes Research and Clinical Practice*, *70*(3), 278-286.

Chandrasekaran, B., Ghosh, A., Prasad, C., Krishnan, K., & Chandrasharma, B. (2010). Age and anthropometric traits predict handgrip strength in healthy normals. *Journal of Hand and Microsurgery*, *2*(2), 58-61.

Chiappa, P., & Singh, S. (2017). Sexual dimorphism in waist-to-hip ratio and divorce frequency in human populations. *Evolutionary Behavioral Sciences*, *11*(3), 221-241. doi:10.1037/ebs0000100Collins, S. A. (2000). Men's voices and women's choices. *Animal Behaviour*, *60*(6), 773-780. doi:10.1006/anbe.2000.1523

Cowan, M. L., Watkins, C. D., Fraccaro, P. J., Feinberg, D. R., & Little, A. C. (2016). It's the way he tells them (and who is listening): Men's dominance is positively correlated with their preference for jokes told by dominant-sounding men. *Evolution and Human Behavior*, *37*(2), 97-104. doi:10.1016/j.evolhumbehav.2015.09.002

Coy, A. E., Green, J. D., & Price, M. E. (2014). Why is low waist-to-chest ratio attractive in males? The mediating roles of perceived dominance, fitness, and protection ability. *Body Image*, *11*(3), 282-289. doi:10.1016/j.bodyim.2014.04.003

Dabbs, J. J., & Mallinger, A. (1999). High testosterone levels predict low voice pitch among men. *Personality and Individual Differences*, *27*(4), 801-804. doi:10.1016/S0191-8869(98)00272-4

Dejonckere, P. (1998). Effect of louder voicing on acoustical measurements in dysphonic patients. Logopedics, Phoniatrics, Vocology, 23, 79–84.

Demaree, H. A., DeDonno, M. A., Burns, K. J., Feldman, P., & Everhart, D. E. (2009). Trait dominance predicts risk-taking. *Personality and Individual Differences*, *47*(5), 419-422. doi:10.1016/j.paid.2009.04.013

Dijkstra, P. & Buunk, B. P. (2001). Sex differences in the jealousy-evoking nature of a rival's body build. *Evolution and Human Behavior*, *22*(5), 335-341.

Dixson, A. F., Halliwell, G., East, R., Wignarajah, P., & Anderson, M. J. (2003). Masculine somatotype and hirsuteness as determinants of sexual attractiveness to women. *Archives of Sexual Behavior*, *32*(1), 29-39. doi:10.1023/A:1021889228469

Dominance Test. (n.d.). Retrieved November 05, 2017, from https://www.psychologytoday.com/tests/career/dominance-test

Evans, S., Neave, N., Wakelin, D., & Hamilton, C. (2008). The relationship between testosterone and vocal frequencies in human males. *Physiology and Behavior*, *93*(4-5), 783-788. doi:10.1016/j.physbeh.2007.11.033

Ferrand, C. T. (2002). Harmonics-to-noise ratio: An index of vocal aging. *Journal of Voice*, *16*(4), 480-487. doi:10.1016/S0892-1997(02)00123-6

Fink, B., Neave, N., & Seydel, H. (2007). Male facial appearance signals physical strength to women. *American Journal of Human Biology*, *19*(1), 82-87.

Fitch, W. T., & Giedd, J. (1999). Morphology and development of the human vocal tract: A study using magnetic resonance imaging. *The Journal of the Acoustical Society of America*, *106*(3), 1511-1522.

Fraser, A., Vallow, J., Preston, A., & Cooper, R. G. (1999). Predicting 'normal' grip strength for rheumatoid arthritis patients. *Rheumatology (Oxford, England)*, *38*(6), 521-528.

Gallup, A. C., White, D. D., & Gallup, G. J. (2007). Handgrip strength predicts sexual behavior, body morphology, and aggression in male college students. *Evolution and Human Behavior*, *28*(6), 423-429. doi:10.1016/j.evolhumbehav.2007.07.001

Gallup, A. C., O'Brien, D. T., White, D. D., & Wilson, D. S. (2010). Handgrip strength and socially dominant behavior in male adolescents. *Evolutionary Psychology*, *8*(2), 229-243. doi:10.1177/147470491000800207

Gladwell, M. (2005). *Blink: The power of thinking without thinking*. New York: Little, Brown & Company.

Günther, C. M., Bürger, A., Rickert, M., Crispin, A., & Schulz, C. U. (2008). Grip strength in healthy caucasian adults: Reference values. *The Journal of Hand Surgery*, *33*(4), 558-565.

Han, C., Kandrik, M., Hahn, A. C., Fisher, C. I., Feinberg, D. R., Holzleitner, I. J., ... & Jones, B. C. (2017). Interrelationships among men's threat potential, facial dominance, and vocal dominance. *Evolutionary Psychology*, *15*(1), 1474704917697332.

Hodges-Simeon, C. R., Gaulin, S. C., & Puts, D. A. (2010). Different vocal parameters predict perceptions of dominance and attractiveness. *Human Nature*, *21*(4), 406-427. doi:10.1007/s12110-010-9101-5

Horvath, T. (1981). Physical attractiveness: The influence of selected torso parameters. *Archives Of Sexual Behavior*, *10*(1), 21-24. doi:10.1007/BF01542671

Hughes, S. M., & Gallup, G. J. (2003). Sex differences in morphological predictors of sexual behavior: Shoulder to hip and waist to hip ratios. *Evolution and Human Behavior*, *24*(3), 173-178. doi:10.1016/S1090-5138(02)00149-6

Hughes, S. M., Pastizzo, M. J., & Gallup, G. J. (2008). The sound of symmetry revisited: Subjective and objective analyses of voice. *Journal of Nonverbal Behavior*, *32*(2), 93-108. doi:10.1007/s10919-007-0042-6

Hughes, S. M., Harrison, M. A., & Gallup, G. J. (2009). Sex-specific body configurations can be estimated from voice samples. *Journal of Social, Evolutionary, and Cultural Psychology*, 3(4), 343-355. doi:10.1037/h0099311

Hughes, S. M., Mogilski, J. K., & Harrison, M. A. (2014). The perception and parameters of intentional voice manipulation. *Journal of Nonverbal Behavior*, *38*(1), 107-127. doi:10.1007/s10919-013-0163-z

Judge, T. A., & Cable, D. M. (2004). The effect of physical height on workplace success and income: Preliminary test of a theoretical model. *Journal of Applied Psychology*, *89*(3), 428-441. doi:10.1037/0021-9010.89.3.428

Kalma, A. P., Visser, L., & Peeters, A. (1993). Sociable and aggressive dominance: Personality differences in leadership style?. *The Leadership Quarterly*, *4*(1), 45-64. doi:10.1016/1048-9843(93)90003-C

Kamarul, T., Ahmad, T. S., & Loh, W. Y. C. (2006). Hand grip strength in the adult Malaysian population. *Journal of Orthopaedic Surgery*, *14*(2), 172-177.

Kasperk, C., Helmboldt, A., Borcsok, I., Heuthe, S., Cloos, O., Niethard, F., & Ziegler, R. (1997). Skeletal site-dependent expression of the androgen receptor in human osteoblastic cell populations. *Calcified Tissue International*, *61*(6), 464-473.

Kleisner, K., Kočnar, T., Rubešová, A., & Flegr, J. (2010). Eye color predicts but does not directly influence perceived dominance in men. *Personality and Individual Differences*, *49*(1), 59-64. doi:10.1016/j.paid.2010.03.011

Klofstad, C. A., Anderson, R. C. & Peters, S. (2012). Sounds like a winner: Voice pitch influences perception of leadership capacity in both men and women. *Proceedings of the Royal Society of London B, 279*, 2698-2704.

Latinus, M., & Taylor, M. J. (2012). Discriminating male and female voices: Differentiating pitch and gender. *Brain Topography, 25*(2), 194-204. doi:10.1007/s10548-011-0207-9

Lefevre, C. E., Lewis, G. J., Perrett, D. I., & Penke, L. (2013). Telling facial metrics: Facial width is associated with testosterone levels in men. *Evolution and Human Behavior, 34*(4), 273-279. doi:10.1016/j.evolhumbehav.2013.03.005

Lippa, R., & Arad, S. (1999). Gender, personality, and prejudice: The display of authoritarianism and social dominance in interviews with college men and women. *Journal of Research In Personality, 33*(4), 463-493. doi:10.1006/jrpe.1999.2266

Lord, R. G., de Vader, C. L., & Alliger, G. M. (1986). A meta-analysis of the relation between personality traits and leadership perceptions: An application of validity generalization procedures. *Journal of Applied Psychology, 71*(3), 402-410. doi:10.1037/0021-9010.71.3.402

Lukaszewski, A. W., & Roney, J. R. (2009). Estimated hormones predict women's mate preferences for dominant personality traits. *Personality and Individual Differences, 47*(3), 191-196. doi:10.1016/j.paid.2009.02.019

Matos, L. C., Tavares, M. M., & Amaral, T. F. (2007). Handgrip strength as a hospital admission nutritional risk screening method. *European Journal of Clinical Nutrition, 61*(9), 1128.

Marsh, A. A., Henry, H. Y., Schechter, J. C., & Blair, R. J. R. (2009). Larger than life: humans' nonverbal status cues alter perceived size. *Plos One, 4*(5), doi.org/10.1371/journal.pone.0005707.

Mayew, W. J., Parsons, C. A. & Venkatachalam, M. (2013). Voice pitch and the labor market success of male chief executive officers. *Evolution and Human Behavior, 34*, 243-248.

Mehta, P. H., van Son, V., Welker, K. M., Prasad, S., Sanfey, A. G., Smidts, A., & Roelofs, K. (2015). Exogenous testosterone in women enhances and inhibits competitive decision-making depending on victory–defeat experience and trait dominance. *Psychoneuroendocrinology*, 60, 224-236. doi:10.1016/j.psyneuen.2015.07.004

Melamed, T. (1992). Personality correlates of physical height. *Personality and Individual Differences*, *13*(12), 1349-1350. doi:10.1016/0191-8869(92)90179-S

Mileva, V. R., Cowan, M. L., Cobey, K. D., Knowles, K. K., & Little, A. C. (2014). In the face of dominance: Self-perceived and other-perceived dominance are positively associated with facial-width-to-height ratio in men. *Personality and Individual Differences*, 69, 115-118. doi:10.1016/j.paid.2014.05.019

Neave, N., Laing, S., Fink, B., & Manning, J. T. (2003). Second to fourth digit ratio, testosterone and perceived male dominance. *Proceedings of the Royal Society of London B: Biological Sciences*, *270*(1529), 2167-2172.

Pawlowski, B., Dunbar, R. I., & Lipowicz, A. (2000). Evolutionary fitness: tall men have more reproductive success. *Nature*, *403*(6766), 156-156.

Persico, N., Postlewaite, A., & Silverman, D. (2004). The effect of adolescent experience on labor market outcomes: The case of height. *Journal of Political Economy*, *112*(5), 1019-1053.

Pierce, C. A. (1996). Body height and romantic attraction: A meta-analytic test of the male-taller norm. *Social Behavior and Personality*, *24*(2), 143-149. doi:10.2224/sbp.1996.24.2.143

Pisanski, K. & Feinberg, D. R. (2013). Cross-cultural variation in mate preferences for averageness, symmetry, body size, and masculinity. *Cross-Cultural Research, 47*, 162–197.

Pisanski, K., Fraccaro, P. J., Tigue, C. C., O'Connor, J. M., Röder, S., Andrews, P. W., & ... Feinberg, D. R. (2014). Vocal indicators of body size in men and women: A meta-analysis. *Animal Behaviour, 95,* 89-99. doi:10.1016/j.anbehav.2014.06.011

Pratto, F., Sidanius, J., Stallworth, L. M., & Malle, B. F. (1994). Social dominance orientation: A personality variable predicting social and political attitudes. *Journal of Personality and Social Psychology*, *67*(4), 741.

Puts, D. A., Gaulin, S. C., & Verdolini, K. (2006). Dominance and the evolution of sexual dimorphism in human voice pitch. *Evolution and Human Behavior*, *27*(4), 283-296. doi:10.1016/j.evolhumbehav.2005.11.003

Puts, D. A., Hodges, C. R., Cárdenas, R. A., & Gaulin, S. C. (2007). Men's voices as dominance signals: Vocal fundamental and formant frequencies influence dominance attributions among men. *Evolution and Human Behavior*, *28*(5), 340-344. doi:10.1016/j.evolhumbehav.2007.05.002

Rantanen, T., Volpato, S., Ferrucci, L., Heikkinen, E., Fried, L. P., & Guralnik, J. M. (2003). Handgrip strength and cause-specific and total mortality in older disabled women: exploring the mechanism. *Journal of the American Geriatrics Society, 51*(5), 636-641.

Re, D. E., DeBruine, L. M., Jones, B. C., & Perrett, D. I. (2013). Facial cues to perceived height influence leadership choices in simulated war and peace contexts. *Evolutionary Psychology*, *11*(1), 89-103.

Re, D. E., Dzhelyova, M., Holzleitner, I. J., Tigue, C. C., Feinberg, D. R., & Perrett, D. I. (2012). Apparent height and body mass index influence perceived leadership ability in three-dimensional faces. *Perception*, *41*(12), 1477-1485.

Seltzer, C. C. (1946). Body disproportions and dominant personality traits. *Psychosomatic Medicine*, *8*75-97. doi:10.1097/00006842-194603000-00001

Shoup, M. L., & Gallup, G. J. (2008). Men's faces convey information about their bodies and their behavior: What you see is what you get. *Evolutionary Psychology*, *6*(3), 469-479. doi:10.1177/147470490800600311

Sills, F. D. (1950). A factor analysis of somatotypes and of their relationship to achievement in motor skills. *Research Quarterly. American Association for Health, Physical Education and Recreation*, *21*(4), 424-437.

Snih, S. A., Markides, K. S., Ray, L., Ostir, G. V., & Goodwin, J. S. (2002). Handgrip strength and mortality in older Mexican Americans. *Journal of The American Geriatrics Society*, *50*(7), 1250-1256. doi:10.1046/j.1532-5415.2002.50312.x

Stulp, G., Buunk, A. P., Verhulst, S., & Pollet, T. V. (2012). High and mighty: Height increases authority in professional refereeing. *Evolutionary Psychology*, *10*(3), 588-601. doi:10.1177/147470491201000314

Stulp, G., Buunk, A. P., & Pollet, T. V. (2013). Women want taller men more than men want shorter women. *Personality and Individual Differences*, *54*(8), 877-883. doi:10.1016/j.paid.2012.12.019

Stulp, G., Buunk, A. P., Verhulst, S., & Pollet, T. V. (2015). Human height is positively related to interpersonal dominance in dyadic interactions. *Plos One*, *10*(2).

Swaddle, J. P., & Reierson, G. W. (2002). Testosterone increases perceived dominance but not attractiveness in human males. *Proceedings of the Royal Society of London B: Biological Sciences*, *269*(1507), 2285-2289.

Swami, V., Furnham, A., Balakumar, N., Williams, C., Canaway, K., & Stanistreet, D. (2008). Factors influencing preferences for height: A replication and extension. *Personality and Individual Differences*, *45*(5), 395-400. doi:10.1016/j.paid.2008.05.012

Tusing, K. J., & Dillard, J. P. (2000). The sounds of dominance: Vocal precursors of perceived dominance during interpersonal influence. *Human Communication Research*, *26*(1), 148-171. doi:10.1093/hcr/26.1.148

Watkins, C. D., Jones, B. C., & DeBruine, L. M. (2010). Individual differences in dominance perception: Dominant men are less sensitive to facial cues of male dominance. *Personality and Individual Differences*, *49*(8), 967-971. doi:10.1016/j.paid.2010.08.006

Watkins, C. D., Quist, M. C., Smith, F. G., DeBruine, L. M., & Jones, B. C. (2012). Individual differences in women's perceptions of other women's dominance. *European Journal of Personality*, *26*(1), 79-86. doi:10.1002/per.837

Watkins, C. D., & Pisanski, K. (2016). Vocal indicators of dominance. *Encyclopedia of Evolutionary Psychological Science*, 1-6.

Windhager, S., Schaefer, K., & Fink, B. (2011). Geometric morphometrics of male facial shape in relation to physical strength and perceived attractiveness, dominance, and masculinity. *American Journal of Human Biology*, *23*(6), 805-814.

Wolff, S. E., & Puts, D. A. (2010). Vocal masculinity is a robust dominance signal in men. *Behavioral Ecology and Sociobiology*, *64*(10), 1673-1683. doi:10.1007/s00265-010-0981-5

Wright, J. C., Zakriski, A. L., & Fisher, P. (1996). Age differences in the correlates of perceived dominance. *Social Development*, *5*(1), 24-40. doi:10.1111/j.1467-9507.1996.tb00070.x

Zhang, J., & Reid, S. A. (2017). Aggression in young men high in threat potential increases after hearing low-pitched male voices: Two tests of the retaliation-cost model. *Evolution and Human Behavior*, *38*(4), 513-521. doi:10.1016/j.evolhumbehav.2017.02.005

Table 1

Independent t-tests Examining Sex Differences in Recorded Traits

Variable	Sex	Mean	*SD*	*T*	*df*	*p*
Personality Dominance Score				1.22	81	.225
	Men	114.75	16.11			
	Women	110.20	16.77			
SDO Score				1.66	81	.102
	Men	42.69	14.42			
	Women	37.02	15.62			
Height				10.81	81	<.001***
	Men	179.55	7.15			
	Women	162.99	6.56			
Average HGS				9.60	80	<.001***
	Men	43.20	9.64			
	Women	26.72	5.92			
WHR				5.83	80	<.001***
	Men	.88	0.09			
	Women	.79	0.05			
SHR				5.54	81	<.001***
	Men	1.17	0.07			
	Women	1.09	0.06			
Pitch				-10.13	81	<.001***
	Men	116.64	43.78			
	Women	192.36	24.31			
Pitch SD				-3.39	81	.001**
	Men	20.95	21.32			
	Women	34.44	14.95			
Jitter				-0.47	81	.643
	Men	2.32	1.14			
	Women	2.41	0.64			
Shimmer				2.08	81	.041**
	Men	1.19	0.25			
	Women	1.08	.21			
NHR				3.79	81	<.001***
	Men	0.23	0.11			
	Women	0.16	0.06			

Note. ***$p < .001$; **$p < .05$; *$p < .05$; *SD = standard deviation; NHR = noise-to-harmonics ratio; AvgHGS = average handgrip strength; WHR = waist-to-hip ratio; SHR = shoulder-to-hip ratio; TotalDomScore = total dominance score; SDO Total = social dominance orientation total score.*

Table 2

Pearson Correlations between Vocal Ratings, Physical Measures, and Acoustic Measures in Men

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Voice Dominance Ratings	--												
2. Estimated Height	.07	--											
3. Measured Height	.06	.23	--										
4. SHR	.16	-.10	-.40*	--									
5. WHR	.12	-.27	-.22	.14	--								
6. Average HGS	.18	.24	.05	.09	.28	--							
7. Personality DS	-.15	.08	-.19	.12	-.27	-.25	--						
8. SDO Score	-.13	.28	.07	.32	-.32	.27	.25	--					
9. Pitch	.15	-.09	.05	-.07	.04	.07	-.04	-.06	--				
10. Pitch SD	-.07	.04	.05	-.13	-.02	.03	.23	-.10	.78***	--			
11. Jitter	-.01	.13	.23	-.12	-.08	.12	.12	.06	.75***	.85***	--		
12. Shimmer	-.13	-.12	.14	-.16	-.02	.04	.16	.01	.57**	.80***	.79***	--	
13. NHR	.02	.08	.24	-.16	-.17	.07	.18	.07	.59***	.76***	.90***	.85***	--

*Note. *** p < .001; **p < .01; *p < .05; SHR = shoulder-to-hip ratio; WHR = waist-to-hip ratio; HGS = handgrip strength; DS = dominance score; SDO Score = social dominance orientation score; SD = standard deviation; NHR = noise-to-harmonics ratio.*

Table 3

Pearson Correlations between Vocal Ratings, Physical Measures, and Acoustic Measures in Women

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Voice Dominance Ratings	--												
2. Estimated Height	.74***	--											
3. Measured Height	-.00	.22	--										
4. SHR	.19	.20	.25	--									
5. WHR	-.15	-.25	-.07	.19	--								
6. Average HGS	.11	.19	.36*	.34*	.03	--							
7. Personality DS	.22	.13	-.09	.21	-.12	-.03	--						
8. SDO Score	.20	.21	-.14	.24	.14	.08	.61***	--					
9. Pitch	-.21	-.30*	-.16	-.08	-.16	-.27	-.01	.12	--				
10. Pitch SD	-.38**	-.40**	.07	-.02	.05	.02	-.17	-.38**	-.07	--			
11. Jitter	-.20	-.19	.14	.25	.16	-.08	-.07	.00	-.03	.47**	--		
12. Shimmer	-.26	-.24	.29*	.06	.18	.10	-.14	-.23	-.48***	.50***	.62***	--	
13. NHR	-.01	-.03	.20	.26	.21	.10	-.03	-.07	-.45**	.50***	.78***	.79***	--

*Note. *** p < .001; **p < .01; *p < .05; SHR = shoulder-to-hip ratio; WHR = waist-to-hip ratio; HGS = handgrip strength; DS = dominance score; SDO Score = social dominance orientation score; SD = standard deviation; NHR = noise-to-harmonics ratio.*