Want to gain height? How body motion makes you taller.

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Abstract

Body height and expansiveness of body motion both affect perceived dominance and status. We investigated whether expansiveness of body motion also has a direct impact on perceptions of height. For two independent rating experiments we turned the body movements of politicians giving a speech into short clips of animated stick-figures. In experiment one, participants judged these stimuli on dominance, trustworthiness, and competence. In experiment two participants assessed the stick-figures' heights. Perceptions of stick-figure heights were related to ratings of dominance even after controlling for actual stimulus height. We concluded that perceived height was influenced by motion cues. Detailed analyses of hand and torso movements revealed that expansive vertical arm movements made our stimuli appear taller. In conclusion, our findings indicate that motion cues do not only affect attributions of personality traits but also distort perceptions of physiognomic features such as body height.

Keywords: nonverbal cues, dominance, competence, social perception, status, impression formation

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In several species larger individuals dominate in interspecific aggressive encounters. As a result they maintain their ground in the social hierarchy and are better able to monopolize resources (Brown & Maurer, 1986). Humans are no exception. Tall men often prevail in aggressive confrontations, are suggested to be physically stronger and have superior fighting skills (Archer & Thanzami, 2009; Puts, 2010; Sell et. al., 2009). However, the ability to dominate physically also seems to transfer to the ability to gain socioeconomic status. In humans – just to give a few examples – body height is positively related to leadership perception (Blaker et al., 2013), perceptions of charisma (Hamstra, 2014), income (Case & Paxson, 2008; Judge & Cable, 2004), and attributions of authority to professional referees (Stulp, Buunk, & Verhulst, 2012).

The close association between height and qualities related to social status or power seems to be deeply ingrained in the human mind. Not only do children ascribe strength and dominance to taller males and females (Montepare, 1995), there is even evidence that the human mind links power and size on an abstract level. For instance, the perceived power of a group is affected by the font size of the group labels (Schubert, Waldzus, & Giessner, 2009). Moreover, tallness not only makes attributions of power and status more likely it also works in reverse. Authorities are perceived as being taller than people of lower status and the same is true for political candidates after they have won an election (Dannenmaier & Thumin, 1964; Higham & Carment, 1992; Rump & Delin, 1973; Wilson, 1968).

Physical height is, of course, not the only dominance cue conveyed by a human body. Humans and non-human primates also appear dominant when displaying expansive body postures, expressive body movements, and broad gestures (D. Carney, Hall, & LeBeau, 2005; De

Waal, 2007; Eisenberg & Reichline, 1939; Mehrabian, 1972; Tiedens & Fragale, 2003).

Moreover, people who adopt open and expansive postures (i.e., power posing) feel more powerful and are perceived as being taller than people who adopt closed and contracted postures (D. R. Carney, Cuddy, & Yap, 2010; Huang, Galinsky, Gruenfeld, & Guillory, 2011; Marsh, Henry, Schechter, & Blair, 2009; Park, Streamer, Huang, & Galinsky, 2013). Considering that both body height and expansive body postures are related to perceptions of dominance and status, it seems plausible that there is also a link between expansiveness and perceptions of body height. In short, people displaying expansive body postures might appear taller.

Human nonverbal communication comprises more than adopting contracted or expansive body postures; interactions between people as well as impression formation are also guided by nonverbal cues arising from the behavioural stream. In the current study we focus on such cues and investigate in which ways they influence judgements of body height. For two rating experiments we turned politicians' body movements into animated stick-figures, thereby diminishing the influence of confounding variables (e.g., appearance, clothing etc.). We then either asked participants to give their impressions of the stick-figures' height or to judge the stick-figures on dominance, trustworthiness and competence. Dominance and trustworthiness are considered basic social categories in person perception (Oosterhof & Todorov, 2008) while perceived competence is linked to status (Fiske, Cuddy, & Glick, 2007) and an important predictor in election outcomes (Olivola & Todorov, 2010).

We hypothesized that the greater the estimated height of the stick-figures the higher they would be judged on dominance and competence, irrespective of their actual height. Previous research using facial cues has shown that dominance and trustworthiness are negatively related for faces communicating threat (Oosterhof & Todorov, 2008). This also appears to be the case

for body movements (Koppensteiner, Stephan, & Jäschke, 2015). Hence, we expected to find a negative relationship of actual stick-figure height and perceived stick-figure height with trustworthiness. Furthermore, we hypothesized that expansive body movements change perceptions of body size. More precisely, the more expansive the body motion the greater the participants' tendency to judge a stick-figure as taller.

Method

Participants

For two independent rating-experiments a total of 123 participants were recruited at locations throughout the University of Vienna. Sixty participants (33 females and 27 males; age $M = 24.2$ years, $SD = 4.1$) were asked to rate the stick-figure stimuli on dominance, competence and trustworthiness (see also Koppensteiner, Stephan, & Jäschke, 2015). These participants received a financial compensation of €5. Students in a practical course recruited another 63 (37 females and 26 males; age $M = 23.3$ years, $SD = 4.3$) participants for a second experiment, during which participants were asked to rate the height of the stick-figure animations. Participants of this experiment were not reimbursed.

Stimulus preparation

For stimulus preparation we randomly selected 60 speeches (30 male and 30 female) that took place in the German parliament. From these speeches we extracted randomly chosen video segments with an average length of 15 seconds (Koppensteiner, Stephan, & Jäschke, 2015).

Body movements were captured by placing so called landmarks (i.e., dots on the video screen) onto different regions of the speakers' body. Landmarks were placed on the speaker's forehead, the hollow of the throat between the collar bones, ears, shoulders, elbows, hands, a

spot in the middle of the body near the navel and the corners of the lectern. Position shifts of these body regions were traced by software routines based on optical flow but mostly by drag and drop operations using a computer mouse. Consequently, the speakers' body movements were converted into time series of two dimensional coordinates. On the basis of the information stored in these time series we created stick figure animations, which served as abstract representations of the corresponding speakers' body movements (more details in Koppensteiner, 2013; Koppensteiner & Grammer, 2010).

Procedure

Participants of both rating-experiments were led to our laboratory, where they received instructions on how to use the rating program. The participants performed ratings independently under the guidance of the rating program. On the left-hand side of the program's user interface stick-figure stimuli were displayed; rating scales were displayed on the right hand side. In the first experiment Likert scales were used. These scales were named dominant, trustworthy and competent with the left pole saying strongly disagree and the right pole saying strongly agree. In the second experiment participants estimated the stimuli's height on a semantic differential indicating whether the stimulus appears small (left pole of scale) or tall (right pole of scale). In both experiments participants completed their ratings by dragging the bar of a trackbar control to the right pole or the left pole using a computer mouse. The scales (i.e., track-bar) were divided into 200 subunits, with -100 being the minimum value and +100 being the maximum value.

In the first experiment each participant rated a randomly selected subset of 20 stimuli. In the second experiment each participant rated a randomly selected subset of 15 stimuli.

Analysis

We used coordinate data recorded during the encoding procedure to create different measures of motion. Therefore, descriptions of the speakers' movements had a strong mathematical basis. We decomposed body movements into horizontal (x) and vertical (y) components because it has already been shown that people' read different meanings into horizontal and vertical components of body motion (Koppensteiner, 2013; Koppensteiner & Grammer, 2010). We determined the magnitude of vertical hand movements: the sum of $\text{lectern}(y) - \text{right hand}(y)$ and $\text{lectern}(y) - \text{left hand}(y)$, and horizontal hand movements: $\text{throat}(x) - \text{right hand}(x)$ and $\text{left hand}(x) - \text{throat}(x)$. We also filtered vertical body movements: $\text{throat}(y) - \text{lectern}(y)$, and horizontal body movements: $\text{throat}(x) - \text{origin}(x)$. Thus, we created four descriptors of the body each yielding a time series of changing amplitude heights. From these time series we extracted amplitudes between successive local maxima and local minima (e.g., hand starting at a minimum, then going up, reaching a maximum and going down again to another minimum). All the amplitudes obtained for a single motion component (e.g., vertical hand movement) were then summed to provide a simple, overall estimate of each motion component's expansiveness. In summary, for each time series and each motion component we summed the amplitudes between successive turning points (Figure 1).

To measure the height of the stick-figure stimuli we subtracted the y-coordinate of the forehead landmark from the y-coordinate of one of the lectern landmarks and determined the maximum distance between these two landmarks (of all measures of sequence). Thus, the maximum vertical distance between forehead and lectern served as measure of the stimuli's heights.

For the statistical analyses we averaged the ratings of dominance, trustworthiness, and competence as well as the estimates of the stimuli's heights for each stick-figure. We assessed

correlations between trait ratings and estimates of the stick-figures' heights. To remove the influence of actual stimulus height (i.e., height measured by landmark coordinates) we also calculated partial correlations. In addition, we carried out multiple regression analyses using the motion parameters as predictors and perceived stimulus height as the dependent variable. Motion variables tended to be highly interdependent. This may distort regression weights due to multicollinearity and thus hamper interpretation of findings. To deal with this we also calculated so called relative weights. Relative weights range between 0 and 1, are unaffected by multicollinearity and give an estimate of a single predictor's influence (i.e., explained variance) on the dependent variable without the influence of the remaining predictors (Lorenzo-Seva, Ferrando, & Chico, 2010). As there are strong correlations between body bones and body height, (i.e., 0.9) controlling for body height (in regression and partial correlation) also controls for the influence of limb size on perceptions of expansiveness (Abrahamyan, Gazarian, Braillon, 2008). All statistical analyses were done in the program R (Team, 2013).

Behaviour encoding is a time consuming procedure, but in previous studies it has been found that 40 to 60 speakers produce enough variance in their behaviours to find prominent effects. Hence, in this study sample size of our stimuli was also in that range (Koppensteiner, 2013; Koppensteiner et. al., 2015).

Figure 1. Landmark Coordinates were used to create stick-figure animations (see right picture).

Changes in distances between landmarks (right picture gives an example) yielded curves (see left picture) from which amplitudes were extracted. All amplitudes were summed to provide an overall measure of expansiveness.

Results

Correlation analyses revealed that stick-figures' actual heights were related to judgments of dominance. More precisely, the taller a stick-figure the more dominant it was perceived. No important effects were found for perceptions of trustworthiness and competence (Table 1). Consequently, actual stimulus height was a communicator of dominance, but not of competence and trustworthiness. Although perceived competence is related to status (Fiske et. al., 2007) and

status related to body height, we found no direct link between competence and stick-figure height.

Table 1

Correlations and Partial Correlation of Actual and Perceived Height with Trait Ratings.

Ratings	Height Measures		
	Actual Height	Perceived Height	Perceived Height Actual Height Controlled
Dominance	.30* [.05, .52]	.45*** [.22, .63]	.35** [.10, .55]
Trustworthiness	-.07 [-.31, .19]	-.19 [-.41, .07]	-.19 [-.42, .07]
Competence	.08 [-.18, .33]	.12 [-.14, .36]	.09 [-.17, .33]

Note. Last column are partial correlations between ratings and perceived height without the influence of actual height. $N = 60$; * $p < .05$; ** $p \leq .01$; *** $p \leq .001$.

Perceived stick-figure height provided a prominent correlation with participants' ratings of dominance. Moreover, perceived trustworthiness was related to perceived stick-figure height; even though the correlation was relatively small (Table 1). In this respect results were different from those obtained for actual stimulus height. They indicate that in addition to actual stimulus height, trait ratings were also influenced by other cues and these cues appear to distort impressions of stick-figure height. Partial correlations supported such a conclusion (Table 1). Removing the influence of actual stimulus height did not undermine the prominent relationship between perceived height and perceived dominance. Again, we found no relationship between competence and perceptions of body height.

It is also interesting that ratings of dominance were positively related to perceived stick-figure height while ratings of trustworthiness were negatively related. Although the effect sizes obtained for trustworthiness were relatively small, such a finding is in accordance with previous research. An inverse relationship between trustworthiness and dominance has already been found for perceptions of facial cues displaying threat and in previous research on body motion (Koppensteiner et. al., 2015; Oosterhof & Todorov, 2008).

Table 2

Correlations and Regression Analyses of Motion Measures with Estimates of Stimulus Height.

Motion Measures	Parameters		
	Correlation	Regression Estimates	Relative Weights
Actual Height	.66*** [.49, .78]	.64*** (.10) [.43, .82]	.39
Hand Horz.	.20 [-.06, .43]	-.01 (.12) [-.25, .24]	.01
Hand Vert.	.35** [.10, .55]	.27** (.12) [.05, .50]	.08
Body Horz.	.21 [-.05, .44]	.02 (.11) [-.19, .26]	.02
Body Vert.	.07 [-.18, .32]	-.18 (.11) [-.35, .09]	.01

Note. Standard errors (in parenthesis) and 95% confidence intervals (in brackets) of regression estimates are based on 9999 bootstrap replicates. Vertical (Vert.) and horizontal (Horz.) hand and body movements are based on measures of motion amplitude. $R^2 = .51$; $N = 60$; * $p < .05$; ** $p \leq .01$; *** $p \leq .001$.

To examine in what way different body movements influenced perceived stimulus height, we performed multiple regression analyses with actual stimulus height as a control variable and

the motion components we extracted as independent variables. Apart from actual stimulus height measures of the stick-figures' vertical hand movements were the strongest contributor to overall variance. This was reflected in the regression weights and the relative weights (see Table 2). Consequently, stick-figures who displayed expansive vertical movements with their hands were perceived as being taller than stick-figures who displayed fewer of these movements. Overall, findings indicate that motion cues affect people's perceptions of height and that expansive vertical arm movements can make someone appear taller.

Discussion

Physical height influences people's perceptions of someone's position in a social hierarchy (Judge & Cable, 2004). In the current study taller stick-figure representatives of speakers tended to be judged as dominant. Attributions of competence and trustworthiness, on the other hand, were unrelated to actual stick-figure height. Although actual height was visible to observers, perceived height was to certain extent unrelated to it. Stick-figures that appeared more dominant tended to be judged as taller. This indicates that motion cues have an impact on height estimation.

What types of cues can make somebody appear taller? Broad gestures and open postures are communicators of dominance in humans and non-human primates (De Waal, 2007; Tiedens & Fragale, 2003). Hence, we assumed that there is a direct link between expansiveness and estimates of body height. The results obtained were not convincing enough to conclude that overall expansiveness affects perceptions of height. However, we found that expansive up and down movements of the hands made stick-figures appear taller. These types of movements have already been shown to impact personality attributions (Koppensteiner, 2013). Here, we demonstrate that they also may distort impressions of body height. It is very plausible that

expansiveness is not the only relevant motion cue in estimations of body height. For this reason future studies need to extend the measures applied here and analyse whether other motion cues (i.e., velocity) also play a role.

Although people of high social status are judged as being taller (Dannenmaier & Thumin, 1964) than low status people and although status is a predictor of perceived competence (Fiske et. al., 2007) we were unable to reveal a link between competence ratings and assessments of height. By contrast, dominance yielded prominent effects. These can be interpreted in light of research on non-human primates that display threat by adopting upright body postures and showing expressive motions (Hobaiter & Byrne, 2014). Similarly, human body motion may work on a very basic level of communication and convey one's willingness to dominate. The link between human body movement and perceived height may thus be part of our evolutionary heritage.

Conclusions

Human communication is dynamic and for this reason research in the field needs to use stimuli that allow for preserving dynamic information. We showed that even simple animations representing body movements of speakers communicate nonverbal dominance cues that confound perceptions of actual body height. Nonverbal behaviours may thus not only affect perceptions of inner qualities such as personality traits but also perceptions of appearance features such as body height. In other words, the gifted self-presenter may be able to display behaviours that render her or him taller.

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