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Physical strength and gender identification from dance movements

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ABSTRACT

Here we show that gender identification of male (but not female) heterosexual, right-handed dancers correlates with physical strength (measured via handgrip strength) after controlling for the effect of body-mass-index on strength. Using optical motion capture technology, we collected the dance movements of men and women for subsequent animations of uniform shape- and texture-standardized virtual characters (avatars). Short video clips (15 s) of these movements were presented to male and female adults and children, who were asked to identify the gender of the avatar. Gender identification performance was significantly higher than chance for both adults and children. Among adults (but not among children) the avatars of male dancers who were physically stronger were perceived as males significantly more often than were the avatars of male dancers who were physically weaker. There was no relationship between strength and gender identification for female dancers. We conclude that physical strength affects gender identification from human dance movements at least for male dancers, and that prepubertal children might not be sensitive to strength cues in dance movements.

1. Introduction

Gender constitutes a key facet of an individual's personal and social identity as it influences virtually all aspects of social communication and social life (Deaux & Major, 1987; Money & Ehrhardt, 1972; West & Zimmerman, 1987). The expression of gender, and our ability to differentiate the gender of others, is often influenced by various physical traits and characteristics. Research suggests that observers can use sexually dimorphic physical features such as body height, weight, muscularity, body hair, facial morphology, and voice pitch, to accurately differentiate adult men and women (Neave, 2008; Puts, 2010). Gender identification has been demonstrated in infants aged 10 months old (Levy & Haaf, 1994) showing that the cognitive abilities required for categorizing social information, such as gender, are present early in life.

Studies using dynamic point-light walkers have demonstrated that adult observers can also accurately judge gender from gait (i.e., an individual's walk) in the absence of all other physical or behavioural cues to gender (Barclay, Cutting, & Kozlowski, 1978; Kozlowski & Cutting, 1977, 1978; Mather & Murdoch, 1994; Sumi, 2000; Troje, 2002). The ability to identify the gender of a person based simply on motion cues implies characteristic differences in the way that men and women move their bodies (Pollick, Kay, Heim, & Stringer, 2005; Pollick, Paterson, Bruderlin, & Sanford, 2001). Cutting, Proffitt, and Kozlowski (1978), for example, reported that men swing their shoulders from side to side more than do women while walking, whereas women swing their hips from side to side more than do men. Indeed, when asked to make judgements of the gender of an animated walker, observers focus primarily on the shoulders and hips (Saunders, Williamson, & Troje, 2010). Other studies suggest that the motion of the legs provides important sex-relevant information (Todd, 1983; Yamasaki, Saki, & Torii, 1991). Thus, gait appears to communicate cues to gender that adult observers are sensitive to.

It is not clear what factors contribute to differences in the way that men and women move, and whether observers utilize these same factors to assess gender. Recent work suggests that sexually dimorphic traits affect body movement in a way that may provide observers with socially relevant, sex-specific information. Sexually dimorphic characteristics develop under the influence of sex steroid hormones, most notably testosterone, and provide the basis for many subsequent observations of sex-specific behaviours in adulthood (Neave, 2008). In perceptual studies of body movement, physical strength appears to be a key sexually dimorphic characteristic affecting social perception. Men are on average twice as strong as are women (Miller, MacDougall, Tarnopolsky, & Sale,

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1993). Strength has been linked to the perceived quality and attractiveness of men's dance movements (McCarty, Hönekopp, Neave, Caplan, & Fink, 2013). Men's dance movements also affect other's perceptions of their sensation seeking behaviour (Hugill, Fink, Neave, Besson, & Bunse, 2011), which correlates positively with men's physical strength (Fink, Hamdaoui, Wenig, & Neave, 2010). Because men's dance movements appear to indicate strength, a highly sexually dimorphic trait, it follows that physical strength may mediate observer's ability to differentiate men from women through their body movements.

Compared to gait, dance is a much more complex human body movement and one that is cross-culturally universal (Hanna, 1987; Kaeppler, 1978; Kurath, 1960). Dance is typically characterized by various gender-specific movements (Hanna, 1987, 2010) and appears to play an important role in courtship behaviour (for reviews, see Fink, Weege, Neave, Ried, & do Lago, 2014). Indeed, unlike gait, the main purpose of dance is not locomotion but rather to express oneself or to impress a counterpart. Thus, dance movements may express salient cues that facilitate gender identification more readily than do other types of body movement, including gait.

A large body of research has examined the ontogeny and development of gender expression and gender identification. This work suggests that behavioural gender differentiation develops at a young age – often the ability is present in infants and toddlers – but becomes increasingly pronounced and stereotyped with age and social experience (see, e.g., Bussey & Bandura, 1999; Martin, Ruble, & Szkrybalo, 2002; Yee & Brown, 1994). Past work has shown that infants as young as 4–7 years old show gender-typicality in their body movements and gait (König, Schölmerich, & Troje, 2008), and that children as young as 5 years old can accurately assess emotion from body and dance movements (Boone & Cunningham, 1998). However, no study has examined the ability of young children to accurately identify gender from body movements, including dance.

In the present study, we tested whether the ability of male and female adults (aged 18–29 years) and children (aged 6–10 years) to accurately identify gender from dance movements was facilitated by the physical strength of the dancers after controlling for differences in the dancers' body size. Male and female dancers were presented in the form of gender-neutral avatars in video clips, created using motion capture technology. We predicted that both adults and children would correctly discriminate the gender of dancers. However, because sexual dimorphism in strength develops around the time of puberty (after age 11) under the influence of testosterone (Seger & Thorstensson, 2000), and appears to play a key role in indicating mate quality (Hugill et al., 2011), any facilitating effect of strength on gender perception from dance may be more pronounced among adults than children. Thus, we predicted that adults would rely more heavily on sexually dimorphic strength cues to gauge the gender of male and female dancers than would children.

2. Methods

2.1. Stimuli

We recruited 167 participants (81 men, 86 women; aged 18–42 years; mainly graduate and undergraduate students of Northumbria University, U.K.) as part of a large-scale study on body movement, in which participants also reported sexual orientation and handedness. Height (cm) and weight (kg) measurements were collected to calculate body-mass-index (BMI; mass/height $(m)^2$) – a known correlate of handgrip strength (Chandrasekaran, Ghosh, Prasad, Krishnan, & Chandrasharma, 2010). Handgrip strength (kgf) was measured using a hand dynamometer (Takei Kiki Kogyo, Japan). Participants were asked to perform a maximum force trial with each hand ("Squeeze as hard as you can"). Strength measurements were collected twice for each participant and the means of two recordings were calculated.

Dance movements were recorded using a 12-camera optical motion-capture system (Vicon, Oxford) running Vicon Nexus software. None of the participants were professional dancers and none reported physical injuries or current health problems that could have affected their movements. Thirty nine 14 mm retro-reflective markers were attached to each participant in accordance with the Vicon Plug-In-Gait marker set to capture all major body structures. Following calibration, participants danced for 30 s to a popular song, of which only the core drumbeat was presented to eliminate possible music likeability effects. No specific instruction was given on how they should dance. These motion-capture data were applied to a featureless, gender-neutral humanoid character (avatar), using Autodesk MotionBuilder (Autodesk, Inc., San Rafael, CA, USA) and finally rendered in the form of 773 × 632 pixel video clips (see Fig. 1). Fifteen-second sequences were extracted from the middle of each dance video for the subsequent gender identification task. For one man and six women, no dance movement video could be produced due to incomplete motion capture data. Thus the final set of stimuli used for presentation in subsequent rating studies included dance movement videos of 80 male and 80 female participants.

2.2. Rating studies

Our sample of adult raters comprised 49 men and 51 women, aged 18–29 years ($M = 22.80$, $SD = 2.76$), mainly heterosexual by self-report (94%), who were recruited predominantly from the student population at the University of Göttingen (Germany). Each participant viewed a random selection of 40 clips out of the total set of dance movement videos. Following each clip, the participant was prompted to indicate whether the dancer was male or female by clicking a button below the video. Clips were presented in a serial, randomised order, centred on a 15.4" laptop screen (1440 × 900 pixels resolution) using Medialab 2012 (Empirisoft Inc., New York) presentation software. The core audio track played during dance recording was not presented to raters.

Our sample of child raters comprised 43 boys and 42 girls between the ages of 6 and 10 years ($M = 8.19$, $SD = 1.16$) recruited from an elementary school in Lower Austria (Austria). Permission for testing was obtained from legal guardians and the methodology was approved by the ethical committee of the University of Göttingen. The experimental setup was the same as for adult participants, but children viewed 10 videos out of the entire set, owing to time constraints with children's availability and concentration capacity.

2.3. Statistical analysis

For the statistical analysis, we calculated the number of trials on which the gender of each dancer was correctly identified. Children's gender identification performance data were not available for two dancers due to the randomization procedure. We focused on right handgrip strength, which was found to correlate highly positively with left handgrip strength in our sample ($r = .94$, $p < .001$). Moreover, we considered only those dancers for analysis who claimed to be exclusively heterosexual and right-handed, rendering the final sample size as $N = 135$ dancers (69 males, 66 females; $M = 21.33$, $SD = 4.12$). Significance tests for group comparisons in gender identification performance were two-tailed and correlations of gender identification performance and handgrip strength were one-tailed with an alpha set to 0.05.