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Not all is noticed: Kinematic cues of emotion-specific gait

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ABSTRACT

Perceiving emotions from gait can serve numerous socio-environmental functions (e.g. perceiving threat, sexual courting behaviours). Participant perceivers were asked to report their strategies for identifying happiness, sadness, anger and fear in point-light walkers. Perceivers claimed they identified happiness by a bouncing gait with increased arm movement, sadness by a slow slouching gait, anger by a fast stomping gait and fear by both fast and slow gaits. The emotion-specific point-light walker stimuli were kinematically analysed to verify the presence of the gait cues perceivers reported using to identify each emotion. Happy and angry walkers both displayed long strides with increased arm movement though angry strides had a faster cadence. Fearful walkers walked with fast short strides reminiscent of a scurrying gait. Sad walkers walked with slow short strides consequently creating the slowest walking pace. However, fearful and sad walkers showed less arm movement in their gait in different ways. Sad walkers moved their entire arms whilst fearful walkers primarily moved their lower arms throughout their gait.

1. Introduction

Since Johansson (1973) first used point-light walkers to investigate the kinematic variants of gender-specific walking styles, it has been shown that a wealth of information is contained in the kinematics of a human walking, including information related to person identification (Troje, Westhoff, & Lavrov, 2005), social status (Schmitt & Atzwanger, 1995), victim potential (Gunns, Johnston, & Hudson, 2002; Winkel & McCormack, 1997), and gender (Troje, 2002). Furthermore, the varying emotional state of an individual can also be recognised through their gait kinematics (Darwin, 1872/1999; Halovic, 2010; Halovic & Kroos, 2009; Halovic & Kroos, 2017; Michalak et al., 2009; Montepare, Goldstein, & Clausen, 1987; Roether, Omlor, Christensen, & Giese, 2009). Walking gait is a high-dimensional biological movement which potentially can express emotional states through many different partial movement patterns. Emotional states can also be identified by perceivers in a range of different biological movements, such as facial expressions (Adolphs, 2006; Ekman & Oster, 1979; Krems, Neuberg, Filip-Crawford, & Kenrick, 2015; Lipp, Price, & Tellegen, 2009), dancing (Dittrich, Troscianko, Lea, & Morgan, 1996; Walk & Homan, 1984), door knocking (Pollick, Paterson, Bruderlin, & Sanford, 2001), drinking (Pollick et al., 2001), and through dyadic non-verbal communications (Zibrek, Hoyet, Ruhland, & Mcdonnell, 2015). It could be reasonably argued that all human behaviour is partially influenced from their felt and presumably perceived emotional state. There is likely some common component to emotional expression and thus perception that transcends the specificity of any one biological movement. Despite the broad range of emotional expressions by humans, walking gait has the potential to express an individual's emotional state at a distance. Subsequent perception of the walker's emotional state at distance can then inform the perceiver's choice to either approach out of friendship or withdraw from possible threat. We will focus in this research solely on human emotional walking gait as we seek to verify that perceivers are aware of the specific emotional gait features underlying their emotion perception.

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Montepare et al. (1987) found that perceivers could accurately identify four emotions (happiness, sadness, anger, and pride) from walking style. The perceivers then rated each viewed walker on four scales related to specific gait parameters; stride length, degree of arm swing, heaviness of footsteps and whether their posture was slouching or not. Montepare et al. (1987) found a) happy walks were characterised by a faster pace. b) angry walks was characterised by more arm swing, heavier footsteps and a longer stride, and c) A sad walk was characterised by significantly less arm swing. Montepare et al. (1987) assumed that each perceivers gait parameter ratings were valid indicators with respect to the kinematic characteristics of the observed movement and that the gait parameters were capable of distinguishing which gait movements communicate which emotions. However, this assumption rests on two premises: 1) Perceivers were aware of the gait movements that they used to discriminate between the different displayed emotions. 2) The gait parameters that perceivers claimed to use, were uniquely displayed in emotion-specific walking styles thus were useful in discriminating between the kinematics of the emotion specific walking styles. As far as we are aware, this assumed congruence between expert performance and expert knowledge has yet to be tested for the perception of emotions from walking gait.

More recent advancements in motion capture technology provide an opportunity to separate emotion perception performance from the conscious knowledge of how perceivers identify each emotion. Roether et al. (2009) recorded actor's gait movements with a motion capture system in their investigation of emotional gait perception and expression. Each actor's gait movements were displayed to perceivers through animated walking avatars comprised of geometric shapes (i.e. cylinders, spheres, ellipsoids). Each expressed emotion was identified by perceivers relatively well (i.e. happiness: 75.1%, sadness: 89.8%, anger: 70.3%, and fear: 77.1%). More detailed analysis of the confusion matrices revealed that happiness was consistently confused with anger (and vice-versa) as was sadness with fear. Analysis of the motion captured movement features of each emotionally expressive gait revealed that happy and angry walks were characterised by larger faster movements whilst sad and fearful walks were characterised by smaller slower movements. Whilst Roether et al. was able to distinguish happy and angry walks from sad and fearful walks, they were less successful at distinguishing happy from angry walks and sad from fearful walks. Nevertheless, Roether et al. acknowledged that the perception and expression of emotion-specific gait are entangled and showed that emotional gait can be understood better by investigating both perspectives.

Temporal variables (e.g. limb velocity, walking pace) underlie both emotional perception and expression (Barliya, Omlor, Giese, Berthoz, & Flash, 2013; Chouchourelou, Matsuka, Harber, & Shiffrar, 2006; Rottenberg, Ray, & Gross, 2007). For example, surprise is a brief intense expression very closely linked to the time of the surprising event (Sato & Yoshikawa, 2004). However, the same temporal variables underlying emotional display also creates great difficulty in isolating the display of emotional intensity through dynamic recordings. A person's emotional state may have a short onset latency and recovery period (Rottenberg & Gross, 2003; Rottenberg et al., 2007), that the same emotion can be experienced with different levels of intensity over time (Biele & Grabowska, 2006), and that some emotions differ in perceived intensity due to differences in the speed of expression (Barliya et al., 2013; Kamachi et al., 2013; Sato & Yoshikawa, 2004). Edgeworth, Keen, Crane, and Gross (2008) showed how temporal gait information influenced emotion perception when they compared sad and angry walks and found that emotion-related gait differences were indistinguishable from speed matched non-emotion-related control gaits. The temporal information contained within dynamic emotional stimuli will influence the display of emotional intensity, which will then influence the relative identification rates of each displayed emotion. Consequently, it is difficult to meaningfully compare the emotion identification rates between different studies and it is not surprising that affective scientists find it quite difficult to investigate the dynamic movements of emotional expression/perception without also effecting the intensity of the expressed/perceived emotional display.

Most previous emotional gait perception studies used actors to display each emotion through their walking style (Destephe, Henning, Zecca, Hashimoto, & Takanishi, 2013; Halovic, 2010; Halovic & Kroos, 2017; Karg, Jenke, Kuhnlenz, & Buss, 2009; Montepare et al., 1987; Roether et al., 2009). It could be argued that actors' display of emotional gait is different to more ecologically valid displays of affect through walking gait. Lemke, Wendorff, Mieth, Buhl, and Linnemann (2000) attempted to circumvent this dilemma by analysing the walking styles of clinically depressed patients relative to healthy controls. Lemke et al. found that depressed walkers walked slower, had lower cadence, shorter stride length and had slower gait cycles than healthy control walkers, which all produce a slower overall walking pace (Kirtley, 2006). Michalak et al. (2009) used a similar approach when they investigated the expression of depression through walking gait. Michalak et al. recorded 14 clinically depressed patients with modern motion capture methods and contrasted their gait characteristics to 14 healthy (i.e. never been depressed) controls. A linear discriminant function was conducted by regressing the walker model parameters by the affiliated group (i.e. depressed vs. non-depressed). The resulting animations were visually compared to identify significant gait features that distinguished depressed and non-depressed individuals and were subsequently compared statistically. Depressed individuals were found to walk slower than non-depressed individuals therefore supporting the earlier findings by Lemke et al. (2000). Furthermore, depressed individuals showed reduced arm swing, greater lateral body sway, a more slumped posture and lower movement of the head thus it appears that a sad walking style is expressed and consequently perceived through a slow lethargic walking style. Whilst, clinically depressed patients afford the opportunity to investigate an intense long-term variant of sadness (Lemke et al., 2000; Michalak et al., 2009), this approach will not work for the investigation of other types of emotional expressions through walking style.

Similar to sadness, fear seems to also be expressed/perceived through a slower walking pace and smaller joint angle movements though more specific gait features that validly discriminate between displays of sadness and fear are lacking in the literature (Roether et al., 2009). The actors of Atkinson, Dittrich, Gemmell, and Young (2004) however, were encouraged to express each emotion through whichever movements that they felt were appropriate. The actors predominantly chose to express fear by withdrawing from the camera, contracting their posture and raising their hands. This pattern of postures/movements are congruent with Darwin's (1872/1999) descriptions of fearful expressions.

In contrast, happiness and anger seem to be expressed/perceived through a faster walking pace. Chouchourelou et al. (2006)