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Is threat in the way they move?

Influences of static and gait information on threat judgments of unknown people

Liam Paul Satchell[1]*

Harry Sebastian Mayes[2]

Anthony J Lee[3]

Liam Christopher O'Reilly[2]

Lucy Akehurst[4]

Paul Morris[4]

[1]Department of Psychology, University of Winchester, UK

[2]School of Sport, Health and Exercise Science, University of Portsmouth, UK

[3]Division of Psychology, University of Stirling, UK

[4]Department of Psychology, University of Portsmouth, UK

*corresponding author. Can be contacted at liam.satchell@winchester.ac.uk. ORCID: 0000-0002-8805-4884 University of Winchester, Sparkford Road, Winchester, Hampshire, UK, SO22 4NR

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Code availability. The analysis code can be found on the Open Science Framework here: https://osf.io/c6aby/?view_only=53a8eed4e67d465a8d69f8414319805d

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Abstract

Recognising intraspecies threat is essential for survival. However, this needs to be balanced against the undue avoidance of unknown others who may be useful to us. Research has shown that judgments of 'aggression' and 'threat' posed by an unknown person can accurately reflect that person's general aggressive tendencies. To date, there has not been a within-sample comparison of the informativeness of static and walking stimuli for threat judgments. In this study, 193 participants rated the threat posed by 23 target people presented as both simplified gait presentations (point-light walkers) and still images. We analysed how threat judgments made by participants were predicted by the target's self-reported aggression (accuracy), the sex of the targets and the medium of target presentation (point-light vs. still image). Our results showed that participants' threat judgments accurately predicted targets' aggression. Male targets received higher threat ratings than female targets and point-light displays were rated as more threatening than still images. There were no effects of target sex and presentation medium on accuracy of threat perception and no sex by medium interactions on judgments themselves. Overall, this study provides further evidence of the accuracy of threat judgments at detecting trait aggression. However, further research is needed to explain what features of the target people are enabling the accurate judgments of aggression.

Keywords: Gait perception; Aggression; Threat Perception; Static Images; Walking Stimuli

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Introduction

For an individual to survive they must be effective at recognising threats, including from those of the same species. There are functional benefits to being risk averse to threat as highlighted by Error Management Theory (Haselton & Buss, 2000; 2009). Type I errors (assuming threats where there are none) increase survival chances more than Type II errors (assuming no threats when a threat is present). However, as a social species, humans can also have significant potential costs associated with Type I error management. Undue avoidance of potentially useful strangers can hinder everyday success and long-term survival. In contemporary life, Type I threat errors could lead to losing out on information about the world gathered through social interaction. Therefore, it is important to study judgments of threat posed by other people beyond a model of error management alone. A range of studies have suggested that individuals' use of 'threat' and 'aggression' judgments can, with a reasonable degree of accuracy, detect those who may pose a risk whether that judgement be made via photographs of targets' faces (e.g. Geniole, Denson, Dixson, Carré, & McCormick, 2015) or videos of them walking (e.g. Satchell, Morris, Akehurst, & Morrison, 2018). To date, there is limited research comparing the relative contribution of the static and movement information present for person perception (*c.f.* movement in faces; Gill, Garrod, Jack, & Schyns, 2014). This is somewhat surprising given the importance of biological motion in perception. There is evidence of motion-specific neurological adaptations to biological motion perception, such as the research into the posterior Superior Temporal Sulcus (Cowey & Vaina, 2000; Grossman et al., 2004; Grossman & Blake, 2002), so biological motion should receive more attention in person perception research. The current study further expands the research on accurate threat detection by studying judgments of the threat posed by walking people presented as either still images (appearance information without movement) or point-light videos (movement information without appearance).

People making judgments of threat or aggression from unknown individuals have been shown to use a 'masculine is dangerous' heuristic. Men are four times more likely to be arrested for aggressive crimes (murder, rape, aggravated assaulted and ‘violent crime’) than women (Federal Bureau of Investigation, 2018) and are stereotyped as more aggressive than women (Banaji et al., 1993). Previous research has gone beyond the ‘masculine is dangerous’ heuristic to study accurate judgments of aggression. This work has typically focused on presentations of still faces as stimuli (Carré & McCormick, 2008; for a meta-analysis see Geniole et al., 2015) and the effectiveness of a ‘sexually dimorphic’ aspect of faces, the face Width-to-Height Ratio (fWHR), for communicating the antisocial traits of a person. Other research has investigated the link between trustworthiness (Stirrat & Perrett, 2010) and dominance (Valentine et al., 2014) with fWHR. There is evidence of a relationship between fWHR and prenatal (Whitehouse et al., 2015), pubertal (Welker et al., 2016), and situational testosterone (Lefevre et al., 2013) and a link between testosterone and antisocial behaviour (Archer, 1991; Book, Starzyk, & Quinsey, 2001; Carré et al., 2017). Thus, if antisocial tendencies are related to testosterone, which is related to facial morphology (fWHR), then the risk of aggression posed by another person could be communicated through facial structure. However, this literature is not consistent. The meta-analytic relationship between aggression and testosterone itself is weak (Book et al., 2001), there are inconsistent findings on fWHR being sexually dimorphic (Kramer et al., 2012; Lefevre et al., 2012; Özener, 2012) and related to self-reported traits (Gómez-Valdés et al., 2013; Kosinski, 2017) or aggressive behaviour (Deaner et al., 2012). There are also concerns about the utility of fWHR for making judgments about antisocial tendencies (Efferson & Vogt, 2013). The endeavour to investigate how a bodily feature can communicate aggressive behaviour is important and the finding that fWHR relates to perceptions is somewhat consistent (Geniole et al., 2015). However, in an everyday context, such as when a person is approaching from a distance, a person appears as more than a head. They are not just an isolated face but attached to a moving, whole, body. For a better understanding of the validity of bodily cues to threat, more comprehensive, whole body stimuli should be used. In particular, static and moving body features with known relationships to aggression such as body shape (Deaner et al., 2012) and gait biomechanics (Satchell, Morris, et al., 2017) should be studied.

The research outlined above on judging threat often focuses on male stimuli due to the asymmetry in sexes engaging in aggressive behaviour. However, targeted studies (Geniole et al.,

2012) and meta-analytic data (Geniole et al., 2015) show that male and female faces have different cues for threat. Further, more masculine morphology within the sexes is seen as more intimidating (Hehman et al., 2013; Satchell, Akehurst, et al., 2017) and dominant (Coy et al., 2014; Windhager et al., 2011). More work needs to be conducted to understand differential cues to threat by sex, especially when general cues to masculine-typical facial morphometry do not inform aggressiveness judgments when studied in female targets (Geniole et al., 2012). This is important as women are frequently encountered in the world and can also be aggressive. A quarter of reported aggressive crimes in the US 2017 arrest statistics were committed by women (Federal Bureau of Investigation, 2018). Our current study was designed to include both male and female targets and to test the utility of a 'masculine is dangerous' heuristic for whole body presentations of stimuli.

Theoretically, accuracy for judging another person's traits can be deconstructed into the four stages highlighted by the Realistic Accuracy Model (RAM) proposed by Funder (1999). The RAM proposes that judgments of another person's traits are more accurate when *relevant* behavioural information regarding personality is *available* for judges to *detect* and then *utilize* for a judgment. The current study focused on two components of the RAM; relevance and availability. Relevant information is the salient behaviours which are related to an individual's disposition. For example, if an individual's trait aggression relates to their body shape or movement style. Availability is the presentation of the relevant information for later observation. An exaggerated hypothetical might be that one's heart rate variability could be relevant information to personality traits, but this is not readily available for another person to observe and thus not functional for personality judgment. The current study investigated the impact of available stimulus information - either static (still image presentation) or walking (point light presentation) - on the accuracy of judgments of theat.

Hypotheses

The current paper investigated the effect of limiting the *availability* of aggression-*relevant* information (in RAM terms) in target people's walks on judgments of threat. We hypothesised that judgments of threat posed by walking target people will differ between static and moving presentations of stimuli (Hypothesis 1a). However, it is not clear which will be more threatening. It could be that the full physical appearance of the targets in still images (as opposed to the dehumanised point-light figures, see figure 1) could decrease the perceptions of threat by 'humanising' the targets or the full appearance of the targets could better facilitate threat judgments. Similarly, point-light videos in the movement-only presentations could be different enough from the expected presentation of a 'person' that they are seen as less threatening (seen as just dots), or this could offer more opportunity for participants to imagine the person 'beyond' the presentation increasing threat judgments. We additionally hypothesised that male targets will be perceived as more threatening than female targets, due to 'masculine is dangerous' heuristic (Hypothesis 1b). We further expected an interaction between the presentation medium (static v dynamic) and sex of target (Hypothesis 1c). This may be because the sex of a target will be much more salient in the still image (static) condition, thus the 'masculine is dangerous' heuristic could be strongest for male targets in the static condition and weakest for the female targets in the walking condition.

Second, we made predictions about the relationship between judgments of threat and the targets' trait aggression; the 'accuracy' of the threat judgment. We expected that the accuracy of threat judgments will differ by presentation of target people as either static or walking stimuli (Hypothesis 2a). Again, it is not clear in which direction, but the different availabilities of relevant information will likely lead to a difference. We also expected that participants will be less accurate at detecting aggression for female targets (Hypothesis 2b). This may be due to the 'masculine is dangerous' heuristic inflating the threat ratings away from a diagnostic line. This will be further manifested in an interaction between presentation of targets and target sex on the accuracy of threat judgments (Hypothesis 2c). This is, again, an open ended hypothesis as we do not have a clear literature base to suggest a direction of effect, however we expect that the different availabilities of aggression-relevant information and the effects of 'masculine is dangerous' heuristics will lead to varying accuracy by presentation medium and sex of target.

Method

Participants ('Judges'). We aimed to recruit 200 participants to meet an a priori defined sample size of N=195 defined by wanting to detect a correlation between participant judgments and target traits of at least r= .20 with α= .05 and a literature-typical 80% power. In total, 200 participants took part in the study as volunteers or participated in exchange for a course credit. After excluding data from participants who provided invariant responses (rated all targets the same) or did not engage with the study task, data from 193 participants was retained for analysis. (M_{Age}=20.18 years, SD_{Age}= 7.90, Female= 137, 11 did not report gender).

All participants gave written informed consent and completed the study individually, in a laboratory setting. To differentiate the participants making judgments from the targets, we henceforth refer to these participants as *judges* of threat.

Materials.

Target aggression. For a measure of the 23 targets' (M_{Age}= 20.57 years, SD_{Age}= 2.02, Female= 12) trait aggression, we used the revised version (Bryant & Smith, 2001) of the Buss-Perry Aggression Questionnaire (Buss & Perry, 1992). We choose a self-report measure of aggression as there are notable concerns with the validity of laboratory tests of aggression (for a review see; Elson, Mohseni, Breuer, Scharkow, & Quandt, 2014; McCarthy & Elson, 2018; Ritter & Eslea, 2005; Tedeschi & Quigley, 1996). We selected the *Physical Aggression* subscale as our measure of aggression as it is the most relevant subscale for our focus on interspecies threat of harm. Bryant and Smith's (2001) revisions mean that respondents can score between 3 (low aggression) and 21 (high aggression) for this factor and our targets made varied total responses in a normal-type distribution ($M_{Aggression}$ = 7.52, $SD_{Aggression}$ = 4.67, $Min_{Aggression}$ = 3, $Max_{Aggression}$ = 19, skewness = 0.90, kurtosis= -0.24).

Presentations of targets. We presented the motion-capture recording as a point-light display (see Figure 1A). These point light walkers became the targets of the threat judgments for our *Movement* trials. For our *Static* trials we presented a still image of the targets wearing standardised clothing at the beginning of their first gait cycle on the treadmill (see Figure 1B).

It is the case that the point-light displays contain some body shape information and that the still image contains some movement information. However, the point light displays were all presented as the same height (distorting apparent morphological information) and the essential dynamic nature of gait is missing from the photograph. As such, whilst the qualities of the two presentation mediums may contain information for both motion and morphology, our lens model-inspired analysis accounted for the anthropometric and biomechanic features in both presentation formats.

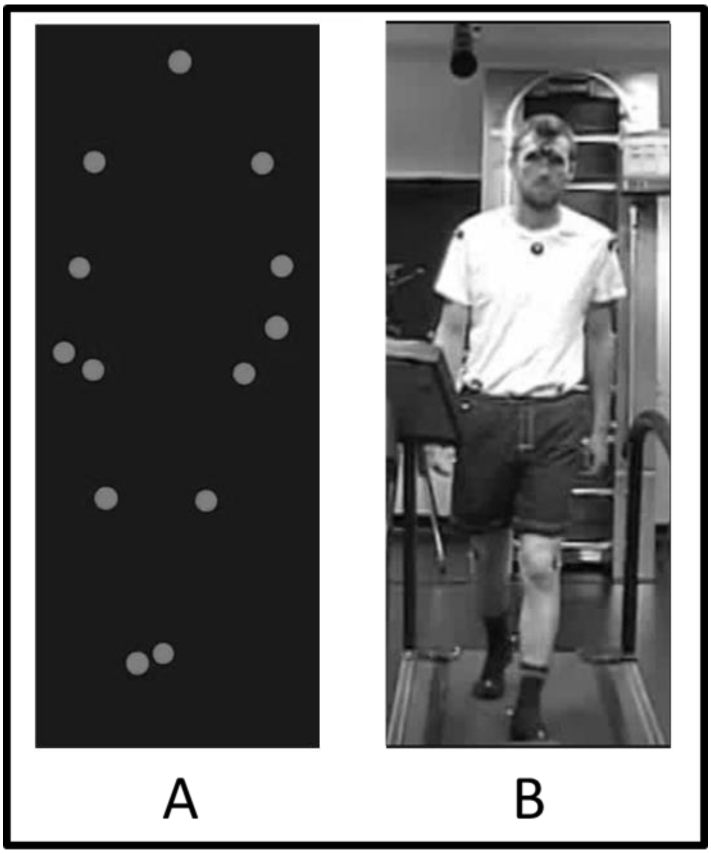

Figure 1. The appearance of targets. A) The presentation of targets in the *Movement* trials. B) The presentation of the targets in the *Static* trials.

Procedure. The study utilised a within subjects design (due to noted idiosyncrasy in judgment accuracy, see Letzring, 2008). All judges observed all targets in both mediums of presentation. After giving informed consent, judges were randomly allocated to watch the 23 targets presented (in a randomised order) in either the moving or static format followed by the 23 targets in the other presentation medium (static or moving). The presentation of all targets in both formats was on a computer screen for five seconds before asking judges to make their ratings on paper. For each target, the judges were asked to rate the target on a scale of *Threatening* (9) to *Non-threatening* (1).

Analysis. Our data were analysed using linear mixed modelling using the *lme4* (Bates et al., 2015) and *lmerTest* (Kuznetsova et al., 2017) packages in the R statistical software (R Core Team, 2013). We used these models to assess the relationship between judges' ratings of threat and targets' trait aggression ('accuracy'), accounting for variation in effects between judges and targets. Random intercepts were specified for both, and random slopes were specified maximally following recommendations in Barr, Levy, Scheepers, and Tily (2013) and Barr (2013). Such analyses avoid the heightened risk of statistical error through aggregation of participant judgments and allow us to report variability (SD) across individual judges' contribution to the models (see table 1 'Judge variability). The models also assess the interaction effect of target sex and presentation medium on the judgment accuracy. We also include supplemental mean difference effect sizes (such as Hedges' *g*) for reader accessibility.

All code for models can be found in the supplemental materials.

Results

Our data and supplemental analyses are available on the Open Science Framework at: https://osf.io/c6aby/?view_only=53a8eed4e67d465a8d69f8414319805d.

Threat judgments by conditions. The results of the models used for interpretation can be found in table 1. Participant threat judgments were higher for the targets presented in the moving medium (M = 3.43, SD= 2.00) than the static (M = 2.99, SD= 1.78, see table 1, g= 1.23 95% CI [1.20, 1.26]), although we note that these average ratings are towards the middle to low end of the 1 to 9 'threatening' scale. Across both mediums, male (M = 3.42, SD = 1.94) targets received higher threat ratings than female targets (M = 3.02, SD= 1.85, see table 1, g= 1.96 95% CI [1.92, 2.00]). There was not a significant interaction between target sex and medium on judgments of threat. Overall, this package of results supports part of our first hypothesis, with medium and sex of target influencing judgments of threat and does not support our prediction of an interaction.

Participant threat judgment accuracy. As can be seen in table 1, judges' ratings of threat significantly related to the targets' trait aggression, demonstrating overall accuracy regardless of condition. There was no effect of target sex on this relationship, nor target presentation medium nor an interaction of the target conditions on accuracy. This was not what we had predicted in our hypotheses and suggests there is information useful for accurately judging aggression through threat ratings in both still and dynamic images for male and female targets. Overall, these results support only part of our second hypothesis; that judgments of threat would be accurate but this did not vary by stimulus properties as we had also hypothesised.

Table 1. *Models summarising the effects of target condition on judges' threat ratings and accuracy of judgments*.

Target predictors	β estimate (s.e.)	*t* (approx. df)	*p*	Judge variability
Intercept	3.22 (.10)	30.91 (113.72)		1.16
Target condition effects				
Medium	-.44 (.10)	-4.17 (49.40)	< .001	0.41
Sex	.39 (.13)	3.11 (21.19)	=.005	0.15
Medium*Sex	.34 (.17)	2.00 (22.80)	=.057	0.16
Accuracy effects (with interactions)				
Aggression	.19 (.06)	2.98 (20.04)	=.007	0.92
Aggression*Sex	.03 (.13)	.26 (19.31)	=.801	0.16
Aggression*Medium	-.03 (.08)	-.33 (19.67)	=.746	0.71
Aggression*Sex*Medium	.17 (.17)	1.03 (19.00)	=.318	0.00

Notes
Threat judgments coded so that larger positive values = more threatening
Aggression self-report coded so that larger positive values = more aggressive
Medium coded so that +0.5 = Static and -0.5 = Dynamic
Target sex coded so that +0.5 = male and -0.5 = female

Additional analyses

Supplemental analyses were requested by reviewers, which involve further exploration of the data. The full detail of the analysis can be found in our supplementary materials: https://osf.io/c6aby/?view_only=53a8eed4e67d465a8d69f8414319805d. First, the effects of this study were analysed separately for the female (*n*= 137) and male (*n*= 45) judges. The effects of the study remained consistent in both subsamples for all effects, including the main above findings of medium of presentation, sex of target and accuracy. However, both subsamples (in particular the male judges) have less power, than our main analysis and further research is needed to evaluate these effects.

It was also requested that the relationship between threat ratings and the other, non-physical, measures of the Buss-Perry aggression scale (Hostility, Anger and Verbal Aggression) be analysed. Detail on these analyses can be sound in the supplementary materials. In brief, none of these traits were predicted by threat rating and in a model including physical aggression the most variance was explained by the hypothesised physical aggression.

Discussion

The results of this study add further evidence to the 'masculine is dangerous' heuristic, with male targets receiving higher threat ratings than female targets. Additionally, the moving displays, which were atypical presentations of other people as dots, were rated as more threatening. Interestingly, target sex and presentation medium did not significantly interact (at our α criterion of

.05). Further, we find more evidence that judgments of threat relate to the trait aggression of an approaching person, however this accuracy was not affected by presentation medium or sex of the target. The lack of interaction was surprising, but this does support both the evidence that aggression can be detected from morphology (Geniole et al., 2012) and the findings that aggression can be detected from movement (e.g. Satchell, Akehurst, et al., 2017).

It is highly consistent with the previous literature to find that male targets are rated as more threatening than female targets (Carré & McCormick, 2008; Geniole et al., 2015; Stirrat & Perrett, 2010; Valentine et al., 2014). However, there is no previous evidence comparing the judged threat of whole body movement to whole body static targets and therefore our finding that point light presentations were more threatening than still images needs discussion. A plausible explanation for the increased threat from movement-only presentations is that the impoverished nature of the movement-only stimuli contains very little ‘human’ information. The target is unusual to look at, perhaps falling into ‘uncanny valley’ (Cheetham, 2017) where the point-lights look almost-human without clearly being a particular person behind the points. This lack of information gives the perceiver more opportunities to make assumptions about the walking target. In fact, to an extent, there is an arguably different psychological process between judging point-light and static image stimuli. The latter task being a more everyday activity in a world where we are regularly exposed to photographs of others, and the former involving the translation of 13 dots into a person. It could be an interesting line of future research to qualitatively explore judges’ experiences of being instructed to form social perceptions of 13 moving dots.

One issue with trying to separate the movement and static information of a video is that these properties are nested within each other. Movement is affected by one’s morphology. Future research could use computer generated walks to try and to standardise any morphological information to morphology in gait presentations and to standardise gait for varying morphologies. However, we should be cautious fully separating nested perceptual information for experimental purposes. In fact, showing walks that are created to be atypical (asynchronous body shape and movement) could lead to further ‘uncanny valley’ problems. In routine experience of the world, we observe gaits that make sense for body shapes. For example, taller individuals with longer stride lengths taking fewer steps than those who are shorter. Digital manipulation of gaits to mis-match morphology and motion may produce strange stimuli which participants may reject as plausible. We may also be designing stimuli that fit our theoretical assumptions of what is 'protypical' gait and risk claiming effects where there are none (for more on this in the context of facial expressions see Barrett, Adolphs, Marsella, Martinez, & Pollak, 2019).

It is also important to note that the current research is still removed from the desired context of everyday threat judgments. Our judges engaged in their threat judgment task in the comfortable environment of a laboratory. There were no consequences of accurately detecting the threat of an approaching person or not. This judgment paradigm also lacks the reciprocal nature of everyday threat judgments. In an everyday setting an individual could change their own behaviour in response to perceived threat, by avoiding eye contact, crossing streets or even changing their own gait to appear more of a threat in response. These critiques are not new (Good, 2007; Neisser, 1980; Satchell, 2019) but are relevant when discussing the applied utility of this research. This is particularly important when considering the issues of stimulus presentation from a RAM perspective (Funder, 2012). Any attempt by researchers to focus on particular features of interest by selective presentation of stimuli, such as gait, bodies or faces, artificially limits the availability of information for personality judgment. In isolating a preferred subset of a person, away from a holistic presentation we run the risk of both underestimating the general accuracy of person judgment and overestimating specific feature effects. If we would want to estimate the general accuracy at detecting aggression from a person at a distance, this is best understood through the holistic presentation of stimuli (with lens model exploration of preferred features) rather than approximating a whole effect from various studies on subsections of gait, faces and bodies. Similarly, we might overestimate the effect of particular features of a stimulus in a limited presentation, such as gait in point-light presentation, as we have removed other information from the person that might pull focus away from our preferred information in a holistic presentation, such as a face receiving more attention. These two issues are due to perceptual wholes not being the sum of their parts. Attempts to deconstruct a person into sub-component 'bubbles' leads to a literature where we do not know if study effects would not be of the same magnitude in holistic presentation. To avoid this "bubble-ism" (see Satchell, 2019, p267) error, future work should investigate threat judgments in natural, street-based settings. Modern video surveillance and discrete eye tracking technologies could allow for a better understanding of *in-vivo* threat judgments.

Conclusion. Judgments of the ‘threat’ posed by a point light representation or photograph of an approaching person can accurately reflect that person’s trait physical aggression. There were interesting interactions between the sex and modality of presentation of our targets in terms of aggression detection accuracy. Overall, this study suggests that there should be more research, using idiographic analyses, into the accuracy of judgments of aggression (implicitly or explicitly) for realistic presentations of approaching people.

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