VICTIM SELECTION AND KINEMATICS: A POINT-LIGHT INVESTIGATION OF VULNERABILITY TO ATTACK

Rebekah E. Gunns, Lucy Johnston, and Stephen M. Hudson

ABSTRACT: Three experiments used a point-light methodology to investigate whether movement style specifies vulnerability to physical attack. Both female (Experiment 1) and male (Experiment 2) walkers could be differentiated according to ease-of-attack based solely on the kinematic information provided whilst walking. Specific walking style features predicted ease-of-attack and profiles of prototypically "easy to attack" and "difficult to attack" walkers were identified. Variations in walking style as a function of clothing and footwear style were also shown to predict differences in ease-of-attack ratings (Experiment 3). Theoretical and practical implications of these findings are considered.

KEY WORDS: kinematics; point-light; vulnerability.

On entering a room of strangers, the social perceiver can quickly detect characteristics of individuals and the nature of their interactions—who is flirting with whom, who is arguing with whom, who is shy and who is domineering. From very brief, "thin slices", of behavior the perceiver can see dominance, anger and warmth in others (Ambady & Rosenthal, 1993). From very brief silent video clips of strangers perceivers have been shown to be accurate in judging personality traits such as extraversion (Albright, Kenny, & Malloy, 1988; Ambady, Hallahan, & Rosenthal, 1995; Funder, 1995; Kenny, Horner, Kashy, & Chu, 1992) characteristics such as babyfacedness (Zebrowitz, 1997; Zebrowitz, Olson, & Hoffman, 1993), inter-

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personal relationships such as status and kinship (Costanzo & Archer, 1989), teacher effectiveness (Ambady & Rosenthal, 1992), sexual orientation (Ambady, Hallahan, & Conner, 1999) and psychopathology (Waxer, 1976, 1977). Non-verbal behavior is, therefore, very important in communicating properties of oneself to others.

Social psychologists have typically focused on the inferential processes performed on social information with few systematic attempts being made to isolate informational properties in the social domain. Consequently, much is known about the processing of social information but little about what constitutes that stimulus information (McArthur & Baron, 1983). Research has not detailed the information to which perceivers respond in detecting characteristics and relationships of others. In order to better understand and predict social interactions, the precise nature of the information specifying characteristics of individuals and the relationship between individuals needs to be described. Attention must be paid to detailing exactly what it is in a person's movements, voice, gestures and facial expressions that communicate to perceivers his or her emotions, intentions, personality characteristics and relationship with others (Archer & Akert, 1977; McArthur & Baron, 1983; Montepare & Zebrowitz-McArthur, 1988; Zebrowitz & Collins, 1997). The current research investigates the perception of vulnerability and investigates the nature of the non-verbal information that specifies this characteristic.

Victims of physical attack, human and animal, are not chosen at random; assailants select their victims. Wolves isolate and attack the most vulnerable among a flock of sheep whilst convicted offenders report that they select victims who offer adequate reward for minimal effort (Farrell, Phillips, & Pease, 1995; Fattah, 1991; LeJeune, 1977), although they are not aware of the cognitive processes involved in their selection (Amir, 1971; LeJeune, 1977; MacDonald, 1975). A small proportion of the population experience the majority of offences (Fattah, 1991; Gottfredson, 1984). Repeat victims are often offended against by a number of different offenders, suggesting that there is something about the victim that may be specifying vulnerability (Farrell et al., 1995; Feinberg, 1980; Lauritsen & Davis Quinet, 1995; Reiss, 1980; Sparks, 1981); some people "afford" (Gibson, 1966) attacking more than others. In order to better understand, predict, and prevent, physical attack, the nature of the information specifying vulnerability to attack needs to be detailed.

Movement has been linked to vulnerability in previous research (Grayson & Stein, 1981; Murzynski & Degelman, 1996): "potential victims may be signaling their vulnerability to would-be assailants through gestures, posture and exaggerated movement" (Grayson & Stein, 1981; p. 68). This link has been picked up in popular literature. Our University Student Association, for example, advocates to women that they "walk tall, walk confident" to ensure their safety on campus (UCSA, 1996). Such claims have been based on poorly conducted research and have lacked a theoretical framework.

One of the few studies (Grayson & Stein, 1981) that has investigated the link between vulnerability and movement filmed individuals walking along a New York street and had males who were incarcerated for assault against strangers rate the silent videotaped individuals according to how easy each walker would be to assault. The incarcerated males could differentiate the walkers on the basis of ease-of-attack and, using Laban analysis of movement style (Laban, 1972; Laban & Lawrence, 1967), Grayson and Stein could differentiate between the walking styles of those rated as easy and as difficult to attack. Although Grayson and Stein (1981) attributed differences in ease-of-attack ratings to differential walking styles there are a number of additional visual properties on which raters could have based their ratings of vulnerability; features, such as clothing style and facial attractiveness, which have themselves been identified as related to vulnerability (Nakdimen, 1984; Sinclair, 1973). Equally, features such as clothing style may have co-varied with movement such that an explanation in terms simply of movement style may not have been warranted. Using a point-light technique that isolates movement cues (Johansson, 1973; see below), Montepare and Zebrowitz-McArthur (1988) examined impressions of people (powerfulness, happiness and warmth) formed only from gait information (movement). The measure of powerfulness was created from, amongst others, ratings of invulnerability and was related to qualities of gait. Greater powerfulness was associated with more youthful gaits (greater hip sway, knee bend, stride length, arm swing, bounce and loose jointedness), although the extent to which variations in gait predicted powerfulness ratings was not presented. The present study extends this research focusing solely on ratings of vulnerability (ease-of-attack) and investigating the extent to which specific features of gait alone can predict ratings of vulnerability. In addition, the present research investigates the extent to which constraints on movement influence judgments of vulnerability.

A theoretical framework for this research is provided by the ecological approach to perception (Gibson, 1966, 1979; McArthur & Baron, 1983; Shaw, Turvey, & Mace, 1982). This approach considers perception in terms of adaptive function and, as such, predicts that physical, mental *and* social qualities which have important adaptive value for the promotion of both individual goal attainment and species survival are those most clearly specified in social stimulus information. The external world, it is argued, provides information to rapidly and accurately guide biologically and socially functional behaviors. Perception of characteristics of others that are relevant to taking adaptive action, such as their age, sex and level of social dominance, is likely to be quick and accurate. Given the adaptive value (through prey selection and mate selection) of detecting characteristics such as physical strength and illness, these properties, and hence vulnerability, should be specified in the stimulus information that people project. The Kinematic Specification of Dynamics (KSD) principle (Runeson, 1985, 1994; Runeson & Frykholm, 1983, 1986) states that the kinematic, or movement, patterns observed in an event (the spatio-temporal invariants of the optic array) specify the dynamics (the underlying causes) of that event. In other words, the kinematics (movement) of an event directly specify the dynamics that constrain and determine them. These dynamic constraints refer to the dispositions that restrain an object's movement given its mechanical properties or anatomical makeup and, in the case of animate beings such as humans, these dispositions also include internal states such as intentions and emotions (Runeson & Frykholm, 1983). Using a point-light technique (Johansson, 1973), previous research has demonstrated the ability of perceivers to correctly identify family and friends (Cutting & Kowlowski, 1977), to correctly identify the sex and age of actors (Kowlowski & Cutting, 1977; Runeson & Frykholm, 1983), to identify personality characteristics such as powerfulness and happiness (Montepare & Zebrowitz-McArthur, 1988), and to identify emotions such as happiness, sadness, anger and pride (Montepare, Goldstein & Clausen, 1987) from gait information alone. Walking style, or gait, can then specify both permanent factors, such as an individual's physical make-up and geometry, and temporary factors, such as an individual's moods, needs, and intentions.

From within this framework we predicted that vulnerability will be specified from movement information. Experiments 1 and 2 investigate this prediction for female and male walkers (targets) respectively. The KSD principle also leads to the prediction that changes in the dynamics underlying gait would lead to changes in vulnerability. Gait can be constrained by, for example, the terrain one is walking on and by one's clothing and footwear (Sinclair, 1973). Such constraints on movement have obvious links to vulnerability and ease-of-attack through, for example, speed of escape from an assailant. Accordingly, such changes in movement style should results in changes in ease-of-attack ratings. Experiment 3 investigates this prediction.

Experiment 1

Overview

Female walkers were videotaped using the point-light methodology. These videotapes were then shown to two groups. Trained coders coded each walker's movement style according to a number of walking style features. In addition, a group of perceivers rated each walker on how easy they thought she would be to both mug and rape. Predictions were also made for the ratings of perceived ease-of-attack from the coded walking style features.

Method

Part 1: Videotaping

Participants. Seventy-one women volunteered to participate. The women were aged 18–52 years (M = 25 years), were between 1.54 and 1.85 meters in height (M = 1.66 m), weighed between 45 and 89 kilograms (M = 61.7 kg), and were predominantly of European origin (New Zealand European, n = 68; New Zealand Maori, n = 2; Asian, n = 1).

Apparatus. The filming apparatus was set up in an experimental room as illustrated in Figure 1. Black sheeting, 6m wide, was fixed to the rear wall and spread out across the floor. All windows were fully blacked out. A National portable black and white video camera, WV-3085, was positioned 5 m from the rear wall (approximately 4.5 m from the participants). A spotlight was mounted adjacent to the camera (25 cm from camera lens) facing the walking area. The camera was fixed in position on a tripod and did not pan to follow the participants. It was located off-center, 1.3 m from the right hand side of the black sheeting. The camera lens was 1.5 m from the floor. The images were recorded on a Hitachi video system, VT-8E, and viewed on a JVC 14-inch television monitor.

The point-light technique (Johansson, 1973) was employed in filming. Individuals were videotaped wearing tight fitting black clothes. The color of the clothing minimizes reflection and its tight-fitting nature minimizes any variations in movement due to clothing type; close fitting lycra clothing allows the movement of the individual's body rather than the independent movement of their clothes to be viewed. Reflectors were attached to the principal joints and limb extremities of the individuals and

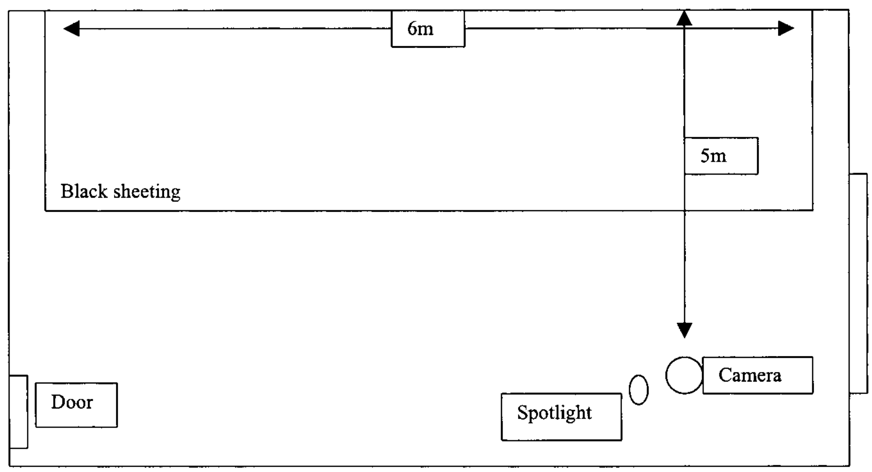

Figure 1. Filming apparatus and set up.

when the video was played back, with the contrast maximized and the brightness minimized, only a configuration of bright lights moving against a dark background was visible; geometric structure was lost and only movement was visible to the perceiver. Movement was separated from body shape, clothing and attractiveness. Hence the impact of movement alone on perception can be investigated without these confounds.

Procedure. Participants were informed that the aim of the study was to investigate links between walking style and vulnerability to attack.[1] The women were told that they would be required to change into tight-fitting black lycra clothing and walk across the room a number of times whilst being videotaped. They were guaranteed anonymity and it was stressed that they would not be identifiable in the videotape segments. The participants were all shown a video clip of somebody else walking across the room in this manner to demonstrate that all that is visible are the moving light patches attached to the body.

Participants answered questions about their age, height, weight, and ethnicity. They then changed into the clothing provided: skivvy (a tight-fitting, long-sleeved, high neck black top), leggings, socks, gloves, and a balaclava (a woolen mask which covers the face and neck with small eye, mouth and nostril holes). Reflective tape cut into 40mm diameter circles was attached to the participants' joints by the experimenter, on the outside of joints on the left-hand side of the body, and the inside of joints on the

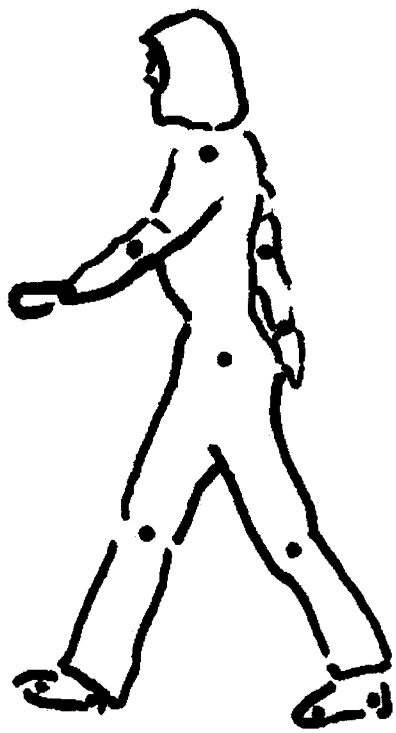

Figure 2. Illustration of the placement of reflective tape patches on walkers.

right-hand side of the body. Twelve reflective tape circles were affixed (as illustrated in Figure 2) to the participant's moving joints (shoulder, elbows, hip, knees, wrists and ankles), and limb extremities (toes).

Participants were instructed to walk as naturally as possible, back and forth across the black sheeting four times. After a practice walk, walkers were informed that videotaping would begin. Participants were videotaped from a side view only. The head and feet were in the camera shot at all times. After videotaping was completed, participants were thanked for their participation.

Editing. Overall, it took walkers approximately 25–30 seconds to walk back and forth 4 times across the room, with an average of 7 steps in camera shot on each cross from right to left. The raw recordings were edited. Each walker's first right-to-left cross in front of the camera and all of their left-to-right returns were edited out. As a result, the edited version showed each woman walking three times across the screen from right to left. Walker numbers and an 8 second space were edited into the tape between each woman.

The number of walkers was reduced to 30 for the main study to reduce the overall duration of the videotape and avoid fatigue effects for the eventual viewers (Montepare & Zebrowitz-McArthur, 1988). To select the smaller sample of walkers 7 men viewed the videotape of all the 71 walkers, on a 21-inch Panasonic colour television with the contrast turned up and the brightness turned down so that only the point-lights were visible. They rated each target according to how easy or difficult they thought she would be to mug and to rape using a 10-point scale developed by incarcerated males (1 = 'A very easy rip-off/rape'; 10 = 'Would avoid it, too big a situation. Too heavy') and used by Grayson and Stein (1981). In order to provide the best test of the ability to predict vulnerability ratings from walking style features, a sample of walkers across the entire distribution of vulnerability ratings was retained. Twelve walkers with a mean rating of 6.5 or more (comparatively difficult to attack), 12 walkers with a mean rating of 4.5 or less (comparatively easy to attack), and 6 with mean ratings of approximately 5.5 (neither especially difficult or especially easy) were included in the final sample. The selected walkers did not differ from the original sample in terms of age (M = 25 years; range 18–52 years, only 3 of whom were aged over 35 years), height (M = 1.66 m; range 1.54–1.85 m) or weight (M = 61.72 kg; range 45–83 kg). All were of European origin. A single random order of these 30 walkers was recorded onto the experimental videotape.

Part 2: Ratings

Participants. Thirty male and thirty female participants volunteered to participate in return for payment.

Procedure. Participants were tested individually or in pairs of the same sex. The participant(s) sat at a small table(s) in the research laboratory, approximately 2.5 meters from a 29-inch Panasonic television monitor. All participants read an information sheet that explained that the current study was investigating links between walking style and vulnerability to attack. They were informed that they would be asked to watch a videotape of thirty female walkers and to rate each according to how easy or difficult they thought she would be to mug and to rape. It was emphasized that the study was concerned with their perceptions of how easy these women would be to attack, and not the likelihood that they themselves would attack any of them. Participants were asked to familiarize themselves with the language and structure of the rape and mug scales, and were informed that there were no right or wrong answers, that all opinions and perceptions were valid, and to make instinctive judgments as much as possible. Once participants felt familiar with the scales, the lights were turned down and they watched the videotape and completed the ratings. The videotape was shown to the participants with the contrast turned up and the brightness turned down, so that only the point-lights were visible on the display. After completion of the ratings participants were fully debriefed, paid and thanked for their participation.

Results and Discussion

For clarity the ease-of-attack ratings for both mug and rape were reversed so that higher scores represent greater ease-of-attack. The primary focus of this experiment was to investigate whether perceived vulnerability to attack could be predicted from walking style features. The emphasis was, therefore, on the walker as the unit of analysis. Before this primary analysis could be conducted, however, a number of preliminary analyses were necessary. First, a number of analyses with the participant who rated the videotapes, as opposed to walkers, as the unit of analysis were conducted to investigate possible participant effects on ratings of ease-of-attack. Second, a number of preliminary analyses were conducted to identify those walking style features to enter into the multiple regression. In order to ensure that the ratio of the number of dependent to independent variables was as high as possible, only those features which were related to vulnerability in the preliminary analyses were entered into the critical multiple regression analysis.

Preliminary Analyses

There were no effects of any of the rater demographics (age, height, weight, sex) on ratings of ease-of-attack. The male and female raters did not differ in their ratings of ease-of-attack and neither did short and tall or heavy and light raters. The demographic features of the raters are therefore not considered further in the reported analyses. The lack of influence of demographic features of the raters is interesting as it indicates that participants were not simply making a comparison between themselves and each of the targets and rating as easier to attack those lighter and/or shorter than themselves. Instead, judgments of ease-of-attack appeared to be independent of any of their own characteristics and therefore based on information provided by the walkers. Across all raters, ratings were higher for the mug than the rape question (*Ms* = 6.06 vs. 5.44) but across participants the correlation between the mug and rape questions was exceptionally high ($r(30) = .99$) and consequently mug and rape ratings were collapsed to form a single ease-of-attack rating for each walker. As expected, some walkers were easier to attack than others ($M = 5.62$; range: 3.63–6.85). An intra-class correlation was conducted to investigate the consistency of ease-of-attack ratings, within cases (walkers) across raters. This yielded a correlation of .922.

Three independent raters coded each of the 30 walkers on eight kinematic features of walking style. These walking style features were taken from Laban analysis (Laban, 1972; Laban & Lawrence, 1967) and included the five features that differentiated high and low vulnerability walkers in Grayson and Stein's (1981) study. As in previous research (Montepare et al., 1988), the subjective ratings of body movement were used as some of the gait qualities could not be readily measured from the videotapes created. Each walker was coded in terms of stride length relative to height (1 = "very short", 7 = "very long"); weight shift (primarily lateral, side-to-side motion; three-dimensional, smooth motion involving the whole body centered around the hips; primarily up and down motion; or primarily forward and back motion); type of walk (postural motion activating the whole body or gestural motion activating only a part of the body); and body movement (contralateral motion of the two sides of the body in counterpoint, for example the right leg and left arm moving together, or unilateral movement of one side of the body at a time). Each walk was also rated in terms of foot movement (1 = 'swung,' heel-to-toe motion; 5 = 'lifted,' the whole foot being raised and lowered as a unit), amount of arm swing (1 = "very little," 5 = "a lot"), amount of energy (1 = "very little," 5 = "a lot"), and degree of constraint (1 = "very little," 5 = "a lot") in the walk. The speed of each woman's walk was calculated from the videotapes. Cronbach's alpha reliability coefficients across the 3 raters for each of the 8 coded walking features were high: stride length, $\alpha = .623$, weight shift, $\alpha = .861$, type of walk, $\alpha = .765$, body movement, $\alpha = 1.00$, foot movement, $\alpha = .781$, arm swing, $\alpha = .923$, energy, $\alpha = .898$ and constraint, $\alpha = .879$. Accordingly, the mean rating for each of the features across the 3 raters for each walker was used in subsequent analyses. Pearson Product Moment correlations were computed between the overall ease-of-attack rating and both the numerically rated walking style features for each walker and the walker's age, height and weight (see Table 1). All the numerical kinematic features were significantly correlated with overall ease-of-attack, as was walker's weight. In addition, the significant correlations between the kinematic features, provided evidence that walking style features are not independent of one another. There were, however, few significant correlations between walkers' demographic features and walking style features indicating that at least some movement features are largely independent of body structure. That is, walking style features such as amount of arm swing are not constrained by body size (height and weight).[2]

Single factor ANOVAs were conducted on the overall ease-of-attack scores for weight shift and type of walk (the categorical variables related to movement). Body movement was not included in the analysis as no variability was evident for this feature; all walkers displayed a contralateral body movement. Significant effects were discovered for each feature: weight shift, F (2, 27) = 7.47, $p < .001$; and type of walk, F (1, 28) = 5.57, $p < .05$. Post-hoc analyses (Tukey, $p < .05$) showed that walkers exhibiting predominantly forward/back or lateral weight shift were perceived as equally easy to attack but as easier to attack than walkers with a 3-dimensional weight shift (*Ms* = 6.79 and 6.31 vs. 5.25). Women with gestural walking styles were rated as easier to attack than women with postural styles (*Ms* = 6.43 vs. 5.46).

Predicting Vulnerability

A multiple regression analysis was conducted in order to determine the relative predictive ability for ease-of-attack of the walking style and demographic features. Only those movement and demographic factors that showed a significant correlation with mean ease-of-attack ratings were entered as independent variables (stride length, foot movement, arm swing, energy, constraint, speed, and weight). Weight shift and type of walk were entered as dummy coded variables (weight shift: 1 = 3-D; −1 = other; type of walk: 1 = postural; −1 = gestural). The multiple regression analysis was significant, F (9, 20) = 11.50, $p < .00001$ and accounted for 76.5% of the variance in ease-of-attack ratings. Only two features, foot movement ($\beta = .356$, $t = 2.48$, $p < .05$) and walking speed ($\beta = -.29$, $t = -2.08$, $p < .05$) were independently predictive of ratings of ease-of-attack. The more a walker lifted her feet and the slower she walked the easier to attack she was considered to be.

Consistent with our predictions and with the KSD principle, features of walking style were related to ease-of-attack ratings. Variation in these features accounted for three-quarters of the variance in ease-of-attack ratings. From these analyses it is possible to formulate profiles of the prototypical easy to attack and the prototypical hard to attack walker. Prototypically

TABLE 1

Pearson Product Moment Correlation Matrix for Walkers' Overall Ease-of-Attack Scores, Numerical Kinematic Features, and Demographic Features (Experiments 1, 2, and 3)

	Ease-of-attack	Stride length	Foot movement	Arm swing	Energy	Constraint	Speed	Age	Height	Weight
Stride length	−.69*	1.00								
	*−.69**	*1.00*								
	−.54*	***1.00***								
Foot movement	.77*	−.66*	1.00							
	*.37**	*−.28**	*1.00*							
	.37*	***−.30****	**1.00**							
Arm swing	−.65*	.45*	−.46*	1.00						
	*−.53**	*.58**	*−.23*	*1.00*						
	−.59*	***.31****	**−.07**	**1.00**						
Energy	−.75*	.55*	−.60*	.61*	1.00					
	*−.61**	*.53**	*−.28**	*.57**	*1.00*					
	−.37*	***.12****	**−.07**	**.30***	**1.00**					

Constraint	.42*	−.36*	.31	−.61*	−.38*	1.00				
	_.74*_	_−.62*_	_.51*_	_−.60*_	_−.59*_	_1.00_				
	__.49*__	__−.50*__	__.49*__	__−.33*__	__−.03__	__1.00__				
Speed	−.60*	−.29	−.33	.32	.66*	−.01	1.00			
	_−.19_	_.04_	_−.18_	_.12_	_.66*_	_−.08_	_1.00_			
	__−.15*__	__.24*__	__−.26*__	__−.16__	__.59*__	__−.38*__	__1.00__			
Age	.00	.27	−.23	−.18	−.00	.17	.02	1.00		
	_−.15_	_−.11_	_.05_	_.01_	_.13_	_.02_	_−.18_	_1.00_		
Height	−.09	.02	−.05	−.03	.09	.20	−.03	.10	1.00	
	_−.25_	_.16_	_.15_	_.07_	_−.25_	_.06_	_.48*_	_.11_	_1.00_	
Weight	−.41*	.21	−.40*	.21	.22	.12	−.37*	.07	.48*	1.00
	_−.29*_	_.19_	_−.12_	_.15_	_−.05_	_.15_	_.20_	_.09_	_.55*_	_1.00_

E1-normal type; E2-_italics_; E3-__bold__.
*$p < .05$.

easy to attack walkers can be characterized as walking with a short stride length relative to their height, having predominantly lateral or forward/back weight shifts, and gestural walking styles. They lift their feet, display limited arm swing, have low energy and high constraint in their walking style, walk relatively slowly, and weigh relatively little. Prototypically hard to attack targets are characterized by long strides relative to height, 3-dimensional weight shifts, and postural walks. They swing their feet, display a full range of arm swing, have high energy and low constraint in their walk, walk relatively fast, and weigh relatively more. These prototypes are similar to those identified by Grayson and Stein (1981), though using a more rigorous methodology that separated the impact of movement from that of other features of walkers such as attractiveness. The prototypical hard to attack walking style is also similar to that associated with more powerful individuals (Montepare & Zebrowitz-McArthur, 1988).

Experiment 2

Overview

This study replicated Experiment 1 but used male instead of female walkers. Males are more at risk from some types of physical attack than are females (van Dijk et al., 1990) and hence it is important to also understand the factors that specify vulnerability to attack for males.

Method

Part 1: Videotaping

Participants. Fifty males volunteered to participate in return for payment. The participants were aged 18–42 years (M = 23.55 years, with only 1 walker over 35 years of age), were between 1.69 and 2.03 meters in height (M = 1.81 m), weighed between 62 and 103 kilograms (M = 78.56 kg), and were predominantly of European origin (NZ European, n = 48; Asian, n = 2).

Apparatus. The filming apparatus was set up in at the University of Canterbury Fine Arts film studio in a manner similar to Experiment 1.

Procedure. The same procedure for videotaping walkers as in Experiment 1 was followed.

Editing. As in Experiment 1 the raw recordings were edited, eliminating each walker's first right to left cross in front of the camera and the left to right returns. The edited version showed each man walking three times across the screen from right to left. Walker numbers and a 5 second space were edited into the tape between each walker. Five versions of the videotape were created to minimize possible order effects. The fifty walkers were divided into blocks of ten and the order of the blocks was counterbalanced across the five videotapes. Within each block of ten, the walkers were always presented in the same randomized order.

Part 2: Ratings

Participants. Thirty male and 30 female participants who had not been involved in any other stage of this research volunteered to participate in return for payment. Six male and 6 female participants watched each version (order) of the videotape.

Procedure. Participants were tested either individually or in pairs. The same procedure was followed as in Experiment 1 except that each walker was only rated once, according to how easy or difficult they would be to physically attack. The anchors on the scale in this study were altered (1 = 'very easy to attack'; 10 = 'very difficult to attack'), that is the language of the incarcerated males employed in Experiment 1 was not used.

Results and Discussion

As in Experiment 1, the ease-of-attack ratings were reversed so that higher scores represent greater ease-of-attack.

Preliminary Analyses

Once again, there was no effect of rater demographics (age, height, weight, sex) on ratings of ease-of-attack. These features of the participants were therefore not considered further. There was no effect of videotape version on participant's ratings and so this factor will not be considered further. Some walkers were again easier to attack than others (M = 5.69; range: 4.32–7.82). An intra-class correlation was conducted to investigate the consistency of ease-of-attack ratings, within cases (walkers) across raters. This yielded a correlation of .920.

Three independent raters coded each of the 50 walkers on the same eight kinematic features, as in Experiment 1. Cronbach's alpha reliability coefficients across the 3 raters for each of the 8 coded walking features were high: stride length, $\alpha = .809$, weight shift, $\alpha = 1.00$, type of walk, $\alpha = .956$, body movement, $\alpha = 1.00$, foot movement, $\alpha = .787$, arm swing, $\alpha = .866$, energy, $\alpha = .852$, constraint, $\alpha = .842$. Accordingly, the mean rating for each of the features across the 3 raters for each target was calculated and used in the subsequent analyses. Speed was again calculated from the videotapes. Pearson Product Moment correlations were computed between ease-of-attack ratings and both the numerical walking style features for each walker and the walker's age, height and weight. All of the numerical kinematic features, except speed, were significantly correlated with the overall ease-of-attack ratings, as shown in Table 1. In addition walkers' weight was significantly correlated with ease-of-attack. As in Experiment 1, there were significant correlations between the kinematic features but few within walkers' demographic features and walking style features.

Single factor ANOVAs were conducted on the overall ease-of-attack ratings for categorical variables, that is weight shift and type of walk. Body movement again showed no variability across the walkers; again all walkers displayed a contralateral body movement. There was a significant effect for type of walk, $F\ (1, 48) = 22.48$, $p < .0001$. Walkers with gestural walking styles were rated as easier to attack than walkers with postural styles (*Ms* = 6.32 vs. 5.42).

Predicting Vulnerability

A multiple regression analysis was conducted in order to determine the relative predictive ability for ease-of-attack of the walking and demographic features. Only those movement and demographic factors that showed a significant correlation with mean ease-of-attack ratings were entered as independent variables (stride length, foot movement, arm swing, energy, constraint, and weight). Type of walk was entered as a dummy variable (1 = postural; −1 = gestural). The regression analysis was significant, $F\ (7, 42) = 13.65$, $p < .0001$ and accounted for 64.4% of the variance in the ease-of-attack ratings. Four features were independently predictive of ratings of ease-of-attack: stride length ($\beta = -.341$, $t = -2.51$, $p < .01$), energy ($\beta = -.263$, $t = -2.24$, $p < .05$), constraint ($\beta = .437$, $t = 3.10$, $p < .01$), and weight ($\beta = -.190$, $t = -2.11$, $p < .05$). The shorter a walker's stride length relative to his height, the less energy, the more constraint in his walk, and the less he weighed, the easier to attack the walker was rated.

These results are similar to those for the female walkers in Experiment

1. The relationship between walking style and ease-of-attack exists for male as well as for female walkers. The pattern of significant correlations between walking style features and ease-of-attack was very similar to that for the female walkers although the walking style features that were independently predictive of ease-of-attack were different. In addition, the weight of the walker was an independent predictor of ease-of-attack for male walkers only, which may reflect the overall greater strength, and hence resistance to attack, of males.

Experiment 3

Overview

Experiments 1 and 2 showed that perceivers can differentiate walkers on the basis of ease-of-attack from the kinematic features in walking style. These studies effectively provide a baseline for research on the perception of vulnerability. Although they demonstrated that movement alone is sufficient to specify ease-of-attack, perceivers do not typically see movement in isolation. It is important to extend these studies by considering the effects of additional information on perceptions of vulnerability. In Experiments 1 and 2 body movement was intentionally unconstrained. In Experiment 3 we investigated the impact of clothing and footwear constraints on movement and vulnerability. Clothing (e.g., tight skirt) and footwear (e.g., high heels) that was likely to constrain movement was employed. The point-light methodology was again employed so that effects of clothing were restricted to their impact on movement and not to their visual impact, which has previously been linked to vulnerability (Marshall & Barbaree, 1990; Nakdimen, 1984). A repeated measures design was employed to investigate whether the walking style of individuals changed as a function of clothing and/or footwear and the impact of such changes on ease-of-attack.

Method

Part 1: Videotaping

Participants. Thirty females volunteered to participate in return for payment. The women were aged 20–29 years ($M = 22.5$ years), were between 1.54 and 1.78 meters in height ($M = 1.70$ m), weighed between 41 and 81 kilograms ($M = 64.9$ kg), and were predominantly of European origin (NZ European, $n = 29$, Asian, $n = 1$).

Videotaping. The videotaping apparatus was set up as for Experiment 2.

Clothing. Three sets of clothing and three types of footwear were used in this study. The baseline clothing condition was that worn by walkers in Experiments 1 and 2. In the trousers condition the leggings were replaced with straight-leg black trousers and in the skirt condition with a tight-fitting simulated skirt. The skirt was simulated with lengths of black velcro which were attached around participants' waists and knees with adjustable lengths in between. Participants were fitted for the skirt while standing with their feet hip width apart. The hemline of the skirt was adjusted to sit 3 cm above the knee. As a result, the fitting of the skirt was kept constant across all participants. With each clothing type, participants had bare feet, wore flat black shoes and wore black high-heeled shoes with an 8 cm heel of 3 cm width.

Procedure. The procedure was the same as for Experiments 1 and 2, except that each walker was videotaped wearing each of the nine clothing and footwear combinations.

Editing. As in Experiments 1 and 2, the raw recordings were edited, eliminating each walker's first right to left cross in front of the camera and their left to right returns in each condition. As a result, the edited version showed each woman walking three times across the screen from right to left in each of the 9 conditions. Walker numbers 1–270 and a 5 second space were edited into the tape between each woman. In order to minimize possible order effects 12 versions of the videotape were created. For 6 of the tapes 3 blocks of walkers were created: 1 contained all the walkers dressed in leggings walking in each of the three footwear conditions; 1 contained all the walkers dressed in trousers walking in each of the three footwear conditions; and 1 contained all the walkers dressed in the skirt walking in each of the three footwear conditions. Across the 6 tapes the order of these 3 blocks was counter balanced so that each block appeared equally often in the first, second and third segment of the videotape. Within each block the ninety walkers were presented in the same random order but this order was different for each block. For the other six tapes a similar procedure was used except that the original 3 blocks of walkers were different. One contained all the walkers bare footed in each of the 3 clothing conditions, 1 contained all the walkers wearing flat shoes in each of the 3 clothing conditions and 1 contained all the walkers wearing high heels in each of the 3 clothing conditions.

Part 2: Ratings

Participants. Thirty-six male and 36 female participants volunteered to participate in return for payment. Three male and 3 female participants watched each version of the videotape.

Procedure. Participants were tested individually. The same procedure was followed as in Experiment 2, with each of the 270 video clips of walkers being rated according to how easy or difficult they would be to physically attack (1 = 'very easy to attack'; 10 = 'very difficult to attack').

Results and Discussion

As in Experiments 1 and 2, the ease-of-attack ratings were reversed so that higher scores represent greater ease-of-attack.

Preliminary Analyses

Once again, there was no effect of rater demographics (age, height, weight, sex) on ratings of ease-of-attack. These features of the participants were therefore not considered further in the reported analyses. There was no effect of videotape version on participant's ratings and so this factor will not be considered further. Some walkers were again easier to attack than others ($M = 5.47$; *range* = 3.19 –7.00). An intra-class correlation was conducted to investigate the consistency of ease-of-attack ratings, within cases (walkers), across raters. This yielded a correlation of .913.

For comparison with Experiments 1 and 2, the ability of walking style features to predict ease-of-attack ratings was computed across all of the experimental conditions. Three independent raters coded each of the 270 walking clips (30 walkers each walking in 9 different conditions) on seven kinematic features, body movement was excluded as there had been no variation across walkers in either Experiment 1 or 2. Cronbach's alpha reliability coefficients across the 3 raters for each of the 8 coded walking features were high: stride length, $\alpha = .694$, weight shift, $\alpha = .757$, type of walk, $\alpha = .801$, body movement, $\alpha = 1.00$, foot movement, $\alpha = .842$, arm swing, $\alpha = .879$, energy, $\alpha = .766$, constraint, $\alpha = .690$. Accordingly the mean rating for each of the features across the 3 raters for each target was calculated and used in the subsequent analyses. Speed was calculated directly from the videotapes. Pearson Product Moment correlations were computed between ease-of-attack ratings and both the numerical walking style features for each walker and the walker's age, height and weight. All of the numerical kinematic features were significantly correlated with the overall ease-of-attack ratings, as shown in Table 1. Once again, there were significant correlations between the kinematic features themselves, providing evidence of the inter-dependence of the walking style features.[3]

Predicting Vulnerability

A multiple regression analysis was conducted across all conditions. All of the numerical features were entered as predictors as was type of walk (1 = postural; −1 = gestural). The regression analysis was significant, $F(7, 262) = 57.66$, $p < .00001$ and accounted for 59.6% of the variance in ease-of-attack ratings. Five of the walking style features were independently predictive of ratings of ease-of-attack: stride length ($\beta = -.258$, $t = -5.61$, $p < .0001$), foot movement ($\beta = .206$, $t = 4.58$, $p < .0001$), arm swing ($\beta = -.369$, $t = -8.25$, $p < .0001$), energy ($\beta = -.250$, $t = -6.00$, $p < .0001$), constraint ($\beta = .140$, $t = 2.73$, $p < .01$). The shorter the stride length, the less walkers swung their feet or arms, and the more they walked with high energy, low constraint or slowly the easier to attack they were rated.

The Impact of Clothing and Footwear

A 3 (clothing: leggings/trousers/skirt) × 3 (footwear: barefoot/flat shoes/high heels) repeated measures ANOVA was conducted on mean ratings of ease-of-attack. There were significant effects of both clothing, $F(2, 58) = 34.37$, $p < .0001$, and footwear, $F(2, 58) = 22.24$, $p < .0001$. Means are shown in Table 2. Post-hoc tests (Tukey, $p < .05$) revealed that the walkers were rated as easier to attack when wearing the skirt than when wearing either the leggings or the trousers which did not differ from one another (*Ms* = 5.93 vs. 5.24 and 5.23). Walkers were also rated as easier to attack when barefoot or wearing high heels than when wearing flat shoes (*Ms* = 5.60 and 5.59 vs. 5.22). The following section considers whether these differences in ease-of-attack ratings can be explained by differences in walking styles features across conditions.

Within each of the nine experimental conditions the 30 walkers were ranked on the basis of their mean ease-of-attack rating. Kendall's coefficient of concordance for these rankings was .603 indicating a high level of similarity in rankings across the experimental conditions. That is, walkers who were rated as one of the easiest walkers to attack in one condition were also rated as one of the easiest to attack in the other conditions.

TABLE 2

Ease-of-Attack Ratings as a Function of Clothing and Footwear Styles (Experiment 3)

	Clothing		
Footwear	Leggings	Trousers	Skirt
High heels	5.02	4.98	5.66
Bare feet	5.36	5.40	6.02
Flat shoes	5.35	5.31	6.10

Comparing Walking Styles Across Conditions

Walking style features were compared across conditions and whether differences in walking style features across the different experimental conditions can explain differences in ease-of-attack ratings across those conditions was investigated. For each walker there were nine conditions that could be compared, giving a total of 36 comparisons possible for each walker. Of particular interest, however, were comparisons between those conditions associated with high and with low ease-of-attack ratings. Accordingly, comparisons are reported between wearing a skirt and the mean of the other two clothing conditions and between wearing high heels and wearing flat shoes.[4]

Single factor ANOVAs were conducted on the numerically coded walking style features for the clothing (skirt vs. leggings/trousers) and footwear (high heels vs. flat shoes) conditions. When wearing the skirt, walkers had shorter stride length relative to height ($F(1, 29) = 13.64$, $p < .001$; $Ms = 3.36$ vs. 3.91), lifted their feet more ($F(1, 29) = 4.20$, $p < .05$; $Ms = 2.97$ vs. 2.87), swung their arms less ($F(1, 29) = 28.42$, $p < .0001$; $Ms = 2.69$ vs. 3.00), had less energy ($F(1, 29) = 3.84$, $p < .06$; $Ms = 3.00$ vs. 3.11), had more constraint ($F(1, 29) = 8.04$, $p < .01$; $Ms = 2.91$ vs. 3.06) and slower speed ($F(1, 29) = 5.01$, $p < .05$; $Ms = .515$ vs. 509 secs/stride) than when wearing either leggings or trousers. When wearing high heels, the walkers had shorter stride lengths ($F(1, 29) = 24.81$, $p < .0001$; $Ms = 3.42$ vs. 4.10), lifted their feet more ($F(1, 29) = 359.77$, $p < .0001$; $Ms = 3.53$ vs. 2.20), had more constraint ($F(1, 29) = 49.92$, $p < .0001$; $Ms = 2.89$ vs. 3.25) and less speed ($F(1, 29) = 31.39$, $p < .0001$; $Ms = .511$ vs. 524) than when wearing flat shoes.

Difference scores were calculated for each walker, for each walking style feature and for the ease-of-attack ratings. For each walker, two sets of difference scores were calculated—between the skirt and the mean of the clothing conditions and between the high heels and flat shoes conditions. Two multiple regression analyses were conducted, one for differences in clothing and one for differences in footwear, in order to determine whether differences in walking style features predicted differences in ease-of-attack ratings. For the footwear analysis, differences in arm swing and energy level were not entered into the analysis as there were no differences between these features across footwear conditions.

For clothing, the overall regression analysis was significant, $F(6, 23) = 13.86$, $p < .0001$ and accounted for 72.68% of the variance in the ease-of-attack difference scores. Differences in stride length were independently predictive of differences in ratings of ease-of-attack, ($\beta = .386$, $t = 3.09$, $p < .005$). Differences in two other walking style features were marginally predictive of differences in ease-of-attack ratings: differences in arm swing ($\beta = .214$, $t = 1.82$, $p = .08$), and differences in constraint ($\beta = -.207$, $t = -1.89$, $p = .07$). For footwear, the regression was significant, $F(4, 25) = 5.28$, $p < .01$, but accounted for only 37.10% of the variance in the ease-of-attack difference scores. Differences in stride length ($\beta = .394$, $t = 2.60$, $p < .05$) and foot movement ($\beta = -.614$, $t = -4.00$, $p < .001$) were independently predictive of differences in ratings of ease-of-attack.

The results of Experiment 3 indicate that differences in clothing and footwear resulted in differences in walking style that, in turn, predict differences in ease-of-attack ratings.

General Discussion

The results of the reported experiments clearly demonstrated the ability of perceivers to differentiate both females and males on the basis of ease-of-attack, solely from the kinematic information provided whilst walking. In each experiment, the coded walking style features accounted for much of the variance in ease-of-attack ratings, although no clear picture of dominant predictive features emerged from the regression analyses. The walking style features were, however, strongly inter-correlated in each experiment suggesting that configural stimulus information may be more important than a summation of individual elements (Secord, Dukes, & Bevan, 1954; Secord & Muthard, 1955) in specifying ease-of-attack.

Consistent prototypes of easy and difficult to attack walkers could be identified from each experiment. The prototypical hard to attack walker was characterized by a longer stride length, swinging foot movement, a larger range of arm swing, higher energy, lower constraint, a faster walk, and a relatively heavier body weight than easy to attack walkers. They also moved posturally, with a three-dimensional weight shift, whereas easy to attack walkers moved gesturally, and with a predominantly lateral or forward/back weight shift. The prototypes identified in our studies are similar to those identified by Grayson and Stein (1981) but were developed using a rigorous methodology that isolated the contribution of kinematic information to perceptions of vulnerability. The characteristics associated with low vulnerability suggest faster escape from potential attack (longer stride length, faster walk, higher energy) or greater ability to defend oneself (heavier body weight; higher energy). The association of such movement features with vulnerability ratings is consistent with the adaptive argument of the ecological approach to perception. It is also noteworthy that perceivers were not simply selecting as the easiest (or hardest) to attack those with extreme, or unusual, walking styles. All the correlations between walking style features and ease-of-attack ratings were linear, only walkers at one extreme of each feature were judged as easiest to attack although walkers at both extremes would likely have equally extreme, unusual or distinctive movement styles.

The prototypical hard-to-attack walking style was also similar to the youthful gait identified by Montepare and Zebrowitz-McArthur (1988) that was correlated with judgments of powerfulness. The similarities between our research and that of Montepare and Zebrowitz-McArthur (1988) raises a question of whether vulnerability is a “stand-alone” trait or whether perceivers are detecting a more general characteristic of targets reflecting vulnerability, social dominance, physical strength, powerfulness and the like. The high correlations between ratings of mugging and rape (Experiment 1) suggest a single characteristic of vulnerability to physical attack. Investigation of the extent to which the perception of vulnerability also correlates with characteristics such as dominance, strength and powerfulness is currently underway in our laboratory. Future investigations should also consider vulnerability to psychological as well as physical attack and the similarity, or otherwise, of the information specifying each form of vulnerability.

The lack of impact on ease-of-attack ratings of demographic features (age, height, weight) of both raters and walkers is noteworthy. There was no effect in any of the experiments of the perceivers’ characteristics on their ratings of ease-of-attack. Perceivers were not simply making relative size judgments, identifying those bigger than themselves as harder, and those smaller than themselves as easier, to attack. Given Montepare and Zebrowitz-McArthur’s (1988) finding of an association between a youthful gait and judgments of powerfulness, it was surprising that in none of our studies was there a correlation between age and ease-of-attack ratings. The age range of our walkers was however somewhat restricted, with our walkers falling into the "youthful" age range; across the three experiments only 4 walkers were aged over 35 years. The possibility that older individuals are perceived as more vulnerable, and the extent to which this may be due to older individuals having different walking styles from younger individuals, awaits further research.

There was also little influence of the size of the walkers on the extent to which they were judged as easy or difficult to attack. In Experiments 1 and 2 walkers' weight was correlated with ease-of-attack ratings but only in Experiment 2 was weight an independent predictor of ease-of-attack. Across Experiments 1 and 2 only 3 of the 36 correlations between walking style features and demographics were significant. Many walking style features are, then, largely independent of body structure. Specific features of the movement style of walkers were predictive of ease-of-attack in each experiment and these were largely independent of walkers' age, height and weight. The results of Experiment 3 further indicate the lack of impact of walker demographics on ease-of-attack ratings. In this experiment ease-of-attack ratings varied across conditions when the walkers' age, height and weight necessarily remained constant. It is worth noting that in the reported research, participants were making ratings of ease-of-attack rather than actually attempting such assaults. It is possible that the body size and shape of walkers may have been more influential if the participant's task involved actually attempting to tackle the walkers.

The finding that walking style specified ease-of-attack is consistent with the prediction derived from the ecological approach to perception that properties that have adaptive value, such as vulnerability, are specified in the stimulus array. From only approximately 1.5 seconds of video of each walker, perceivers were able to make judgments relating to vulnerability. Thin slices of a single aspect of non-verbal behavior, movement, was sufficient to specify vulnerability, as it was for age and sex (Kowlowski & Cutting, 1977; Montepare & Zebrowitz-McArthur, 1988; Runeson & Frykholm, 1983) and various emotions (Montepare et al., 1987). It is possible that judgments of ease-of-attack were consciously mediated by perceivers' stereotypic beliefs about the prototypical victim of attack. However, these decisions were made very rapidly from very restricted visual information. Despite the evidence of strategic victim selection amongst rapists and muggers, these perpetrators have been shown to be unaware of the factors on which they based their decisions (Amir, 1971; LeJeune, 1977; MacDonald, 1975). Those who actually attack others, it appears, have procedural or tacit knowledge about the attackability of their victims, but not the conceptual or declarative knowledge on which those decisions are based (Cohen & Squire, 1980; Graf & Schacter, 1985). Similarly, it is unlikely that participants in our studies were aware of the factors on which they based their ratings of ease-of-attack and hence were evaluating targets against those criteria. Indeed previous research has shown perceivers to be unable to identify the movement features on which they based judgments of vulnerability (Grayson & Stein, 1981; Gunns, 1998).

Experiment 3 investigated the impact of constraints on walking style, as a result of clothing and footwear variations. The different clothing and footwear styles did, as predicted, result in differences in walking style. These differences in walking style between experimental conditions then accounted for much of the variance in differences in ease-of-attack ratings between those conditions. These findings are consistent with arguments that clothing styles, such as skirts, affect a woman's power and appearance (Henley, 1977).

In order to conclude that perceivers were accurate in their perceptions of vulnerability it would be necessary to demonstrate that those individuals rated as easiest to attack were actually easiest to attack. Research in other domains has demonstrated a link between perception and action. Warren (1984), for example, showed the stair riser height that required least energy expenditure in stair climbing was also that judged, solely from visual information, to be the most comfortable to climb. The similarity between our findings and those of Grayson and Stein (1981) whose participants were incarcerated male inmates convicted of assaultative crimes against strangers would, though, support a link between perception and action. Convicted males, by definition, have engaged in actual assaults in addition to judging the vulnerability of strangers to assault and, as such, are likely to be more attuned to information specifying vulnerability in potential victims (Amir, 1971; LeJeune, 1977; MacDonald, 1975) and also to have received feedback on the success or failure of their perceptions. Sensitivity to relevant information can increase with experience (E. Gibson, 1969; Neisser, 1976) such that offenders' sensitivity to information specifying ease-of-attack may increase as they attend to cues that were characteristic of vulnerable targets in the past. Ongoing research in our laboratory, including the use of virtual reality simulation, is investigating further the link between ratings of ease-of-attack and actual ease-of-attack.

The findings from the reported research demonstrated that perceivers could detect ease-of-attack when they were given, through the experimental instructions, the specific goal or intention of judging ease-of-attack. Whether they would spontaneously attend to information specifying ease-of-attack is unknown. Proponents of the ecological approach to perception argue that the information specifying characteristics, such as vulnerability, is always available to perceivers (Gibson, 1977) but that perceivers do not necessarily attend to that information. The information that is attended to will depend on the attunement of the perceiver at any given moment. Intentions and expectations of perceivers influence the information attended to which in turn influences the perception of an event (Massad, Hubbard, & Newtson, 1979). Some people, for example, would-be assailants may, then, be more likely to attend to information specifying ease-of-attack than others as a function of their intentions. Future research should consider offender characteristics, such as sexual aggression, and how they relate to attention and sensitivity to information specifying vulnerability to attack.

The reported studies focused exclusively on kinematic information to test predictions derived from the KSD principle and conclusions drawn from previous research. Accordingly, point-light methodology that uses a stimulus array that is impoverished on all dimensions except movement was employed. Only by so doing could the unique contribution of kinematic information to perception be considered. This focus on kinematics should not be interpreted as suggesting that kinematic information is the only, or even the most important, information in perceiving vulnerability in natural situations when additional visual information and other sensory input is available to perceivers. The reported research showed that kinematic information *can* specify vulnerability but the impact of additional information needs to be considered in order to gain a fuller picture of the extent to which this kinematic specification of vulnerability influences everyday perception. Other information such as clothing and attractiveness (Henley, 1977; Marshall & Barbaree, 1990) have been linked to physical attack. The extent to which additional information complements, overrides, or has no impact on the perception of vulnerability as specified by movement alone needs to be examined. An interesting question about the dominance of different information properties arises when contradictory sources are combined, for example, a walking style specifying high vulnerability but conservative dress specifying low vulnerability.

An obvious question arising from this research is whether individuals can change their walking style and hence lower their vulnerability to attack. A series of studies carried out in our laboratory (Johnston, Hudson, Richardson, Gunns, & Garner, 2001) suggest that deliberate changes to walking style as a function of movement training can reduce ratings of ease-of-attack. Results from Experiment 3 demonstrated that factors that constrain movement (clothing and footwear) influenced ease-of-attack ratings. The vulnerability of any given individual is not, therefore, fixed but can vary as a function of factors such as attire. The features manipulated in Experiment 3 constrained the movement of all walkers. Accordingly, there was a strong correlation in the rank order of the walkers in terms of ease-of-attack ratings across the different clothing style conditions; the ease-of-attack ratings of all the walkers was influenced to a similar extent. Normally, of course, walkers would be free to choose their clothing and footwear styles such that some walkers may choose clothing or footwear that increases or decreases their tendency to walk in a style indicative of high vulnerability. Future research is planned to investigate such conditions, using full-view in addition to point-light videotaping.

The present research demonstrated that perceivers were able to differentiate walkers according to ease-of-attack on the basis of kinematic information alone. Specific walking style features were identified as specifiers of vulnerability. These findings added empirical strength to the previous claims made about the relationship between walking style and vulnerability to attack. At a more general level, these findings demonstrate that it is possible to detail the nature of the stimulus information to which social perceivers respond, and introduces methodologies for so doing.

Notes

1. The University of Canterbury Human Ethics Committee required that walkers in each experiment be informed as to the overall purpose of the research. Walkers were told that their video clips would be shown to other experimental participants who would make estimates regarding perceived vulnerability. The walkers were not, however, told that specific walking style features would be coded and links between these features and vulnerability ratings investigated.
2. Scatterplots and multiple regression analyses were also computed to test for quadratic rather than linear relationships between walking and demographic variables and ratings of ease-of-attack. There were, however, only linear relationships between the variables, as indicated in the text. No quadratic relationships were seen. Full details of these analyses can be obtained from the authors.
3. The correlations were also computed separately for each of the experimental conditions. These correlations showed a similar pattern of effects to those reported. For full details of the statistical analyses within each experimental condition please contact the authors. Walker demographics were not included in the analysis for Experiment 3 since these factors remained constant across all the experimental conditions, unlike the walking style features. Separate analyses within each condition indicated, however, low correlations (non-significant) between walkers' age, weight and height and both ratings of ease-of-attack and walking style features.
4. The barefoot condition was not considered in this comparison since being barefooted is unusual when walking outdoors and ease-of-attack ratings did not differ in the barefoot and high heels conditions. Full details of all the analyses, including those comparisons not reported in the results section can be obtained from the authors.

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