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The Effect of Threat Perception on Judging Interpersonal Distance

Connor N. Kuntz
University of Dayton

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Connor Kuntz

Department: Psychology

Advisor: Benjamin Kunz, Ph.D.

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Abstract

This study examined the potential impact of threat perception on judgments of interpersonal distance. A growing body of research suggests that the perception of space and objects within space can be impacted by non-visual factors. For instance, research illustrates a connection between threat perception and spatial judgments, in that objects that pose a danger are seen as being closer or farther than they really are. Stereotypes, which are generalized beliefs about a group, can result in threat perception, which, by extension, means that stereotypes could impact the perception of interpersonal distance. The perceived distance between oneself and another object or person can be measured using different methods, such as verbally calling out an estimate of distance or walking an estimated distance to a target without visual feedback. The present study employed virtual reality technology to assess whether participants misperceived the distances between themselves and virtual targets as a function of whether the targets appeared threatening or benign. Our results found a significant impact of target appearance on the perception of distance. This was characterized by the more threatening target being perceived as further away than the benign target. These results are reviewed in the context of previous research exploring the influence of threat on spatial judgments. This study lays the groundwork for future studies that will investigate the impacts of group membership on the perception of threat and interpersonal distance.

University *of* Dayton

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The prevalence of biases and their effects on behavior is a topic of intense study in the field of psychology, with implications for both an understanding of human cognition and for society more broadly. In particular, the perception of threat posed by others may play a significant role in understanding how some individuals perceive others and what guides their interactions with them. Being able to detect a threat is advantageous for humans in many ways, such as quickening reaction times, increasing adrenaline, and producing other automatic fight-or-flight responses that promote survival. However, threat detection is imperfect and can be misguided due to imagined threats. An object or person perceived as a threat may be perceived differently than a non-threatening person or object because of the brain's tendency to create schemas and modify sensory information to fit those schemas, changing perception. This misjudgment could lead to misperceptions of the person or object, which in turn would influence behavior directed toward that person or object. This study examines one such implication of stereotypes regarding threat; does an assumption that a target person is threatening make that person appear closer than they are?

Threat and Spatial Judgments

Although visual perception is often assumed to closely resemble the world outside the mind, it is prone to distortion and bias; for example, if perceptions were always exact, optical illusions would not exist. Research has begun to demonstrate that optical and non-visual factors can lead to misperception. For example, Balcetis and Dunning (2010) conducted a study showing that more desired objects in the environment can appear

closer than less desired objects. This research was further expanded upon by a subsequent study looking at the same integration of desirability and perception of distance (Dunning & Balcetis, 2013). Specifically, this study found that perceptions of ambiguous visual information and environments reflected the desired perceptions of participants, such as seeing a more desired object as closer (Dunning & Balcetis, 2013). The Dunning & Balcetis (2013) study is differentiated from the Balcetis and Dunning (2010) study because the former found a broader impact of desire on perception while the latter only observed the perception of distance. Another study found a relationship between threat posed by a person and the perceived distance of that person from participants (Cole et al., 2013). This study found a significant difference between the perception of distance when comparing threatening, disgusting, and neutral targets (Cole et al., 2013). The results showed that the threatening target was perceived as significantly closer than the disgusting or neutral target (Cole et al., 2013). Notably, the threat in this experiment came from affective signals, such as a male student behaving aggressively rather than based simply on the target's appearance (Cole et al., 2013). The disgust in this experiment came from affective signals, such as a male student behaving repulsively (Cole et al., 2013). The neutral target was characterized by a lack of affective signals (Cole et al., 2013). These studies have illustrated that non-visual factors influence the visual-spatial perception of objects; however, the influence of non-visual factors, such as the appearance of a target person, on the perception of a target person is still largely unexplored. To explore this, the current study used a target appearance that reflected threatening stereotypes to impose threat. This differs from previous studies that imposed threat though aggressive actions of targets (Cole et al., 2013).

Stereotypes

Stereotypes are generalized beliefs about a group of people that ignore individual differences between group members. The reason humans form these stereotypes is to act as heuristics that can increase processing speed, resulting in quicker reactions to stimuli. As a result of this sizable benefit, humans have evolved to make use of stereotypes. There are a wide range of beliefs that can be associated with stereotypes, and these beliefs can be both positive and negative. For instance, one potentially harmful stereotype people hold is that doctors are male while nurses are female. Another type of stereotype revolves around presumed threats posed by others based on their appearance or visual characteristics. (Cox et al., 2012; Wilson et al., 2017). The relationship between perceived threats and stereotypes is a growing area of research (Bonam et al., 2010; Cesario & Navarrete, 2014; Cox et al., 2012; Krosch, 2022; Wilson et al., 2017). Bonam et al. (2010) studied how physical space being racialized, as with redlining, can cause the psychology of individuals to change and affect "person perception and social identity threat" towards members of out-groups and those with stereotypes placed upon them. Similarly, Krosch (2022) proposed that perceived threats due to the environment, in-groups, and out-groups can cause minority individuals to appear more threatening than they are in reality. Cesario and Navarrete (2014) examine how perceptual bias based on in-group and out-group relationships can change threat perception. Cox et al. (2012) investigated the effects of prejudice and stereotypes, with one study reporting that white individuals perceived black men as more imposing and potentially threatening than other participants. Wilson et al. (2017) discuss how racial bias can change the perception of size and formidability and how these perceptions can also affect how threat is perceived.

What these studies demonstrate is that stereotypes have a significant effect on perception. These perceptual effects persist when the stereotypes do not reflect accurate information. Together, these studies suggest that perceived threat due to stereotypes could impact the way we see the world and others around us, including the perception of distance, specifically interpersonal distance.

Distance Perception

Perceiving distance is critical for spatial awareness, navigating the environment, and interacting with people within the environment. For instance, when encountering an acquaintance on the street, one must first accurately see the distance between themselves and the other person in order to approach to shake hands. When compared to more overt behaviors and actions, the way one sees or perceives a target object is difficult to observe and measure. Measuring perception is indirect since current technology prevents researchers from observing or recording how a person "sees" a target or the environment. One way to infer how people perceive distance is through the use of the blind walking task. In this task, one walks without visual feedback to a previously viewed target using one's perception of distance between them and the target. Blind walking is an overt and measurable action that relies on a person's perception of distance and is a relatively standard way of judging distance in studies with reasonable accuracy (Andre & Rogers, 2006; Philbeck et al., 2010). Alternatively, a self-reported measure could be used to assess the perceived distance. For instance, verbally reporting perceived distance presumably reveals one's subjective experience of how close or far a target appears to be. As a subjective measure, verbal reports may also be more prone to cognitive biases than blind walking and could actually be the product of different visual processing pathways

in the brain distance (Andre & Rogers, 2006; Kunz et al., 2009; Napieralski et al., 2011). While neither of these measures is able to perfectly capture visual perception and they may reflect different aspects of visual processing, they are often used in conjunction in order to assess distance perception.

Current Study

This experiment investigated how perceived threat impacts the perception of interpersonal distance. Based upon research suggesting that more threatening targets appear closer than more benign targets, this experiment attempted to replicate this result under new conditions (Cole et al., 2013). The initial research done by Cole et al. (2013) involved a male student demonstrating aggressive behavior to stimulate threat perception. This new study modified these conditions by removing the factor of aggressive behavior and relying solely on a target intended to evoke stereotypes related to threats based solely on appearance.

The hypothesis driving this experiment was that viewing a person who seemed to pose a physical threat would influence the perception of the physical distance to that person. More specifically, it was predicted that a target with a stereotypically threatening appearance would be perceived as closer than a target with a less stereotypically threatening appearance. This would suggest that our perceptions of interpersonal distances are influenced by not just visual information but also by social cues/factors. Furthermore, it was predicted that this difference would be more evident in the verbal report condition than in the blind walking condition because verbal reports are more prone to bias (Andre & Rogers, 2006; Kunz et al., 2009; Napieralski et al., 2011).

Virtual reality was employed to avoid ethical and practical issues related to making judgments about other people who may be perceived as threatening. Potential ethical concerns included subjecting members of outgroups to demeaning conditions as they acted out playing a threat. Additionally, virtual reality was used to conduct this experiment to decrease the likelihood of putting participants in triggering environments and situations. Practically speaking, virtual reality was more efficient than creating costumes and employing actors for the experiment.

Participants viewed a virtual lab via a head-mounted display in which there was a target person (avatar) rendered to appear either threatening/intimidating (via physical formidability such as bulkiness/muscularity, dress (e.g., dark clothes, hooded sweatshirt), posture, animated movements indicating anxious mood, etc.) or benign and non-threatening (i.e., less muscular, wearing business-casual attire, standing passively, etc.); neither avatar wielded weapons or other threatening items. The avatar was presented at one of three randomly selected distances from the participant, with each viewing distance repeated three times for each of the two types of avatars. To measure the perceived distance to the target avatar, participants viewed the avatar and surroundings until they were confident in their judgment and then either called out the perceived distance to the avatar (verbal reports of distance) or walked without visual feedback (i.e., blind walking) until they believed they are standing in the same location as the avatar.

Method

This study used a repeated measures 2 (target type) x 2 (judgment type) x 3 (target distance) factorial design. The entire experiment was conducted in an immersive

virtual reality environment that resembled the real laboratory environment, with realistic virtual people (avatars) serving as targets.

Sample

This study used a convenience sample that drew from the University of Dayton pool of PSY 101 students. This resulted in a total of 66 participants, with 48 being female and 18 being male.

Materials

The virtual environment in which the experiment was conducted was made to resemble the physical laboratory space in terms of size/dimensions and surface characteristics (see Figure 1). While the geometry of the lab was recreated, windows, doors, and other accessory details were omitted from the virtual room in order to reduce familiar size information that could provide cues for perceived distance to participants, which could impact the perceived distance of the target avatar from the participants. The environment had white walls, equivalent lighting conditions, and similar flooring to the original.

Figure 1

Virtual Environment

Note. A room with white walks, a dark gray carpet, ivory-colored baseboards, a gray ceiling, and lights embedded in the ceiling.

Avatars consisted of a benign male figure and a threatening male figure (see Figure 2); each target was viewed at the target distances of 3m, 5m, or 7m, in random order. The targets were matched in terms of size but otherwise appeared distinct. The benign figure wore shorts and a T-shirt, had the build of an average male individual, and had a slightly hunched-over posture (see Figure 2). The threatening target wore jeans, a T-shirt, and a jacket, had a more muscular build, and a more assertive posture (see Figure 2).

Figure 2

Threatening and Benign Targets

Note. A masked muscular male figure wearing jeans, a jacket, and a T-shirt, with an assertive posture to the left. An averagely built male figure wearing shorts and a T-shirt with a slightly hunched-over posture to the right.

Two dependent measures were used to assess the distances the participants perceived between themselves and the avatars: walking without vision to the avatars location and verbally reporting the distance to the avatar. When walking without vision, or blind walking, participants were asked to walk purposefully and with a natural stride to the target. They were asked to stop walking when they believed they were standing on the

same spot where the target was standing. When preparing to walk, participants were asked to imagine the environment moving by them while they walked. In addition, participants were asked to only walk based on their mental picture of the environment, as opposed to other strategies such as counting steps. When verbally reporting, participants were asked to close their eyes and state the perceived distance between the target and themselves. This stated distance was meant to be as accurate and precise as possible using feet and fractions of feet, feet and inches, meters and fractions of meters, or meters and centimeters based on participant preference.

The virtual environment and avatars were presented using a VIVE Pro virtual reality headset and a Unity-based simulation. The VIVE Pro virtual reality headset, or head-mounted display (HMD), functions by having mounted cameras spread throughout the room that track the movement of the headset. More specifically, the position of the helmet in 3-dimensional space is tracked via infrared emitters on the HMD that are picked up by infrared cameras positioned throughout the lab space. The rotational movements of the helmet are tracked via inertial sensors and gyroscopes. Together, these trackers enable the viewer to move naturally through a virtual environment that is updated in real-time in response to the wearer's movements. There are internal screens in the headset that are used to present an immersive stereoscopic representation of the virtual environment.

Upon completion of the distance judgment trials in the virtual environment, participants would answer a series of survey questions to self-assess their own perceptions of the avatars and their judgments of the distances to the avatars. These questions were "a) 'How accurate do you feel you were on a 10-point scale (1 being not

at all accurate/guessing to 10 being accurate to within a few inches),'" "b) 'How confident were you in your ratings of the distance on a 1 to 10 scale (1 being not at all confident; 10 being completely sure),'" "c) 'How realistic was the environment you were viewing on a 1 to 10 scale (1 being not at all realistic, 10 being as real as the real space),'" "d) 'How intimidating was the masked target you were viewing on a 1 to 10 scale (1 being not at all realistic, 10 being as real as the real space),'" "e) 'How intimidating was the unmasked target you were viewing on a 1 to 10 scale (1 being not at all realistic, 10 being as real as the real space),'" and "f) 'What is your sex assigned at birth? Female, male, other?'"

Procedure

Participants would enter a waiting area outside of the space where the experimental trials would be conducted. While in this area they would read and sign a consent form detailing the basic elements of the study. Following this, they would be handed a set of written instructions describing how the blind walking and verbal reporting tasks would be conducted in relation to the experiment. These instructions stated that participants would put on a virtual reality headset in order to see a target in the virtual environment. Then, they would either blind walk to the target or verbally report the distance. These instructions were then repeated verbally by a researcher to the participant. Before starting the study, a Snellen chart test checking for 20/30 vison and a stereopsis test were conducted.

After completing all preliminary processes, participants would have the HMD fitted and be led into the testing room without visual input in the headset. Participants

would then practice walking blindly with a researcher until they were able to walk comfortably with a normal stride. In addition, participants would then practice blind walking without the researcher physically guiding them. The purpose of this was to ensure the participant would be able to walk with a natural stride and would not be deterred from walking the full distance to a target for fear of hitting any walls or obstacles. In order to ensure participant safety, a researcher walked alongside the participant at all times and alerted the participant whenever they were approaching a wall or other obstacle. Participants would then be led to a starting point where they would see a practice target. This target was white and devoid of any significant feature in a way comparable to an unclothed mannequin. A practice trial for the blind walking condition and then the verbal report condition were conducted with this practice target.

Following the practice trials, participants would see one of the two primary targets and then signal to a researcher that they were ready to give their judgment. The screen would then be blanked, and participants would be prompted to either verbally report the perceived distance between themselves and the target or to walk to where they believed the target was standing. When participants walked to the perceived target distance without visual feedback, they were to stop when standing at the same location as the previously viewed target. The distance walked was measured by a digital, laser-based tape measure. After making their judgments, participants were guided back to the starting location (in the blind-walking trials), and the next trial would begin. The screen would be unblanked and the participant would view one of the two avatars at the next randomly selected distance. All possible combinations of target distance, target type, and judgment type were presented in the experiment, with each combination being presented to

participants twice for a total of 24 trials. The order of these combinations was randomized for each trial. During the trials, there would be one researcher recording data and one monitoring the participant.

At the conclusion of the experimental trials, participants removed the headset and completed the self-report measures of the perceptions and judgments of the avatars.

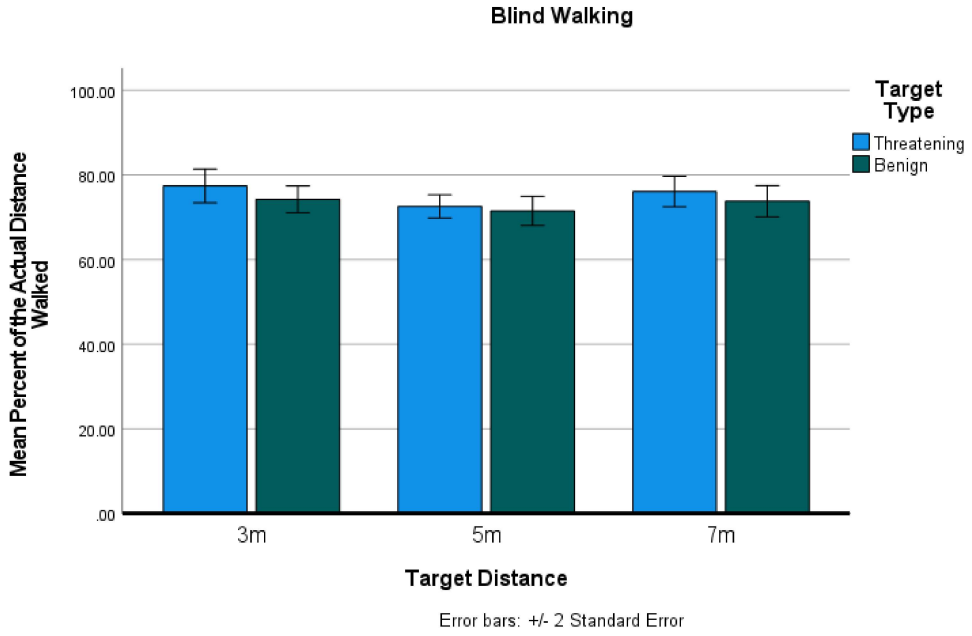
Results

To verify that the threatening target did, in fact, appear more threatening than the benign target, a manipulation check was implemented, in which participants were asked to rate how threatening each target appeared, as described above. This manipulation check found that the mean rating of perceived threatening appearance was significantly greater for the threatening target ($M = 5.84$) than for the benign target ($M = 2.46$), $t(1, 63) = 12.97$, $p < .001$.

In order to determine the precision of spatial judgments, accuracy scores were computed by taking the distance walked or verbally reported by participants, creating separate averages for each of the target distances, dividing the participants' distance judgment by the actual target distance, and then multiplying by 100. These accuracy scores were computed for all target distances and for both target types. A repeated measures ANOVA was conducted using these accuracy scores in order to compare the effects and interactions for target type, judgment type, and target distance on the accuracy of judgments of interpersonal distance (see Figures 3 and 4).

Figure 3

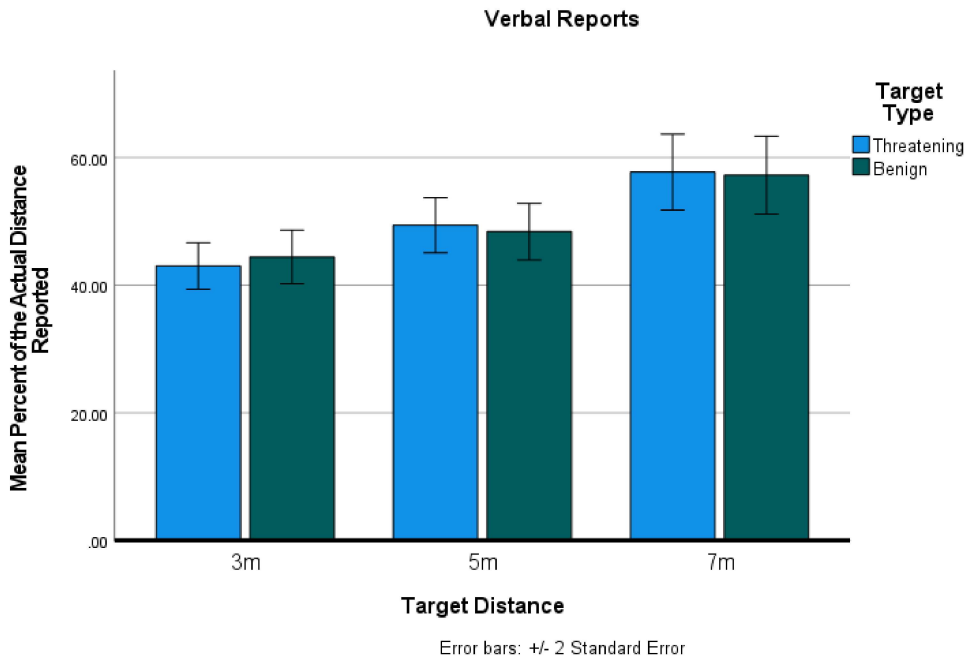
Blind Walking Estimated Marginal Means



Note. Mean percent of the actual distance walked by participants at each of the target distances for the threatening and benign targets in the blind walking condition.

Figure 4

Verbal Reports Marginal Means



Note. Mean percent of the actual distance reported by participants at each of the target distances for the threatening and benign targets in the verbal report condition.

Main Effects

There was a main effect of target distance, $F(2,63) = 18.59$, $p < .001$, $\eta_p^2 = .23$. This effect was driven by greater accuracy in the 7m distance ($M = 66.21$) than in the 3m ($M = 59.77$), $p < .001$, or 5m ($M = 60.47$) distances, $p < .001$. As expected, based upon prior research using different types of estimates of perceived distance, there was a main effect of judgment type, $F(1,64) = 123.20$, $p < .001$, $\eta_p^2 = .66$. This effect showed that blind walking estimates were more accurate ($M = 74.26$) than verbal reports ($M = 50.03$), $p < .001$. Perhaps most importantly, there was a main effect related to target type, $F(1,64) = 5.60$, $p = .021$, $\eta_p^2 = .08$, with the threatening target type being viewed more accurately ($M = 62.70$) than the benign target ($M = 61.60$), $p = 0.21$.

Interactions

There was a significant interaction between target type and judgment type, $F(1, 64) = 4.57$, $p = .036$. Pairwise comparisons revealed that this interaction was driven by a significant difference in the accuracy of judgments of the threatening target ($M = 75.35$) versus the benign target ($M = 73.18$) in the blind walking condition, $p = .005$, but not in the verbal report condition, $p = .963$. In other words, there was no significant difference between the verbally reported judgments of the perceived distances of the threatening ($M = 50.05$) and benign ($M = 50.02$) targets.

There was a significant interaction between judgment type and target distance, $F(2,128) = 24..92$, $p < .001$. Pairwise comparisons revealed that This interaction was driven by significant differences between judgments at all target distances for both blind walking and verbal reports, with the exception of the 3m and 7m distances for blind walking ($p = .53$). There were no other significant two-way or three-way interactions.

Discussion

This study aimed to demonstrate the impacts of threatening stereotypes on the perception of interpersonal distance, as indicated by blind walking distance and verbal reports. The results of this study found that there were significant differences in the accuracy of distance judgments as a function of target distance, target type, and judgment type. As expected, blind walking led to significantly more accurate distance judgments than verbal reports, which aligns with the previous research (Andre & Rogers, 2006; Kunz et al., 2009; Napieralski et al., 2011; Philbeck et al.) Somewhat surprisingly, distance estimates were most accurate when judging avatars at the longest distance of 7m,

with these judgments being significantly more accurate than for the 3m and 5m target avatars. Also unexpected was that distance estimates to the threatening target were significantly more accurate than estimates of the distances to the benign target, at least for the blind-walking estimates. More notable, however, is that when blind-walking the perceived distance to the avatars, participants estimated threatening targets to be farther than benign targets. Because all judgments substantially underestimated the actual distance, participants were more accurate when judging the distance to the threatening target (or less inaccurate). In short, while it was predicted that the threatening target would be judged closer than the benign target, particularly when verbally reporting the perceived distance, the results were just the opposite: participants judged the threatening target to be farther than the benign target, but only when blind-walking the perceived distance to the target.

The finding that verbal reports were not affected by the target appearance is surprising given that research suggests that verbal reports are more prone to bias than are action-based measures of distance perception (Andre & Rogers, 2006; Kunz et al., 2009; Napieralski et al., 2011). The finding that threatening targets were perceived more accurately (farther) than benign targets, although inconsistent with the hypotheses, is largely compatible with earlier related research. The threatening target appearing farther away from participants corresponds with findings from the Balcetis and Dunning (2010) and Dunning and Baletis (2013) studies. These studies found that more desired objects appear closer than less desired stimuli. The results of the Cole et al. (2013) study also suggested that the perception of threat led to significant differences in the perception of distance when compared to other non-threatening targets. The Balcetis and Dunning

(2010) and Dunning and Baletis (2013) studies and the Cole et al. (2013) were at odds with each other since the Balcetis and Dunning (2010) and Dunning and Baletis (2013) studies found that more desirable stimuli were perceived as closer, while Cole et al. (2013) found that more threatening stimuli were perceived closer. This could possibly be due to the Balcetis and Dunning (2010) and Dunning and Baletis (2013) studies using objects as stimuli, while the Cole et al. (2013) study used people as stimuli. The results of the current study aligned more closely with the Balcetis and Dunning (2010) and Dunning and Baletis (2013) studies than the Cole et al. (2013) study. With the threatening target being perceived as farther away than the benign target, granted, the current study used human avatars, which is more similar to the stimuli used in the Cole et al. (2013) study.

It is not likely that the unexpected result was here was due to a failure to manipulate the perceived threat posed by the avatars. In the post-experiment questionnaire, participants self-reported that they found the threatening target to be significantly more threatening than the benign target. Although the results from this study and previous studies are mixed, the present results reinforce research that demonstrates that threat perception has an effect on the perception of distance. 2010).

Limitations and Future Directions

Given the inconsistency among studies examining the influence of perceived threat on distance perception, additional work is warranted. In the present study, it is possible that participant gender could have played a role in the threat perception of the targets. Although purely speculative, it is possible that the male targets appeared more

threatening to participants of the opposite sex as opposed to participants of the same sex. This study was unable to recruit a sufficient number of male participants to assess gender as an additional variable that may have interacted with the variable of avatar type. Future studies could prioritize testing comparable numbers of male and female participants or matching the sex of the target avatar with the sex of the participant.

The use of a self-report measure to assess the perception of threat in participants could be an inaccurate way of determining threat perception. This potential inaccuracy acted as a limiting factor in assessing how differing levels of threat perception could impact perception. Potential alternative ways of measuring threat perception could be monitoring heart rate, perspiration, or respiration.

Other possible limitations of this study were a lack of variation in and excessive repetition of target distances. The threatening target may have appeared less threatening with repeated exposure. Limiting the study to only using three distances could have resulted in participants using previous judgments to create new judgments instead of naturally judging distances. Having the distances repeated throughout the trials could have potentially resulted in participants becoming accustomed to the distances. This familiarity could have impacted the distance judgments of participants, confounding the effects of threat perception. Specifically, the verbal report measure could have been impacted by participants repeating their answers when the same distance is repeated based on memory, not instinctual perception. Relatedly, closer target distances may have evoked greater impressions of threat posed by the target. This would have resulted in disproportionate levels of threat perception across target distances.

A new study currently underway intends to see if these results can be replicated with minor adjustments to address some of these limitations. This revised study uses a greater number of intermediate distances without repeating any distance for the same target type or target judgment distance. Furthermore, participant ages will be recorded, and there will be greater emphasis on testing comparable amounts of male and female participants before the data is analyzed. The threatening target was also changed to a more monster-like appearance, characterized by inhuman traits such as significantly different proportions from a human and an overly emaciated body. This change removes the influence of human stereotypes and group biases but is intended to reflect a more innately threatening target. This innate threat is being used to determine if the previous target was sufficiently threatening or not. If the results replicate, this would suggest that threatening stereotypes impact our perception in a similar way to more innate threats.

A future direction of research could come from collecting more demographic data from participants. This data would be used to investigate the impacts of stereotypes on the perception of groups similar and different from participants. This would enable the analysis of how in-group and out-group membership could potentially impact the perception of interpersonal distance. To do this, new targets would be used to represent different possible groups, such as having targets of different races be presented. These targets would be made to be as similar as possible, except for aspects related to potential group membership, such as skin tone. Adding this factor into research could be especially informative in understanding how threat perception influences perception in the real world.

Conclusion

This study tested the prediction that stereotypes about a threat posed by another person would influence perceived interpersonal distance. While the results of the study did not support the hypothesis that threatening targets would be perceived as closer than non-threatening targets, they did broadly demonstrate that threat perception based on stereotypes can impact the perception of interpersonal distance. While the present study looked at a potentially benign stereotype, it suggests that assumptions made based on a target's appearance affect visual-spatial processing. This finding may extend to other stereotypes that are more harmful, such as stereotypes regarding race or gender, and may affect other aspects of perception, judgments, and behavior.

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