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First Impressions From Faces in Dynamic Approach–Avoidance Contexts

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Theoretical understanding of first impressions from faces has been closely associated with the proposal that rapid approach–avoidance decisions are needed during social interactions. Nevertheless, experimental work has rarely examined first impressions of people who are actually moving—instead extrapolating from photographic images. In six experiments, we describe the relationship between social attributions (dominance and trustworthiness) and the motion and apparent intent of a perceived person. We first show strong correspondence between judgments of photos and avatars of the same people (Experiment 1). Avatars were rated as more dominant and trustworthy when walking toward the viewer than when stationary (Experiment 2). Furthermore, avatars approaching the viewer were rated as more dominant than those avoiding (walking past) the viewer, or remaining stationary (Experiment 3). Trustworthiness was increased by movement, but not affected by approaching/avoiding paths. Surprisingly, dominance ratings increased both when avatars were approaching and being approached (Experiments 4–6), independently of agency. However, diverging movement (moving backward) reduced dominance ratings—again independently of agency (Experiment 6). These results demonstrate the close link between dominance judgments and approach and show the updatable nature of first impressions—their formation depended on the immediate dynamic context in a more subtle manner than previously suggested.

Public Significance Statement

Prior research demonstrates that we form first impressions from brief exposures to faces and that these impressions can influence our subsequent behavior in meaningful ways. However, the preponderance of evidence on this topic comes from studies using static photographs. Here we use animated avatars to investigate the effects of movement on first impressions. We find that movement alone increases impressions of trustworthiness while specifically approach-related movement increases impressions of dominance. Together these data demonstrate that theories of first impressions should accommodate for their dynamic and flexible nature, even within the first seconds of exposure.

Keywords: first impressions, trait judgments, face perception, approach–avoidance, virtual environment

First impressions based upon brief exposure to an unknown person's face influence a wide range of behaviors, including voting choice and judicial sentencing (Olivola et al., 2014; Todorov et al., 2015). While most data on the power of first impressions from faces comes from experimental methods using static images, research also suggests that dynamic cues in stimuli, such as emotional expressions (e.g., Said et al., 2009; Sutherland et al., 2013; Young, 2018) further influence these judgments. More generally, full-body dynamic stimuli have been shown to influence personality judgments and impression formation (Ambady & Rosenthal, 1993).

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Given that first encounters in the real world involve movement and interaction, understanding the contribution of these dynamic qualities is key to our understanding of first impression from faces. Moreover, studying first impressions in dynamic and interactive contexts provides a way of testing the stability of these initial judgments in the presence of instant changes in the perceptual environment. First impressions occur rapidly (Willis & Todorov, 2006) but it remains unclear how flexible their formation could be when new perceptual evidence is quickly accumulated.

The formation of first impression judgments from faces has been extensively studied, bridging fields of visual cognition and face perception with theories of social stereotypes and social cognition. Exploring first impressions has involved understanding the role of low-level visual information that forms facial features and its interaction with more complex social constructs (e.g., Oh et al., 2020). The origins of such attributions have been recently discussed from different theoretical perspectives—evolutionary, developmental, cultural, and individual (Sutherland & Young, 2022). Findings on first impressions from faces have also motivated research in the auditory modality (Lavan, 2022; Lavan et al., 2021; Mileva & Lavan, 2023), enabling comparisons between visual and auditory cognition while providing the basis of a more unified understanding of social trait judgments.

A major finding on first impressions from faces is that their formation occurs rapidly and with a high level of agreement across individuals (Todorov et al., 2009; Willis & Todorov, 2006). Despite this, social judgments have very limited validity (Foo et al., 2022; Todorov, 2017; Todorov et al., 2015). While the attribution of many different traits has been studied, these can be captured by a smaller number of underlying dimensions. Oosterhof and Todorov (2008) observed evaluative dimensions that are often labeled "trustworthiness" and "dominance," based on attributions made to parametrically manipulated graphical faces. Sampling from a larger range of more realistic "ambient" face images, Sutherland et al. (2013) confirmed the importance of these two dimensions, adding a third, "youthful attractiveness."

Despite high interrater agreement on judgments of specific images, ratings are highly dependent on the specific photographic image of any individual. Images of the same person can vary substantially, and this variability affects first impressions (Jenkins et al., 2011; Lavan et al., 2021; Mileva et al., 2019; Sutherland et al., 2017; Todorov & Porter, 2014). Mileva et al. (2019) have demonstrated that low-level image statistics, such as shape and texture properties, predict impressions of trustworthiness, dominance, and attractiveness from faces.

Moreover, dynamic features of a face can affect social judgments (Sutherland & Young, 2022). Smiling faces are seen as more trustworthy and more attractive than those with a neutral expression (e.g., Sutherland et al., 2013). Images of a head tilted upward or downward both increase impressions of the target as intimidating (Hehman et al., 2013). These examples demonstrate that features of an individual that are not merely changeable, but that can change rapidly from moment-to-moment, influence first impressions. Despite the importance of these transient changes, dynamic properties of the social stimulus or environment have typically not been the focus of first impressions research. Static face images have usually been studied without systematic manipulation of dynamic contextual cues that could convey, for example, information about a person's intention. Potentially important factors include the location of a person within the environment, their apparent state, whether or not they are performing any action, and the nature of this action.

In this context, physical approach is an obvious candidate for influencing first impressions. At a basic level, approach versus avoidance motivations provide a broad, cross-species framework for understanding the influence of affect on behavior (Elliot, 2008). In terms of both reflexive and intentional actions, appetitive stimuli elicit approach while aversive stimuli elicit avoidance. In the animal literature, this very general distinction maps onto predator versus prey behavior (Lang & Bradley, 2010). Not only do prey avoid predators, but the distal versus proximal presence of a predator elicits dissociable neural and behavioral responses in prey (e.g., general avoidance vs. flight; Mobbs et al., 2020).

In human research, the distinction between approach and avoidance motivations is often discussed in dispositional terms (Elliot & Thrash, 2002). For example, individuals in positions of power show more approach in terms of an enhanced attention toward rewards and an increase in the general tendency to take action (Cho & Keltner, 2020; Keltner et al., 2003). Human research on proxemics has also explored approach motivations in a more literal sense, where physical proximity can reveal a willingness to engage in both friendly and aggressive social interactions (McCall & Singer, 2015). Along these lines, individuals high in trait dominance tend to come closer to others during social interactions (J. A. Hall et al., 2005) and individuals in a high-power state come closer to those who engage them in direct gaze (Weick et al., 2017). It is perhaps not surprising, then, that people tend to believe that dominant individuals are more likely to come closer to them during an interaction (Carney et al., 2005). However, it is not clear from the current experimental literature whether dynamic approach behavior actually influences a viewer's first impressions. This is a natural hypothesis, given that theoretical accounts of social judgment are often couched in terms of underlying approach/avoid decisions (Jones & Kramer, 2021; Todorov, 2008). Nevertheless, this has not been established empirically—an important step if the theoretical generalizations in the current literature are found to be valid.

There is a further problem that arises from the dearth of studies directly examining perception of people who are actually approaching or avoiding the viewer. As discussed above, viewers make very fast social judgments, and this has been taken to have important social consequences. However, it is currently not clear how quickly these judgments can be updated. If an initial judgment can be modified over a short time period (e.g., the time it takes for an interlocutor to approach) then the oft-reported fast time-course of these judgments have different social consequences in real life, that is, we may not be committed to our first impressions in the way that laboratory experiments suggest. The studies below examine this issue.

Testing the proposal that approach influences first impressions raises considerable methodological challenges. The unpredictable behavior of human confederates limits experimental control and the need for large stimulus sets of unfamiliar individuals make some manipulations difficult and costly. Virtual environments can address these challenges, in part because they offer a compromise between highly controlled laboratory tasks and unconstrained natural observation (McCall & Blascovich, 2009). They furthermore allow for manipulations of the environment and its inhabitants in ways that would be difficult or even impossible in the real world (Fox et al., 2009). For example, the fact that avatars have bodies allows us to manipulate the identity and behavior of target individuals (e.g., Fysh et al., 2022;

McCall et al., 2016). This may be particularly important to the present topic given recent evidence that impressions of dominance are shaped by whole person (i.e., both face and body) perception (Hu & O'Toole, 2023). As such, virtual environments have the potential to provide a straightforward means of examining contextual and dynamic influences on first impressions from faces.

Here we use a virtual environment to examine social judgments made to avatars based on real people's faces in both static and dynamic environments. This examination is based on both practical and theoretical concerns. First, the usefulness of virtual interactions depends, to some extent, on preserving critical aspects of real interactions—including the face-based attributions we make about each other constantly. Establishing the level of correspondence between the faces we encounter in real and virtual worlds is therefore of considerable practical importance. We begin our investigation by comparing judgments of trustworthiness and dominance for photos and avatars of the same people (Experiment 1). Second, we use avatars within a virtual environment to test the effects of dynamic behavior on first impression judgments (Experiments 2 and 3). In these experiments, we employ a contextual scene (an airport) and compare social judgments made to static or moving avatars, which can approach the viewer or not. Given research linking approach with dominance, power, and aggression, we were particularly interested in the effects of approach behavior on judgments of dominance. Finally, we test the effect of dynamic behavior on first impressions a step further by exploring its dependency on the agent and the direction of movement (Experiments 4–6).

Experiment 1

In this experiment, we investigated whether first impression judgments from faces are comparable between photos and avatars of the same target individuals. We did so, in part, to examine the extent to which we can assume that avatars preserve the trait inferences demonstrated by research using photographic stimuli. This study also has potential practical implications for the use of avatars in applied contexts in which traits such as trust are important (e.g., therapeutic settings, Parsons et al., 2017; Tarr et al., 2018). Indeed, some evidence suggests that artificial faces are rated as both less trustworthy and less dominant than real photos (Balas & Pacella, 2017; Balas et al., 2018), although these prior studies used photo-realistic artificial faces that were heavily cropped to exclude external features. It is unknown whether this reduction in apparent trustworthiness and dominance would generalize to the type of digital avatar faces used here, which aim to capture a more realistic representation of a particular individual.

The database used for this study comprises photos and avatars of 120 people (see Fysh et al., 2022, for details). These avatars preserve the identity of the faces well. Viewers familiar with the people recognize their avatars accurately, and unfamiliar viewers show similar performance to standard photo-to-photo matching tasks (Bindemann et al., 2022; Fysh et al., 2022). So, while identity is preserved in the virtual environment (by comparison to photos) the question we ask here is whether the perceived social attributes of these people are also preserved.

Method

Participants

Forty-eight participants (34 female, 14 male) aged between 18 and 63 years ($M = 36.1$, $SD = 13.35$) took part in the study after being recruited via Prolific.co. The data from two other participants were not included in the analyses as they responded correctly to less than 80% of catch trials. This sample size was based on two criteria. First, since the main analysis of interest was correlations on mean ratings by item, we wanted to make sure that we would select a sample size that would produce stable averages for trustworthiness and dominance traits. A recent study investigating the stability of averages in first impressions suggested a sample of at least 31 for obtaining stable averages for both traits on a scale from 1 to 7 with a corridor of stability ± 0.50 with 95% confidence intervals (Hehman et al., 2018). The second criterion was that the sample size should be divisible by 24 (the number of possible combinations of the order of the four main tasks). The selected sample size was also comparable to a previous study comparing social traits of photographed and nonphotographed face images (Balas & Pacella, 2017).

Materials

The stimuli consisted of 120 photos and 120 avatar screenshots, both showing full-face images against a plain background (see Figure 1). The set comprised volunteers (55 men, 65 women) with a range of ethnicities and ages (age $M = 32$ years; $SD = 13.5$; range = 16–86). Avatars were created using high-fidelity 3D scans that were acquired on the same day as the photographs. Clothing and body shape varied between avatars (see Fysh et al., 2022, for details). Image size was 200 (W) × 257 (H) pixels for all stimuli.

Procedure

This experiment was run online using the Gorilla Experiment Builder (Anwyl-Irvine et al., 2020). Participants were asked to rate all 240 stimuli on a scale of 1 to 7 (*low* to *high*) for dominance and trustworthiness. No additional explanations or definitions of the traits were given. Stimuli and tasks were blocked (Photos/Avatars × Dominance/Trustworthiness) and the order of the four blocks was counter-balanced across participants. The order of stimuli was randomized separately for each participant within blocks.

In each trial, participants saw a face image that appeared at full size whenever possible and was dynamically adjusted in cases of smaller monitor and browser window sizes. Responses were entered on a scroll bar indicating the range 1–7. Trials were self-paced with the face remaining on the screen until a response was made. Across the experiment, there were also 48 catch-trials (12 per block) in which a number appeared, rather than a face. In these trials, participants were asked to respond by entering the number on the scroll bar. Blocks were separated by a short break.

Transparency and Openness

For Experiment 1 and all experiments in this article, we report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study. All data are available at https://osf.io/ufxj5/. This study's design and its analysis were not preregistered.

Constraints on Generality

Experiment 1 and the other experiments in this article used a UK-based sample. We made this choice because our stimulus set

Figure 1

Example Stimuli in Experiment 1, Comprising of ID-Style Photographs (Top Row) and Avatar Images (Bottom Row)

Note. See the online article for the color version of this figure.

was created using images from a UK-based sample (Fysh et al., 2022) and prior work using it demonstrates that patterns in real-world face perception (i.e., face recognition) are preserved within perceivers from the same population (Bindemann et al., 2022). Nevertheless, our use of only a UK-based sample may constrain the generality of our findings (Simons et al., 2017). Although prior research demonstrates substantial cross-cultural agreement in facial impressions (Sutherland et al., 2018; Tsantani et al., 2022), there is evidence for some cultural specificity (Over et al., 2020; Zebrowitz et al., 2012).

Results

Mean ratings by condition are presented in Table 1. Data were analyzed using classic and Bayesian within-subjects analyses of variance (ANOVAs). The default priors of JASP Ver. 0.17.1 (JASP Team, 2023) were used for the calculation of the Bayes factors (BFs) in this and all subsequent experiments. A BF_{10} above 3 was interpreted as substantial (moderate) evidence for the alternative hypothesis (H_1) over the null hypothesis (H_0) (Wagenmakers et al., 2018). Conversely, BF_{10} values below 1/3 or BF_{01} values above 3 were interpreted as substantial evidence for the H_0 over the H_1. A 2 (image type: photo, avatar) × 2 (social trait: trustworthiness, dominance) within-subjects ANOVA revealed a significant main effect of image type, $F(1, 47) = 12.38$, $p = .001$, $\eta_p^2 = .21$, and a significant interaction between image type and social trait, $F(1, 47) = 23.98$, $p < .001$, $\eta_p^2 = .34$. The main effect of social trait was not significant, $F(1, 47) = 1.22$, $p = .276$, $\eta_p^2 = .03$. A comparison between the null model and a model containing the two within-subjects factors and their interaction term (the best model) revealed strong evidence in favor of the H_1, $BF_{10} = 21{,}026.57$ (image and social trait model: $BF_{10} = 9.56$; image model: $BF_{10} = 22.91$; social trait model: $BF_{10} = 0.43$). Simple main effects analysis showed an effect of image type for trustworthiness judgments, $F(1, 94) = 31.83$, $p < .001$, $\eta_p^2 = .25$, reflecting higher ratings for photo than avatar images. There was no significant effect of image type for dominance judgments, $F(1, 94) = 0.05$, $p = .829$, $\eta_p^2 < .01$. These results were consistent with Bayesian paired samples *t* tests that provided strong evidence for the H_1 in the photo and avatar comparison for trustworthiness, $BF_{10} = 7{,}238.70$, and moderate evidence for the H_0 for dominance, $BF_{10} = 0.16$ ($BF_{01} = 6.22$).

Table 1

Mean Ratings and Standard Deviations (in Parentheses) by Image Type and Social Trait

	Social trait	
Image	Trustworthiness	Dominance
Photo	4.16 (0.67)	3.78 (0.66)
Avatar	3.62 (0.81)	3.76 (0.79)

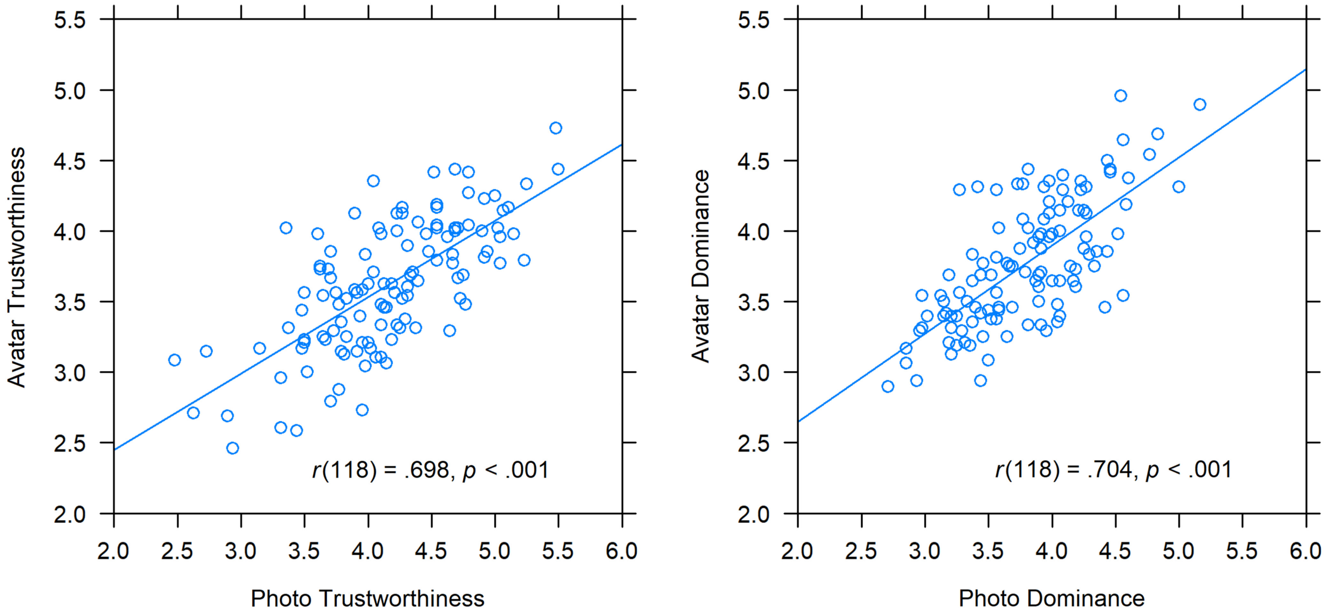
Pearson correlations on mean ratings by item showed that photo and avatar ratings correlated positively on trustworthiness, $r(118) = .698$, $p < .001$, as well as on dominance, $r(118) = .704$, $p < .001$ (Figure 2). In addition, trustworthiness correlated negatively with dominance for photo, $r(118) = -.713$, $p < .001$, and avatar images, $r(118) = -.644$, $p < .001$.

Discussion

The results of Experiment 1 showed that ratings of trustworthiness and dominance have a strong correspondence between photographic face images and images of the same people derived from a virtual environment (avatars). These results suggest that the perceived social characteristics of individuals, inferred from faces, are transferable between the two different media types. In fact, the correlation of ratings between formats compares favorably to estimates of test–retest reliability for ratings of trustworthiness and dominance (e.g., Kramer et al., 2018; Peterson et al., 2022).

Interestingly, there is a significant reduction in trustworthiness, but not dominance ratings for the avatar images, despite the fact that trustworthiness ratings correlated strongly between photo and avatar images, indicating that this dimension was relatively well preserved. As described above, there is some precedent for artificial images attracting lower trustworthiness ratings (Balas & Pacella, 2017)—a finding that seems to generalize to these avatars. However, the levels of dominance observed seem entirely unaffected by the photo/avatar manipulation. These results support the use of avatar stimuli in research on first impressions, and so in the next experiment, we examine first impressions in response to whole-body avatars, and the effects of approach behavior on these perceptions.

Figure 2
Trustworthiness (Left) and Dominance (Right) Ratings for Photo and Avatar Images



Note. See the online article for the color version of this figure.

Experiment 2

First impression studies in face perception have predominantly used photographic images showing an isolated face. Contextual information, such as the person's body or their position within the immediate social environment, is not usually present in experimental stimuli. We followed this style in Experiment 1. However, dynamic cues, such as emotional expressions, and contextual cues, such as the contextual scene, have been demonstrated to influence first impressions (Koji & Fernandes, 2010; Sutherland et al., 2013; Young, 2018). It is likely that other dynamic and contextual factors might also affect these social judgments. One possible cue along these lines is approach behavior. Prior work on social proxemics suggests that aggressive or powerful individuals come closer to others during social interactions (McCall & Singer, 2015; Weick et al., 2017). Moreover, people high in dominance are more likely to come closer to others during interactions (J. A. Hall et al., 2005) and people tend to expect them to do so (Carney et al., 2005). As such, we hypothesized that individuals will perceive an approaching individual as more dominant.

The aim of Experiment 2 was therefore to extend current findings from studies using static images of isolated faces by exploring whether the immediate social environment could affect social trait judgments. We examined a dynamic condition in which an individual (avatar) was seen directly approaching the viewer. We hypothesized that a movement toward the viewer would increase the perceived dominance of the avatar. However, increased dominance might also arise from the closeness of the avatar itself, rather than approach movement per se. For this reason, we also included two static conditions, one showing the avatar at the position where they would start their walk toward the viewer and one showing them where they would end it. We also assessed the effects of the manipulation on trustworthiness to establish if any effects on dominance were specific to that trait judgment.

Method

Participants

Seventy-eight participants (54 female, 24 male) aged between 19 and 59 years ($M = 31.2$, $SD = 10.76$) took part in the study after being recruited via Prolific.co. The data from eight further participants were excluded from the analyses as six responded correctly to less than 80% of the catch trials and the other two reported not having seen animations of walking people, suggesting technical issues during their participation. The sample size was based on a power analysis with G*Power 3.1.9.7 (Faul et al., 2009) for statistical test ANOVA: repeated measures, within factors, with a small effect size ($f = 0.15$; power = .95, number of groups = 1, number of measurements = 6, correlation between repeated measures = .5, nonsphericity correction = 1) with a suggested sample of 75. A sample of 78 was selected, so that it was divisible by 6 and would allow for an equal number of participants per counterbalancing condition (3 × display condition, 2 × task order).

Materials

The stimuli were constructed using the same database of 120 avatar objects with photo-realistic faces as the one used in Experiment 1. In addition to the faces, however, the avatar objects used here contained full bodies. These were created by attaching a 3D scan of a person's head onto a standard body mesh (see Fysh et al., 2022, for details). Avatars were displayed in an airport context, as shown in Figure 3 (see Bindemann et al., 2022, for details).

For the purposes of Experiment 2, three sets of stimuli were generated from each of the avatar object items, comprising two static images and a video. Images were frontal photographs of each of the avatars in two different proximity positions—distant and close (see Figure 3). In the photographs, the people appeared in a resting position and a walking action was not implied. The corresponding video stimuli showed each person walking forward from the distant position to the close position while directly facing the camera and the observer. The camera position was held constant for all three types of stimuli and was set to ensure that the head pitch of the avatars appeared relatively neutral (chin not lifted or lowered). Images and videos had a resolution of 1280 × 720 pixels. The videos had a framerate of 30 frames per second and a duration of approximately 1,500 ms. In addition to the experimental stimuli, catch-trials displaying only digits were also generated using the same airport environment as a background. The digits ranged from 1 to 7 and appeared instead of people.

Procedure

As with Experiment 1, this study ran online using Gorilla Experiment Builder (Anwyl-Irvine et al., 2020). Participants were asked to rate stimuli on a scale from 1 to 7 (*low* to *high*) for dominance and trustworthiness. These conditions were blocked, with half of the participants making dominance ratings first, and half making trustworthiness ratings first. Each block contained 120 critical trials and 12 catch-trials and was further divided into separate subblocks, representing the three display conditions—close image, distant image, and walking video (40 trials each). Subblocks appeared in a random order for each subject, and stimuli were counterbalanced such that, across the experiment, each target person appeared equally often in the close image, distant image, and video conditions.

As in Experiment 1, trials were self-paced. Unlike Experiment 1, however, the exposure to the stimuli was limited, so that the duration of stimulus presentation was identical for image and video items. On each trial, participants saw either a video or an image of an avatar for 1,500 ms. Participants were informed that they would see each person for a limited time only, after which they should make their response on a scrollbar. After the completion of both tasks, participants were asked "Were some of the people walking?" and were given a yes-or-no option for a response. This question was included to check whether the videos ran successfully on the participant's device. Permitted devices included laptops and desktop computers.

Results

Mean ratings by condition are presented in Figure 4. A 3 (display type: close image, distant image, video) × 2 (social trait: trustworthiness, dominance) within-subjects ANOVA revealed a main effect of display type, $F(2, 154) = 12.62$, $p < .001$, $\eta_p^2 = .14$, a main effect of social trait, $F(1, 77) = 4.20$, $p = .044$, $\eta_p^2 = .05$, and a significant interaction between these factors, $F(2, 154) = 5.09$, $p = .007$, $\eta_p^2 = .06$. Model comparisons relative to the null model with Bayesian within-subjects ANOVA indicated that the best model included both factors and their interaction term (the full model), providing strong evidence for the H_1, $BF_{10} = 3{,}680.80$ (display and social trait model: $BF_{10} = 464.67$; display model: $BF_{10} = 279.96$; social trait model: $BF_{10} = 2.04$).

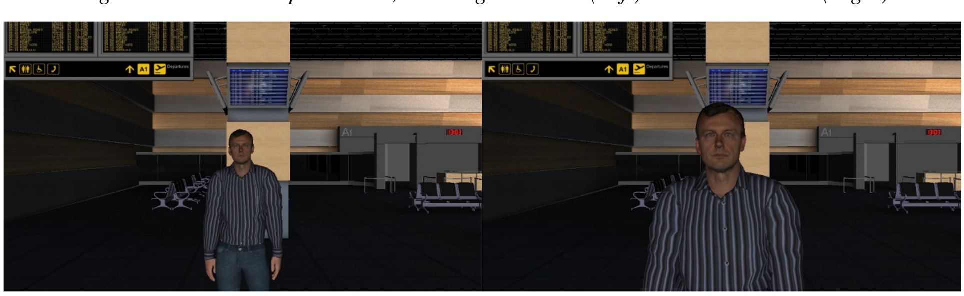
Simple main effect tests showed that the effect of display was significant for both trustworthiness, $F(2, 308) = 5.00$, $p = .007$, $\eta_p^2 = .03$, and dominance, $F(2, 308) = 12.40$, $p < .001$, $\eta_p^2 = .07$. Pairwise comparisons, Tukey honestly significant difference (HSD) test, $F_{crit}(1, 154) = 5.56$, $p < .05$, showed that for dominance, the video condition was rated significantly higher than close, $F(1, 154) = 11.41$, and distant, $F(1, 154) = 23.61$, still images. The still images did not differ, $F(1, 154) = 2.20$. For trustworthiness, the difference between the close image and the video was significant, $F(1, 154 = 9.13$, but other comparisons did not differ significantly, distant image versus video, $F(1, 154) = 0.50$; close versus distant image, $F(1, 154) = 5.36$. Bayesian paired samples *t* tests showed similar pattern. For dominance, there was strong evidence for the H_1 in video versus close, $BF_{10} = 26.38$, and video versus distant conditions, $BF_{10} = 366.20$, but moderate evidence for the H_0 in the close versus distant condition, $BF_{10} = 0.30$ ($BF_{01} = 3.33$). For trustworthiness, there was strong evidence for the H_1 only for the close and video comparison, $BF_{10} = 50.53$. There was inconclusive evidence in the close versus distant comparison, $BF_{10} = 1.25$; and moderate evidence for the H_0 in the distant versus video comparison, $BF_{10} = 0.17$ ($BF_{01} = 5.92$).

Discussion

The results of Experiment 2 suggest that perceiving an approaching walking action affects social trait judgments. Both trustworthiness and dominance ratings were significantly increased in comparison to at least one static image condition. The pattern was particularly robust in the ratings of dominance, in which the video condition differed significantly from both distant and close image conditions—that is, the act of walking toward the viewer increases the perceived dominance of an avatar. This is an interesting pattern because it suggests that observing the avatar moving toward one gives the impression of higher dominance even compared to its closest point. This is

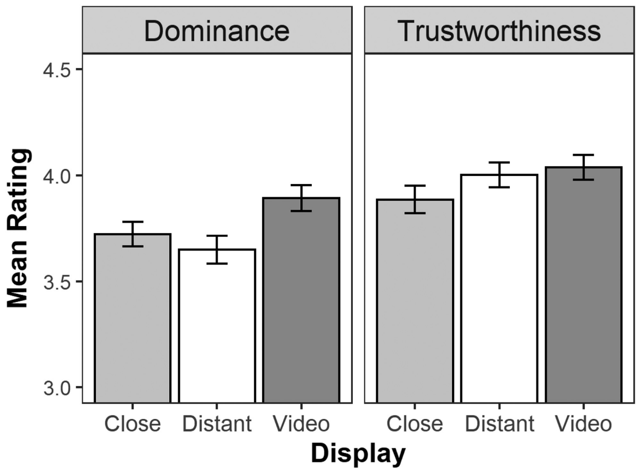
Figure 3

Static Image Conditions in Experiment 2, Showing a Distant (Left) and Close Avatar (Right)



Note. See the online article for the color version of this figure.

Figure 4
Mean Ratings by Display Type and Social Trait in Experiment 2



Note. Error bars represent within-subjects standard error (Cousineau, 2005).

consistent with previous findings suggesting that more dominant individuals are more likely to approach others during interactions (J. A. Hall et al., 2005) and are expected to do so (Carney et al., 2005).

There was a more nuanced effect for trustworthiness, which does not give rise to such a straightforward explanation. Note that the only reliable difference between conditions is that the close image appears less trustworthy than the walking video—even though both end up close to the viewer. We will return to a discussion of the differential effect of movement on different social judgments below.

Experiment 3

The results of Experiment 2 provided evidence that the perception of an action, such as walking toward the viewer, can affect social trait judgment. However, the precise nature of this association remains unknown. In Experiment 2, avatars directly approached the viewer, apparently affecting social perception. However, the effect could be due to movement per se, rather than specifically due to approach. In Experiment 3, we directly compared ratings elicited by approaching and nonapproaching avatar movement, with a static comparison.

Method

Participants

Seventy-eight participants (49 female, 29 male) aged between 18 and 65 ($M = 34.0$, $SD = 11.14$) took part in the study after being recruited via Prolific.co. The data from seven further participants were excluded from the analyses as six responded correctly to less than 80% of the catch trials and one participant responded with *no* to the technical check question, suggesting that they did not see the video stimuli during their participation. The sample size was based on the same considerations as Experiment 2, which had the same number of conditions. A power analysis with G*Power 3.1.9.7 (Faul et al., 2009) for statistical test ANOVA: repeated measures, within factors, with a small effect size ($f = 0.15$; power = .95, number of groups = 1, number of measurements = 6, correlation between repeated measures = .5, nonsphericity correction = 1) had a result of 75, and a sample of 78 was selected, so that it is divisible by 6 (3 × display condition, 2 × task order).

Materials

This experiment used the same avatar database as Experiment 2. For each avatar, we generated three stimulus sets: two videos and a static image. The first video stimulus set comprised the approaching videos used in Experiment 2. In the second set, avatars approached the viewer to an intermediate point (approximately 1,000 ms after the onset), where they changed direction to a trajectory avoiding the observer, as though to pass to their side. Both types of video stimuli had a framerate of 30 frames per second and a total duration of approximately 1,500 ms. Static stimuli represented the avatar at the point of divergence—in between the two static conditions in Experiment 2.

Procedure

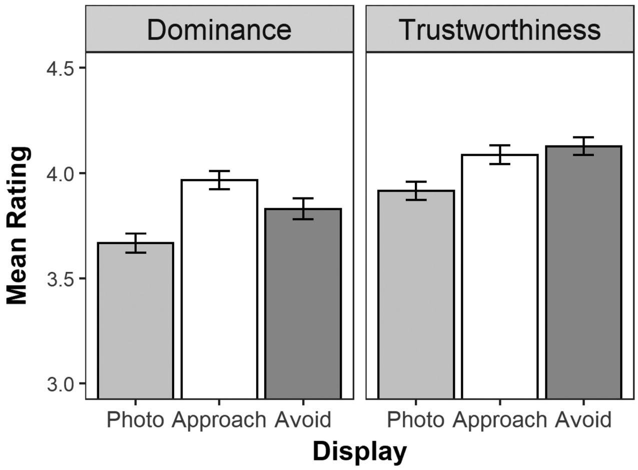
The procedure was the same as Experiment 2. Participants were asked to rate stimuli on a scale from 1 to 7 (*low* to *high*) for dominance and trustworthiness. These were counterbalanced such that half of the participants submitted dominance ratings first, and half submitted trustworthiness ratings first. Each block contained 120 critical trials, plus 12 catch-trials, and was further divided into separate subblocks, representing the three display conditions—approaching video, avoiding video, and static image (40 trials each). Subblocks appeared in a random order for each subject, and stimuli were counterbalanced such that, across the experiment, each target person appeared equally often in the three display conditions. Trials lasted approximately 1,500 ms and participants made an on-screen decision, after which the following trial appeared immediately.

Results

Mean ratings per condition are shown in Figure 5. A 3 (display type: photo, approach video, avoid video) × 2 (social trait: trustworthiness, dominance) within-subjects ANOVA revealed a main effect of display type, $F(2, 154) = 21.39$, $p < .001$, $\eta_p^2 = .22$, a main effect of social trait, $F(1, 77) = 11.47$, $p = .001$, $\eta_p^2 = .13$, and a significant interaction, $F(2, 154) = 3.12$, $p = .047$, $\eta_p^2 = .04$. Bayesian within-subjects ANOVA model comparisons relative to the null model showed that the best model included display and social trait with no interaction term, providing strong evidence for the H_1, $BF_{10} = 9.543 \times 10^6$ (display, social trait and interaction model: $BF_{10} = 9.247 \times 10^6$; display model: $BF_{10} = 329{,}504.43$; social trait model: $BF_{10} = 28.65$). Analysis of effects across matched models showed $BF_{incl} = 0.97$ for the interaction term, suggesting inconclusive evidence for its contribution (Keysers et al., 2020).

Simple main effects for display type were significant for both trustworthiness, $F(2, 308) = 9.02$, $p < .001$, $\eta_p^2 = .06$, and dominance, $F(2, 308) = 16.14$, $p < .001$, $\eta_p^2 = .09$. Pairwise comparisons, Tukey HSD test, $F_{crit}(1, 154) = 5.56$, $p < .05$, showed that for dominance, all conditions differed significantly from one another, photo versus approaching video, $F(1, 154) = 32.19$; photo versus avoiding video, $F(1, 154) = 9.59$; approaching versus avoiding videos, $F(1, 154) = 6.65$. For trustworthiness, both video conditions elicited higher ratings than the photo, photo versus approach video, $F(1, 154) = 10.43$; photo versus avoiding video, $F(1, 154) = 16.03$, but the two video conditions did not differ significantly, $F(1, 154) = 0.6$. Bayesian paired samples t

Figure 5
Mean Ratings by Display Type and Social Trait in Experiment 3



Note. Error bars represent within-subjects standard error (Cousineau, 2005).

tests were consistent with these results. For dominance, there was strong evidence for the H_1 in the comparison between the photo versus approaching video, $BF_{10} = 6{,}706.79$; and moderate evidence for the H_1 in the photo versus avoiding video condition, $BF_{10} = 3.95$, and the approaching versus avoiding videos, $BF_{10} = 4.31$. For trustworthiness, there was strong evidence for the H_1 in the photo versus approaching video condition, $BF_{10} = 11.87$, and in the photo versus avoiding video condition, $BF_{10} = 236.51$, and moderate evidence for the H_0 in the approaching versus avoiding videos, $BF_{10} = 0.20$ ($BF_{01} = 5.14$).

Discussion

The results of Experiment 3 showed that the dynamic avatar stimuli received significantly higher trustworthiness and dominance ratings than the static avatar images. The overall pattern, however, differed for the two traits. Unlike trustworthiness ratings, which were similar in the two video conditions, dominance was affected not only by the perception of the action, but also by its outcome. The approaching walking action led to significantly higher dominance ratings than the avoiding walking action. It is intuitively reasonable that the approaching avatar will be rated as more dominant than the avatar which changes course to avoid the viewer. However, this demonstration provides clear evidence for the effect and taken with Experiment 2, suggests that first impressions are affected by apparent intention, and not just motion.

There is a further interesting aspect to the data, considering ratings of dominance. Both types of video sequences showed identical information up to the point at which the "avoid" condition showed the avatar change trajectory to avoid the viewer (about 1 s through the 1.5 s video). The fact that ratings were affected by differences in these videos suggests that dominance judgment can unfold over time. Again, this is intuitively reasonable. However, it is interesting to observe this effect, because first impressions are often held to form very quickly, for example, Willis and Todorov (2006) observe some consistent judgments after just 100 ms. Our results suggest that, if judgments are taken very fast, they are nevertheless updatable as events unfold, even over the relatively short time courses used here. This has important consequences. Findings using static images, showing very fast judgments, are often taken to imply the importance of first impressions. However, if these impressions are also updated very quickly, then initial perception has less opportunity to influence subsequent behavior. We will return to this issue below.

Experiment 4

The previous two experiments have provided evidence that dynamic behaviors affect the perceived traits of approaching individuals relative to stationary ones. We have studied dominance because it is relatively straightforward to predict the effect: approaching people will be seen as more dominant. The data reported above is consistent with this hypothesis. We have also presented data for a second trait, trustworthiness, in order to establish whether effects for dominance might show up in any attribution or are specific to particular traits. As we can see above, the effects of motion on trustworthiness are more complex and nuanced—in that motion in general enhances this perception, but the effect does not seem to be tied to the intention of the avatar. We tentatively hypothesize that this is because moving avatars are seen as more human-like than static images.

In the next three experiments, we seek to establish the extent to which perceived intention is driving the perception of dominance. In Experiment 4, we compare conditions in which the avatar approaches the viewer or the viewer approaches the avatar. These conditions are comparable in terms of the "looming" avatar (i.e., starting distant and finishing close), but differ in terms of the avatar movement and apparent intention. We predict that avatars approaching the viewer will be perceived as more dominant. Once again, we include conditions in which participants are asked to rate trustworthiness over these changes, essentially as a comparison for dominance perception.

Method

Participants

Seventy-eight participants (49 female, 29 male) aged between 19 and 66 years ($M = 36.68$, $SD = 11.84$) took part in the study after being recruited via Prolific.co. The data from five further participants were excluded from the analyses as one responded correctly to less than 80% of the catch trials and the other four reported not having seen videos, suggesting technical issues during their participation. The sample size was based on a power analysis with G*Power 3.1.9.7 (Faul et al., 2009) for statistical test ANOVA: repeated measures, within factors, with a small effect size ($f = 0.15$; power = .95, number of groups = 1, number of measurements = 6, correlation between repeated measures = .5, nonsphericity correction = 1) with a suggested sample of 75. A sample of 78 was selected, so that it was divisible by 6 and would allow for equal number of participants per counterbalancing condition (3 × display condition, 2 × task order).

Materials

The stimuli were constructed using the same database of 120 avatar objects as in the previous experiments and these appeared in the same virtual airport environment. There were three sets of stimuli—two types of video and an image set. One of the video conditions showed the same stimuli used in Experiments 2 and 3, in which the avatar approaches the viewer. In the second video condition, avatars remained stationary, while the camera approached them, apparently zooming in. The initial and final relative positions of the camera and avatar were identical in both conditions. The static control condition showed distant avatars—that is, the starting frame of both videos. Videos and static images had the same properties as the earlier experiments. The images had a resolution of 1280 × 720 pixels. The videos had a framerate of 30 frames per second and a duration of approximately 1,500 ms. As in the previous experiments, catch trials showing digits were also included.

Procedure

The study ran online using Gorilla Experiment Builder (Anwyl-Irvine et al., 2020). Trials began with a presentation of a picture of the virtual environment with no avatar and a message "Press next to see the person." After the button press, the trial was initiated, and the stimulus and the response scrollbar were presented on the screen as above. Participants were asked to rate the stimuli on a scale from 1 to 7 (*low* to *high*) for dominance or trustworthiness according to condition. The order of the judgment tasks was counterbalanced, and presented in separate blocks of 120 critical trials and 12 catch trials. Each of the display conditions appeared in a separate subblock and the order of those was randomized.

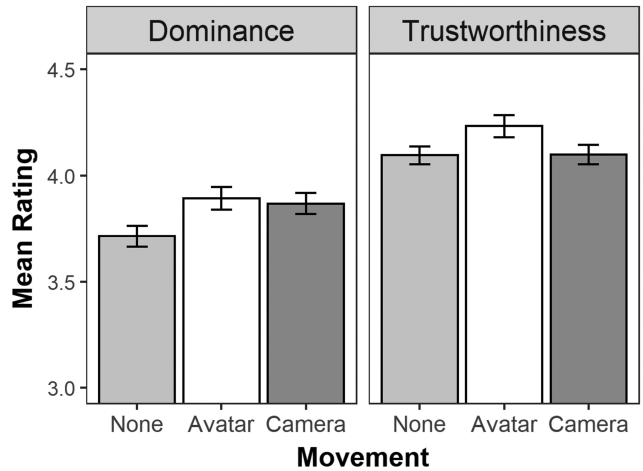
Results

Mean ratings by condition are presented in Figure 6. A 3 (movement: none, i.e., control still image; avatar moves; camera moves) × 2 (social trait: trustworthiness; dominance) within-subjects ANOVA revealed a main effect of social trait, $F(1, 77) = 15.68$, $p < .001$, $\eta_p^2 = .17$, and a main effect of movement, $F(2, 154) = 13.56$, $p < .001$, $\eta_p^2 = .15$. The interaction between these factors was not significant, $F(2, 154) = 2.01$, $p = .138$, $\eta_p^2 = .03$. Bayesian within-subjects ANOVA model comparisons relative to the null model showed that the best model included movement and social trait with no interaction term, providing strong evidence for the H_1, $BF_{10} = 13{,}545.55$ (movement, social trait and interaction model: $BF_{10} = 7{,}699.63$; social trait model: $BF_{10} = 148.85$; movement model: $BF_{10} = 91.30$).

As the main motivation of this experiment was to explore the difference between the conditions in which the avatar approaches the viewer or the viewer approaches the avatar, the effect of movement was further investigated separately for each of the two traits. Simple main effect tests showed that the effect of movement was significant for both dominance, $F(2, 308) = 7.72$, $p = .001$, $\eta_p^2 = .05$, and trustworthiness, $F(2, 308) = 5.01$, $p = .007$, $\eta_p^2 = .03$. Pairwise comparisons, Tukey HSD test, $F_{crit}(1, 154) = 5.56$, $p < .05$, showed that for dominance, the avatar movement condition produced significantly higher ratings than the no movement control condition, $F(1, 154) = 13.15$; as did the camera movement relative to the control, $F(1, 154) = 9.77$. The avatar and the camera conditions were not significantly different from one another, $F(1, 154) = 0.25$. For trustworthiness, the avatar movement condition elicited higher ratings than both the no movement condition, $F(1, 154) = 7.70$, and the camera movement condition, $F(1, 154) = 7.34$. The camera and the no movement conditions did not differ significantly, $F(1, 154) < 0.01$. Bayesian paired samples *t* tests were consistent with these results. For dominance, there was moderate evidence for the H_1 in the comparison between no movement and avatar movement, $BF_{10} = 4.96$; and strong evidence for the H_1 in the no movement versus camera movement condition, $BF_{10} = 19.45$. There was moderate evidence for the H_0 in the avatar movement versus camera movement comparison, $BF_{10} = 0.14$ ($BF_{01} = 7.33$). For trustworthiness, there was strong evidence for the H_1 in the no movement versus avatar movement comparison, $BF_{10} = 12.63$; moderate evidence for the H_1 in the avatar movement versus camera movement comparison, $BF_{10} = 6.43$, but moderate evidence for the H_0 in the no movement versus camera movement comparison, $BF_{10} = 0.13$ ($BF_{01} = 7.99$).

Figure 6

Mean Ratings by Movement Agent and Social Trait in Experiment 4



Note. Error bars represent within-subjects standard error (Cousineau, 2005).

Discussion

The results of Experiment 4 showed that approaching movement affected social trait judgments, replicating the findings from Experiments 2 and 3. However, contrary to our initial hypothesis, dominance perception was not affected by the source of movement, that is, whether the avatar approached the camera or vice versa. This is perhaps surprising. Movement of avatars themselves would appear to imbue them with agency, but bodily movement was not a prerequisite for the perception of higher dominance here. In contrast, moving avatars were rated as more trustworthy than those remaining still while approached by the camera (consistent with the video/still comparisons in the experiments above). In this context, the dominance ratings are somewhat puzzling, in that movement of both camera and avatar result in a greater perception of dominance, compared to a static image, but do not themselves differ.

Before seeking to explain this surprising result, it is important to replicate it. In the following experiment, we again measure attributions of dominance and trustworthiness as the viewer and the target come into proximity through motion of the camera or the avatar. However, we introduce some changes designed to strengthen the manipulation of the independent variable, by enhancing the difference between avatar-moves and camera-moves conditions.

Experiment 5

In this experiment, we again examine the effect of movement between the viewer and an avatar, comparing movement by one or the other. In comparison to Experiment 4, we introduce the following changes: First, we increased the initial distance between viewer and avatar, resulting in a corresponding increase in time for the approach. Second, we used a different motion for the camera to approach the avatar. In Experiment 4, the camera approached in a smooth trajectory, mimicking an approach one might see in a movie. In Experiment 5, we replaced this with a clearer first-person perspective in which the camera was attached to an invisible avatar, who was approaching or approached by the target. This gives a more biological, slightly rolling, motion which enhances the first-person perspective as the viewer approaches the avatar. A number of minor procedural changes were also made in comparison to Experiment 4 (see Method) and the overall intention was to investigate the effect of movement further, using superficially different stimuli and procedures.

Method

Participants

Seventy-eight participants (45 female, 33 male) aged between 19 and 64 ($M = 38.56$, $SD = 12.42$) took part in the study after being recruited via Prolific.co. The data from five further participants were excluded from the analyses as they responded negatively to a final technical check video question, suggesting that they did not see the video stimuli during their participation. The sample size was based on the same considerations as the previous experiments.

Materials

The stimuli were constructed using the same database of 120 avatar objects as used in the previous experiments in the same virtual environment. Again, there were two sets of videos, differing in terms of agent of the approach, and one set of control image conditions. This time, however, the videos had a duration that was twice as long as the one in Experiment 4. The avatars appeared further back in the environment initially, and their full bodies were visible at the beginning of the videos. This change allowed for more visual cues regarding the agency of the approach. The duration of approach was consequently longer, and each video stimulus lasted approximately 3 s in this experiment. For the camera-approach condition, viewers saw the perspective of a camera attached to the upper body of an invisible avatar (camera operator), resulting in movement simulating a human walker. The same manipulation was used when the avatar was walking toward the camera, resulting in the same slightly unstable viewpoint. This manipulation was introduced to aim to induce a perception of a first-person perspective to the viewer.

The static image control stimulus set also differed from the one in Experiment 4. The avatar appeared closer to the camera and therefore the avatar's face looked slightly bigger than in the control condition of the previous experiment. The distance between the camera and the avatar was identical to the close condition in Experiment 2. This distance was also the same as the final distance between the avatar and the camera in the two video conditions. Therefore, the size of the avatar's face in the control picture condition was now the same as the final size of the avatar's face in the video conditions. Finally, as with the previous experiments, catch trials showing digits were also included.

Procedure

The procedure was identical to Experiments 2 and 3. Each trial began with the presentation of a photo or video stimulus for approximately 3,000 ms after which participants made an on-screen decision, via a scrollbar. Participants were asked to rate stimuli on a scale from 1 to 7 (*low* to *high*) for dominance or trustworthiness (according to block) and the trial appeared immediately following this response. The trait judgments were counterbalanced such that half of the participants submitted dominance ratings first, and half submitted trustworthiness ratings first. Each block contained 120 critical trials, plus 12 catch-trials, and was further divided into separate subblocks, representing the three agent conditions—no agent (control image), avatar agent, and camera agent (40 trials each). Subblocks appeared in a random order for each participant, and stimuli were counterbalanced such that, across the experiment, each target person appeared equally often in the three display conditions.

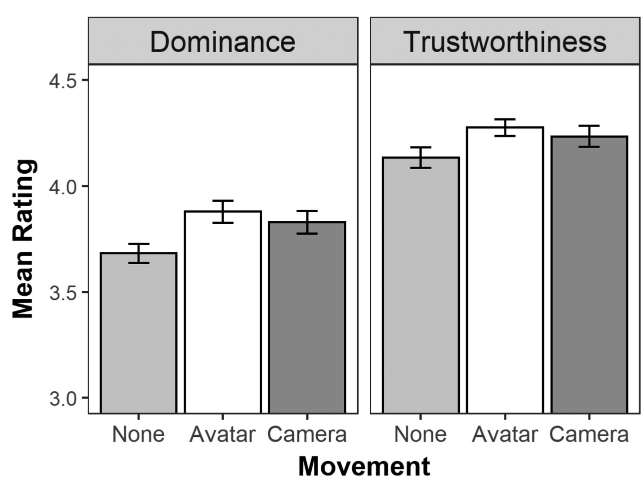
Results

Mean ratings per condition are shown in Figure 7. A 3 (movement: control still image; avatar; camera) × 2 (social trait: trustworthiness; dominance) within-subjects ANOVA revealed a main effect of social trait, $F(1, 77) = 29.98$, $p < .001$, $\eta_p^2 = .28$, and a main effect of movement, $F(2, 154) = 14.15$, $p < .001$, $\eta_p^2 = .16$. The interaction between these factors was not significant, $F(2, 154) = 0.27$, $p = .761$, $\eta_p^2 < .01$. Bayesian within-subjects ANOVA model comparisons relative to the null model showed that the best model included movement and social trait with no interaction term, providing strong evidence for the H_1, $BF_{10} = 6.153 \times 10^6$ (movement, social trait and interaction model: $BF_{10} = 381{,}620.11$; social trait model: $BF_{10} = 26{,}819.81$; movement model: $BF_{10} = 228.65$).

As in Experiment 4, the goal was to explore the difference between the conditions in which the avatar approaches the viewer or the viewer approaches the avatar, and therefore the effect of movement was further investigated. Simple main effect tests showed that the effect of movement was significant for both dominance, *F*(2,

Figure 7

Mean Ratings by Movement Agent and Social Trait in Experiment 5



Note. Error bars represent within-subjects standard error (Cousineau, 2005).

308) = 7.73, $p = .001$, $\eta_p^2 = .05$, and trustworthiness, $F(2, 308) = 3.91$, $p = .021$, $\eta_p^2 = .02$. Pairwise comparisons, Tukey HSD test, $F_{crit}(1, 154) = 5.56$, $p < .05$, showed that for dominance, the avatar movement condition produced significantly higher ratings than the no agent control condition, $F(1, 154) = 14.26$; as did the camera movement relative to the no agent control, $F(1, 154) = 8.05$. The avatar and the camera conditions were not significantly different from one another, $F(1, 154) = 0.88$. This pattern of results replicated the findings for dominance in Experiment 4. For trustworthiness, the avatar movement condition elicited significantly higher ratings than the no movement condition, $F(1, 154) = 7.40$, but not significantly higher than the camera movement condition, $F(1, 154) = 0.64$. The camera and the no movement conditions did not differ significantly, $F(1, 154) = 3.69$. This pattern was slightly different from the one in Experiment 4, as the avatar condition had significantly higher rating only relative to the control, and the two video conditions were not significantly different from one another.

The results from the Bayesian paired samples *t* tests were also consistent with these findings. For dominance, there was strong evidence for the H_1 in the no movement versus avatar movement comparison, $BF_{10} = 14.73$; and moderate evidence for the H_1 in the no movement versus camera movement comparison, $BF_{10} = 4.52$. There was moderate evidence for the H_0 in the avatar movement versus camera movement comparison, $BF_{10} = 0.18$ ($BF_{01} = 5.73$). For trustworthiness, there was strong evidence for the H_1 in the no movement versus avatar movement comparison, $BF_{10} = 20.60$; inconclusive evidence in the no movement versus camera movement comparison, $BF_{10} = 1.18$, and moderate evidence for the H_0 in the avatar movement versus camera movement comparison, $BF_{10} = 0.17$ ($BF_{01} = 5.75$).

Discussion

The results of Experiment 5 replicated the main findings in Experiment 4 despite the differences in the procedure and the stimulus material. Once again, dominance ratings were increased by the perception of approach, regardless of who initiated the approach. Both walking avatars and avatars that did not perform any action but were approached by the viewer were perceived as more dominant than the avatars in the static control condition. The pattern of results for trustworthiness was less stable across the two experiments but the moving avatars were again perceived as significantly more trustworthy than the ones in the control no agent condition, a result that has now replicated across four experiments. The mean trustworthiness ratings of the avatars in the camera-movement condition lay between the other two, but did not differ significantly from either.

The main finding of Experiment 5 is a replication of the surprising pattern of results for the perception of dominance, despite some changes in stimuli and procedure compared to Experiment 4. It seems that an "approach to" or an "approach by" the target avatar increases its apparent dominance. If these results were due to perceived agency, then we might expect that the avatar doing the approaching would be perceived as more dominant. Alternatively, if these results reflect more fundamental perceptual properties of the stimuli—perhaps based on their physical exposure—then social constructs such as agency may have little effect. In the final experiment, we make a strong test of the hypothesis that perceived agency is unimportant for the perception of dominance in these stimuli. This time, we manipulate the direction of movement, either toward or away from a target avatar. These conditions contain essentially the same visual information, but they clearly have very different social meanings.

Experiment 6

Experiment 6 aimed to explore how the temporal order and the outcome of a sequence of visual events affect the formation of first impressions. To do so, we compared the two approaching video conditions from Experiment 5 (camera moves or avatar moves) with two conditions showing the same video frames in reversed order. Any differences between normal and reversed corresponding conditions would suggest that conceptual and causal information is extracted for the formation of first impressions, an intuitive prediction which has been challenged by the results of Experiments 4 and 5. This experiment also brings us back to the consideration of approach versus avoidance as a predictor of social attributions, as explored in Experiment 3. In the present experiment, the trajectory between viewer and avatar is always straight, but the direction of motion indicates approach or avoidance, while presenting the same overall visual information.

Method

Participants

Eighty participants (51 female, 29 male) aged between 19 and 60 ($M = 34.58$, $SD = 10.62$) took part in the study after being recruited via Prolific.co. The data from 13 further participants were excluded from the analyses as five of them failed the attention checks (accuracy less than 80% of the catch trials), and further eight responded negatively to a final technical check video question, suggesting that they did not see the video stimuli properly during their participation. The sample size was increased with two additional participants relative to the previous experiments in the series to accommodate the difference in the number of counterbalancing conditions.

Materials

The stimuli comprised the same videos as Experiment 5, an approach between viewer and target avatar due to movement of the camera or the target. Two additional video sets were created by reversing the order of frames from the originals.

Procedure

The procedure was similar to Experiment 5. Again, participants were asked to rate stimuli on a scale from 1 to 7 (*low* to *high*) for dominance and trustworthiness by adjusting a response slider. Each trial began with a video stimulus that lasted for approximately 3,000 ms after which the response slider was displayed, and the participants entered their ratings. The following trial appeared immediately after the response. The trait judgments were counterbalanced such that half of the participants submitted dominance ratings first, and half submitted trustworthiness ratings first. Each block contained 120 critical trials, plus 12 catch-trials, and was further divided into four separate subblocks (30 trials each), showing each of the four different conditions. Subblocks appeared in a random order for each subject, and stimuli were counterbalanced such that, across the experiment, each target person appeared equally often in the four conditions.

Results

Figure 8 shows mean ratings per condition. Since the focus of the theoretical motivation of this experiment was on explaining the previously demonstrated effects on dominance, and for ease of interpretation with this design, the two rating tasks were analyzed separately.

Dominance

A 2 (movement agent: avatar; camera) × 2 (direction: moving apart; moving toward) within-subjects ANOVA revealed a main effect of direction, $F(1, 79) = 16.95$, $p < .001$, $\eta_p^2 = .18$. The effect of agent was not significant, $F(1, 79) = 0.02$, $p = .894$, $\eta_p^2 < .01$. The interaction between these factors was not significant, $F(1, 79) = 1.57$, $p = .215$, $\eta_p^2 = .02$. Bayesian within-subjects ANOVA model comparisons relative to the null model showed that the best model included direction only, providing strong evidence for the H_1, $BF_{10} = 203.90$ (movement agent and direction model: $BF_{10} = 30.40$; movement agent, direction and their interaction model: $BF_{10} = 11.743$; movement agent model: $BF_{10} = 0.15$).

Simple main effect tests showed that the effect of direction was significant for both avatar, $F(1, 158) = 15.86$, $p < .001$, $\eta_p^2 = .09$, and camera, $F(1, 158) = 5.77$, $p = .017$, $\eta_p^2 = .04$. Bayesian paired samples *t* tests also provided evidence for the H_1: strong in the apart versus toward contrast for avatar, $BF_{10} = 28.35$; and moderate for the same contrast for camera, $BF_{10} = 5.98$. However, consistent with the ANOVA results, when comparing the same direction conditions across agents, Bayesian paired samples *t* tests provided evidence for the H_0 in both apart, $BF_{10} = 0.16$ ($BF_{01} = 6.09$) and toward conditions, $BF_{10} = 0.20$ ($BF_{01} = 4.97$).

Trustworthiness

A 2 (movement agent: avatar; camera) × 2 (direction: moving apart; moving toward) within-subjects ANOVA revealed a main effect of direction, $F(1, 79) = 4.18$, $p = .044$, $\eta_p^2 = .05$. The effect of agent was not significant, $F(1, 79) = 1.91$, $p = .171$, $\eta_p^2 = .02$, nor was the interaction between these factors, $F(1, 79) = 0.12$, $p = .732$, $\eta_p^2 < .01$. Bayesian within-subjects model comparisons did not provide any conclusive evidence for the H_1 as all models were less likely than the null model (direction model: $BF_{10} = 0.98$; movement agent model: $BF_{10} = 0.27$; movement agent and direction model: $BF_{10} = 0.26$; full model: $BF_{10} = 0.05$).

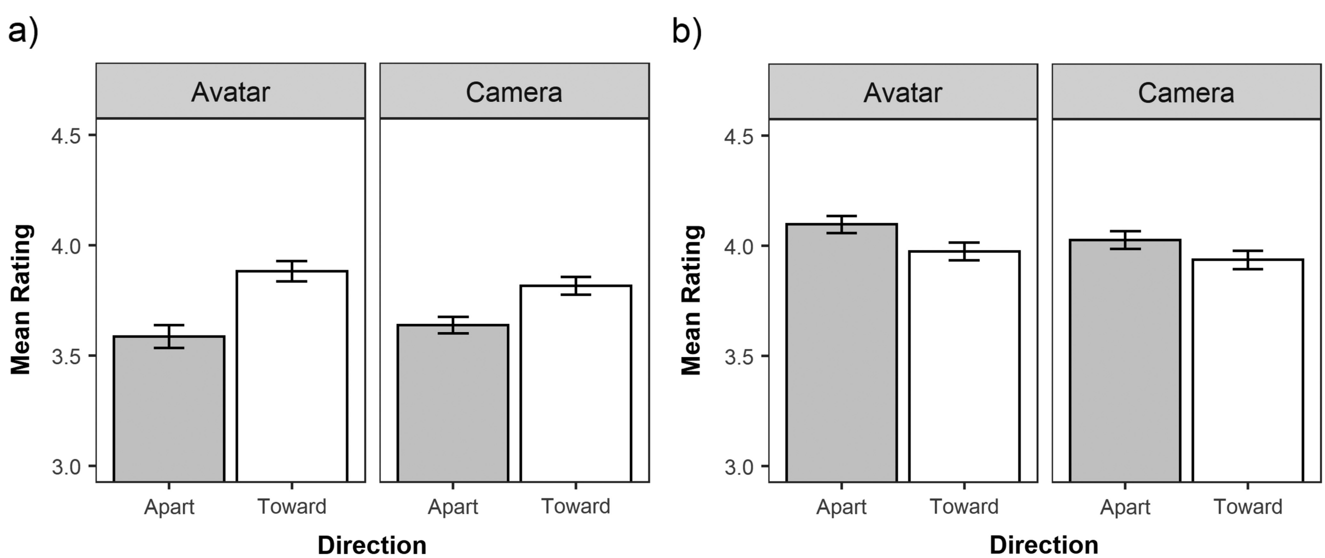
Simple main effect tests showed that the effect of direction was not significant for neither avatar, $F(1, 158) = 3.05$, $p = .083$, $\eta_p^2 = .02$, nor camera, $F(1, 158) = 1.65$, $p = .2$, $\eta_p^2 = .01$. Bayesian paired samples *t* tests did not provide evidence for either hypothesis in the apart versus toward contrast for avatar, $BF_{10} = 0.541$ ($BF_{01} = 1.850$); and provided moderate evidence for the H_0 in the same contrast for camera, $BF_{10} = 0.268$ ($BF_{01} = 3.736$). Comparisons within the same direction conditions across agents with Bayesian paired samples *t* tests provided evidence for the H_0 in both apart, $BF_{10} = 0.243$ ($BF_{01} = 4.119$) and toward conditions, $BF_{10} = 0.148$ ($BF_{01} = 6.735$).

Discussion

The results of Experiment 6 show clearly that dominance perception is directly affected by the direction of movement between viewer and target avatar. Movements bringing them together result in higher dominance ratings than those taking them apart. This shows that the social attributions to the stimuli must be based on more than the perceptual information they contain, at least in any simple account of information. However, note that this result is equivalent for perspectives in which the avatar approaches the viewer or vice versa. This is a further replication of the apparently surprising result that the agent of movement is not affecting dominance perception. We will return to this in the General Discussion.

The pattern of results for the trustworthiness rating is also interesting. Here, a separating movement leads to higher ratings, but again, this is

Figure 8
Mean Ratings of (a) Dominance and (b) Trustworthiness by Direction and Movement Agent in Experiment 6



Note. Error bars represent within-subjects standard error (Cousineau, 2005).

unaffected by who is initiating the movement, viewer, or avatar. Once again, it is perhaps surprising to see no effect of agency here. While the predictions are not as clear for the perception of trustworthiness as for dominance, the consistency of results across experiments shows that different judgments are affected differently by the manipulations we have studied here—giving one confidence that the results are not a simple consequence of superficial experimental operationalisations.

General Discussion

We have demonstrated that first impressions from faces in photographic images of unfamiliar individuals correspond quite closely to those of avatars of the same individuals. This was evident from the results of Experiment 1, demonstrating high correlations between ratings for photos and avatars on both dominance and trustworthiness. These findings are very encouraging, particularly in the context of the growing literature suggesting that first impressions vary substantially across photographic images of the same individuals (Jenkins et al., 2011; Lavan et al., 2021; Mileva et al., 2019; Todorov & Porter, 2014). This suggests that social attributions are not simply volatile, changing as a result of minor perceptual image differences, but instead are influenced by meaningful variation (e.g., expression) but not by superficial variations (photo/avatar formats). Virtual reality technology could therefore be used to address limitations of photographic images in studying first impressions from faces.

To further explore factors affecting spontaneous social judgments of faces, we introduced additional context and dynamic features that are typically present in a social environment. The presence of bodily movement changed the perception of social attributions to faces. Experiment 2 demonstrated that avatars who approached the viewer received higher ratings of both trustworthiness and dominance than still images of these avatars within the same visual environment. The trend was particularly evident for ratings of dominance, consistent with the fact that individuals associate dominance with approach behaviors during social interactions (Carney et al., 2005; J. A. Hall et al., 2005). These findings suggest that common features of the immediate interactive environment, such as dynamic behaviors, affect the formation of first impressions from faces. Social judgments were not affected by the implied distance of the perceived individual from the viewer, but by the approach itself. The results of Experiment 2 therefore extended those of Experiment 1 and showed that digital avatars not only preserved the representations of social attributes, but also offered a successful methodology for exploring how those attributes were affected by dynamic factors of the social environment.

In Experiment 3, we examined the movement of avatars more closely, introducing a comparison between approaching and avoiding walk-trajectories. Avatars approaching the viewer were perceived as significantly more dominant than those avoiding the viewer or those remaining stationary. This effect showed a different pattern for trustworthiness, which attracted higher ratings for moving avatars, whether or not they approached the viewer. These results show that dominance is not only affected by dynamic features of the environment such as perception of movement, but is also closely related to approach behavior. This is consistent with previous literature suggesting that more dominant individuals are more likely to, and are expected to, approach others during interactions (Carney et al., 2005; J. A. Hall et al., 2005), and demonstrates that approach behavior influences first impressions for unfamiliar individuals.

Experiments 4 and 5 replicated the effect of the approach on first impressions and further extended these findings by demonstrating that the perception of bodily movement, such as walking, was not a prerequisite for observing the effect. Avatars that remained stationary were also perceived as more dominant when they were approached by the viewer than when they were not, suggesting that the effect on dominance was not generated strictly by the initiation of the action by the target individual, but rather on the presence of a forward approaching motion. Control conditions, which sometimes vary according to experiment, eliminate simple image characteristics as an explanation for this effect. Instead, this seems to be caused by the presence of dynamic convergence, possibly linked to the more abstract concept of approach.

Experiment 6 consolidated the findings of Experiments 2–5, demonstrating that perception of dominance is increased by a converging approach, whether by target or viewer. Divergent trajectories, which could be regarded as avoidance, gave rise to decreased dominance perception, and once again this pattern held regardless of the agent of movement, avatar, or viewer. This is rather an interesting pattern, supporting findings from the earlier experiments that the agency of motion is less important for the perception of dominance than the direction of motion. Across all experiments, the dominance and trustworthiness attributions showed different responses to manipulations of movement, demonstrating that ratings were individually sensitive to this factor. The detailed pattern of trustworthiness perception was more nuanced than dominance, but consistently showed that movement increased trust.

The dependence of dominance ratings on the direction of motion, rather than on the agent of motion, could be considered as counterintuitive for at least two different reasons. First, it shows that action perception in the form of bodily movement from the target is not a prerequisite for the effect of approach on dominance. Second, the results of the camera apart condition in Experiment 6 showed that observation of moving back from the target decreased the perceived dominance. Dominance ratings in first impression studies have been often discussed in terms of the perceived capability of carrying out (possibly bad) intentions, and indeed threat judgments are positively correlated to perceived dominance (Oosterhof & Todorov, 2008). Perception of some form of threat, on the other hand, could lead to avoidance behavior. The results here might suggest that the indirect link between the reason for avoidance, such as possible threat, and dominance have not been considered in these first impression judgments. As threat is linked to avoidance and dominance is linked to threat, individuals who are avoided might have been perceived as more dominant. However, a reversed pattern was observed. Perception of avoidance, more specifically, moving apart from an individual, decreased dominance judgments. A possible explanation could be that such perspective taking, and modification of social attributes requires more complex interactions that provide further intentionality cues and possibly additional processing time.

This pattern suggests that first impressions are formed from the visual input without much cognitive effort and without more profound judgment using relatively simple characteristics of the stimuli, possibly due to favoring faster speed to validity of the decision. This is in line with the evidence that such judgments occur quite rapidly, although with limited validity (Foo et al., 2022; Todorov, 2017; Todorov et al., 2015; Willis & Todorov, 2006). It is also consistent with the suggestion that these processes are at least partially automatic, due to such judgments occurring so quickly and possibly inevitably (Ritchie et al., 2017; Sutherland & Young, 2022; Swe et al., 2022).

The fast, apparently unreflective, response to a closing gap between viewer and target is reminiscent of the well-documented fear response elicited by a looming visual stimulus that occurs in humans and many animals (Ball & Tronick, 1971; Schiff et al., 1962). This is a very powerful response, induced by any looming pattern, social or not, though it can be modulated by a viewer's knowledge of the approaching stimulus, that is, whether it is inherently threatening or not (Vagnoni et al., 2012). It is possible then, that the root of the dominance ratings made to approaching avatars lies in a perceptual response to a looming pattern. It would be interesting to carry out further studies which preserve the movement characteristics of our stimuli but obscure their form. This is tractable in the virtual environment. Of particular interest would be the interaction between ratings to static and moving stimuli, under conditions which encourage interpretation of the stimulus as human or not. Given that we know that impressions are formed very quickly to static (i.e., nonlooming) human stimuli, are these simply eliminated, or perhaps modulated, by a response based on fundamental perceptual properties triggered by motion?

Taken together, the results of Experiment 2–6 also show that even if trait judgments are formed instantly, they continue to be influenced by subsequent visual cues. This pattern was quite robust for dominance ratings, which depended on the initial state, the transition, and the outcome of the encounters in the virtual world. For example, in Experiment 2, the end state of the walking avatar was reaching the position of the close static avatar. The walking avatar was, however, rated as more dominant than the close avatar, suggesting that the availability of the initial stages of the action affected dominance ratings by providing some temporal context. The outcome also influenced dominance ratings, as evident by the results of Experiment 3, which showed that dominance ratings were higher in the outcome of approach, compared to the outcome of avoidance. These findings were further consolidated by the results of Experiment 6 which, with a different design also demonstrated the role of the temporal context and the effect of approach and avoidance on the formation of first impressions.

These findings suggest that, even though first impressions can occur quite rapidly, their representation may be flexible, perhaps depending on the availability of the dynamic context. Studies exploring the rapid occurrence of first impressions from faces in the past have contrasted conditions with different times of exposure to the stimuli, showing that more processing time does not necessarily lead to an improvement in the reliability of the ratings (Willis & Todorov, 2006). However, these studies employed static photographic images that did not change throughout exposure. Here we studied a visual sequence that unfolded over time. The two types of walking avatars in Experiment 3, for example, started at the same point in the virtual environment and were identical in the initial stages but not at the final stages, in which they expressed different behavior. These results suggest that even though the representations of social attributes were relatively stable and were preserved across media types, their formation was sensitive to dynamic changes and had a flexible nature.

These findings extend the existing evidence on first impressions from faces by demonstrating that they are affected by changes in the dynamic environment over and above the previously documented effects of changing emotional expressions. As already discussed, the valence of emotional expressions predicts first impression judgments from faces (e.g., Sutherland et al., 2013). Furthermore, neutral faces slightly resembling emotional expressions are attributed traits associated with the emotion they resemble (Said et al., 2009). The emotional recognition system has been suggested to be involved in the rapid formation of first impression judgments—transient emotional states are overgeneralized to personality traits to inform an approach or avoidance decision (Todorov, 2008). In the present experiments, however, the emotional expressions were controlled as the avatars had identical faces across conditions. Furthermore, the type of movement, gait, and position within the environment were also controlled for. These results show that other factors with dynamic properties can also affect first-impression judgments.

The results are in line with the theory that social judgments are related to instant decisions of whether an individual should be approached or avoided (Jones & Kramer, 2021; Todorov, 2008). Of course, in these experiments, it is not the viewer who actively made that decision or performed a walking action toward a target person. We should also note that the judgments on the two traits had a different pattern in the present experiments: Trustworthiness was not as strongly associated with approach behavior as dominance in these experiments. However, across the experiments, perceived trustworthiness was consistently increased with the dynamic conditions, relative to the control ones. The perception of a walking action was sufficient to boost trustworthiness relative to the static condition, regardless of the approach or avoidance behavior of the perceived individual. In addition, the walking avatar was rated as more trustworthy than the avatar that appeared close to the perceiver, but as trustworthy as the distant avatar.

One possible explanation for the pattern of results from trustworthiness judgments lies in the degree to which the avatars are perceived as human-like. At a distance, or while moving, the avatars may appear more natural than close-up static images (e.g., graphical rendering artifacts may be more apparent in a close static image). Such an explanation is consistent with the results in Experiment 1, as well as with previous findings in which artificial images attracted lower trustworthiness ratings than photographic images (Balas & Pacella, 2017). Alternatively, factors associated with the implied proximity within the social environment may be important. For example, reduced social distance is known to produce feelings of discomfort in some contexts (such as encounters with strangers; e.g., Aiello et al., 1977; Evans & Wener, 2007). If an individual is too close, and the distance is not safe, the perceived intentions of that individual might decrease in valence. The findings for trustworthiness in the present experiments might be a result of the interaction between the availability of dynamic intentionality cues and the implied distance in the environment.

Further research could use virtual reality to examine these effects, leveraging the ability to manipulate bodies as well as faces. In particular, it will be important to explore the relationship between the viewer's actions and the target's actions. In these experiments, the viewer was passive, but how might the results change if the viewer was actively approaching targets? This would allow the experimenter to introduce two important aspects of agency which are not available in the current experiment. First, an active walker could choose the trajectory of approach (spatially and temporally). Second, it would be possible to introduce genuinely interactive trajectories, for example, allowing a user to avoid an approaching avatar. These complexities are clearly key to daily life, and could be explored in future work. Indeed, the present work has direct relevance to research on proxemics and could help explain how approach-related behavior affects social impressions in the mid of face-to-face interactions (McCall, 2015; McCall & Singer, 2015; Weick et al., 2017). Questions about social interaction are particularly relevant given the fact that the avatars in these experiments approach well within the "social distance" of the camera, that is, the distance people comfortably use for conversation (E. T. Hall, 1966; Sorokowska et al., 2017). Regardless, we have shown that virtual environments of the type used here are suitable for research on dynamic social impressions, and in particular, could be used in experiments investigating the ongoing changes in our attributions to social participants, even those subtle changes that take place over very short periods.

In sum, we have demonstrated that the dynamic nature of exposure to human-like avatars can differentially affect judgments of dominance and trustworthiness in line with what one might predict from prior work on social approach and avoidance. We have also demonstrated that initial impressions may be updated very fast—as observed by different ratings of stimuli at the beginning and end of a short movement. The results provide a platform for further exploration of social judgments from faces within virtual environments, including the potential to manipulate social context independently of the personal characteristics of target stimuli. Indeed, context may moderate the effects of different dynamic behaviors; approach at a dance may be interpreted differently from an approach at an airport. Virtual environments provide the opportunity to examine face perception within social contexts in ways that go beyond the limits of traditional experimental designs.

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