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Following Other People's Footsteps: A Contextual-Attraction Effect Induced by Biological Motion

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Abstract

Our visual system is bombarded with numerous social interactions that form intangible social bonds among people, as exemplified by synchronized walking in crowds. Here, we investigated whether these perceived social bonds implicitly intrude on visual perception and induce a contextual effect. Using multiple point-light walkers and a classical contextual paradigm, we tested 72 college-age adults across six experiments and found that the perceived direction of the central walker was attracted toward the direction of the surrounding walkers. The observed contextual-attraction effect occurred even when the surrounding walkers differed from the central walker in gender and walking speed but disappeared when they were asynchronously presented or replaced by inanimate motion. Strikingly, this contextual-attraction effect partially persisted in the context of local motion rather than static figures. These findings, in contrast to the typical contextual-repulsion effect, lend support for the distinctiveness of perceived social bonds on contextual modulation and suggest a specialized contextual mechanism tuned to social factors.

Keywords

biological motion, walking direction, collective motion, contextual effect, social bonds

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Our perception is not always a mirror image of the physical world. There has been ample evidence that perception of a target is always biased against the surrounding context, termed the *contextual-repulsion effect*. Take the well-known tilt illusion as an example; a vertical grating can be perceived away from the orientation of the surrounding context (Clifford, 2014). In addition to orientation (Clifford, 2014; Yuan et al., 2017), other basic visual properties, such as luminance (Harris et al., 2011) and size (Chen et al., 2018), have also been revealed to be perceptually susceptible to the contextual information. In general, the repulsive modulation of these visual features is explained by lateral inhibition whereby stimulated neurons are suppressed by the excitation of nearby neurons (Blakemore et al., 1970). This context-dependent mechanism may be evolutionarily developed to sharpen our sense perception and enhance stimuli saliency (Li, 1999).

Not only basic visual properties but also complex visual scenes can be perceptually influenced by contextual information (Bar, 2004). A well-known example is the scene-consistency effect. Objects that appear in

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semantically congruent contexts are recognized more accurately and quickly, compared with those that appear in semantically incongruent contexts (Hollingworth & Henderson, 1998). For example, a sofa embedded in a living-room setting is easier to identify than a sofa in an African plains background (Davenport & Potter, 2004). Such context-dependent processing might be accounted for by observers' prior knowledge from statistical regularities of the world (Oliva & Torralba, 2007). A neural representation of scene information enables the visual brain to rapidly identify the target in the complex scene (Kaiser et al., 2019).

The contextual effect, although taking into consideration the low-level physical properties (i.e., contextual-repulsion effect) or the semantic association between physical objects (i.e., scene-consistency effect), has so far been rarely explored in the social domain. However, humans are continually exposed to a body of intangible social bonds, that is, interpersonal interaction and the resulting social relationships or belongings (Aslaksen, 2017; Shultz & Dunbar, 2010). It remains unknown how these social bonds modulate our visual perception in a context-dependent manner.

In our daily lives, the intangible social bonds are most profoundly manifested in collective motion, where a group of people are prompted to move in synchrony, especially the coordination of walking direction (Shamay-Tsoory et al., 2019; Warren, 2018). Arguably, the perceived closeness of social bonds unfolds through the movement alignment of social group (Lee et al., 2020; Wilson & Gos, 2019). On this basis, by systematically manipulating the movement alignment of biological entities, we explored whether perceived social bonds that implicitly serve as a contextual factor could bias our perception about the movement of one individual among the group to which he or she belongs.

It has been demonstrated that our visual system is prone to perceptually cohere multiple interactive individuals into a unified, homogeneous group (Sweeny et al., 2013; Vestner et al., 2019). Likewise, we speculated that implicitly perceived social bonds may exert an attractive rather than a repulsive contextual effect on our visual perception of walking direction. Specifically, if someone is walking in the crowd, his or her walking direction is more likely to be perceived as aligning with his or her surrounding walkers' direction, rather than being repelled to an opposite direction as the low-level visual features do.

To examine this hypothesis, we quantified through a psychophysical test the extent to which observers' direction judgment of a central walker was biased by surrounding walkers who walked leftward and rightward, respectively. In Experiment 1, we investigated whether the perceptual walking direction of the central walker was attracted toward the surrounding walkers' direction. To further elucidate the mechanism responsible for this contextual effect, we investigated which factor is necessary to produce such an effect in Experiments 2 to 6.

Statement of Relevance

Social interaction is ubiquitous in our daily lives, as when a group of pedestrians always walks collectively. We perceive these intangible social bonds among people almost effortlessly. How do these implicitly perceived social bonds impinge on our perceptual processes? In this research, we presented observers with central and surrounding walkers simultaneously and asked them to judge the walking direction of the central walker. We found that they tended to perceptually align the direction of the central walker with the surrounding walkers. In contrast to a contextual-repulsion effect in low-level visual properties (e.g., orientation), these results demonstrate a contextual-attraction effect induced by implicitly perceived social bonds. This work implies an evolutionary-adaptive mechanism that favors implicit perceptual biases in accordance with social alignment and suggests that our perceptual system is intimately associated with higher-level social cognition.

Method

Participants

A total of 72 college students took part in the current study, with 12 participants in each experiment (Experiment 1: five men, age: $M = 23.2$ years, $SD = 2.5$; Experiment 2: five men, age: $M = 20.9$ years, $SD = 1.5$; Experiment 3: five men, age: $M = 21.7$ years, $SD = 3.1$; Experiment 4: four men, age: $M = 24.2$ years, $SD = 2.5$; Experiment 5: four men, age: $M = 22.7$ years, $SD = 2.2$; Experiment 6: three men, age: $M = 23.2$ years, $SD = 2.7$). The sample size was determined by Jackson and Blake's (2010) study (Experiment 4), which adopted biological-motion walkers to investigate the perceptual aftereffect of walking direction. A G*Power analysis (Faul et al., 2009) indicated that a sample size of at least eight participants could ensure adequate power to detect a perceptual aftereffect (two tailed; Cohen's $d = 1.96$; $\alpha = .05$; $1 - \beta = 0.99$). We increased the sample size to 12 per experiment in order to explore the potential contextual effect of biological motion. All participants had normal or corrected-to-normal vision and

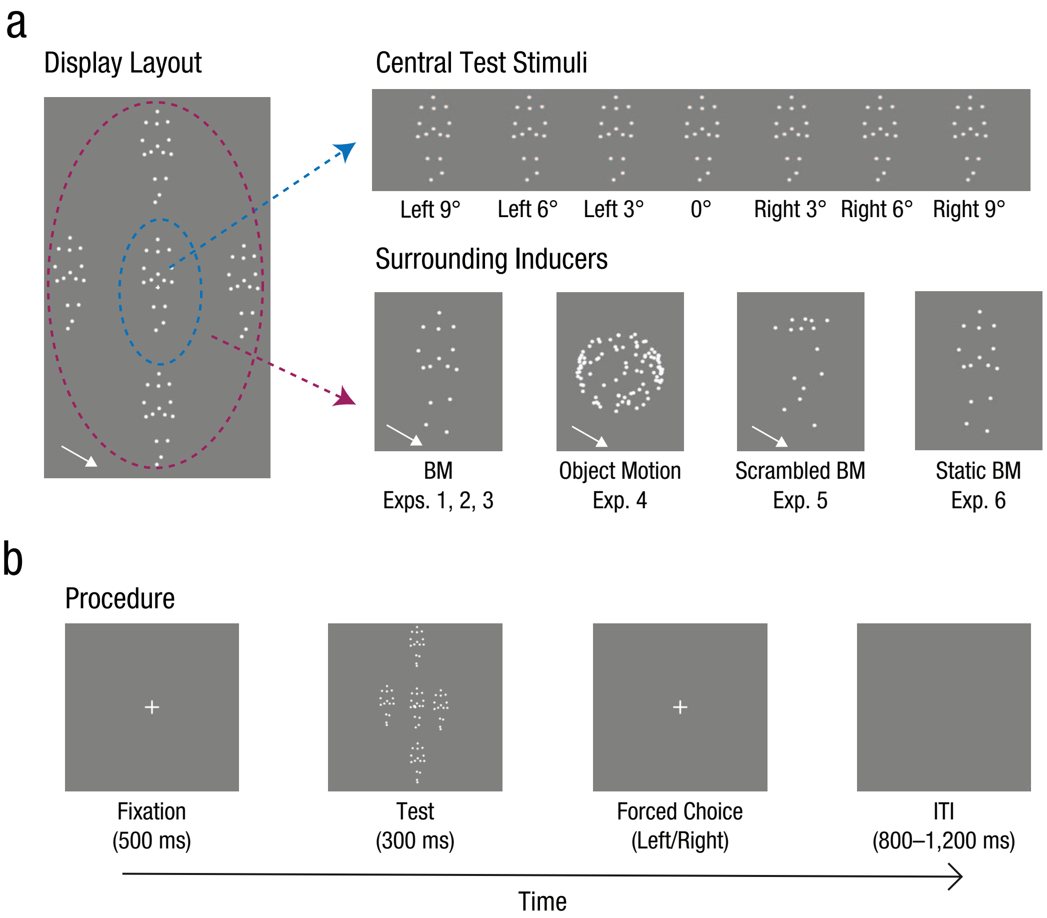

Fig. 1. Display layout, stimuli, and procedure. The central walker had seven different walking directions (a), and each experiment used different types of surrounding inducers according to the experimental aims. Arrows indicate the motion direction and were not presented in the actual experiments. An example trial sequence (b) is shown from Experiment 1. BM = biological motion; ITI = intertrial interval.

provided written informed consent prior to the formal experiment. The current study was conducted in accordance with the Declaration of Helsinki and was approved by the institutional review board of the Institute of Psychology, Chinese Academy of Sciences.

Apparatus and stimulus

Participants sat comfortably in a dim room, with a viewing distance of 57 cm from an LCD monitor (44.5 cm × 33 cm, 60-Hz refresh rate). Stimuli were presented against a gray background on the monitor using MATLAB (The MathWorks, Natick, MA) together with the Psychophysics Toolbox extensions (Brainard, 1997; Pelli, 1997).

The display stimuli were composed of a central walker (approximately 1.5° × 3.5° in visual angle) and four surrounding walkers or control stimuli (positioned approximately 3° horizontally and 5° vertically from the center; see Fig. 1a). In all experiments, the central walker was visualized by 15 point-light dots (i.e., a biological-motion walker; see Fig. 1a), which were placed at the major body joints of a human figure, as described in more detail elsewhere (Troje, 2002). As shown in Figure 1a, the surrounding stimuli were identical to the central biological-motion walker (except for the walking direction) in Experiments 1 and 3. In Experiment 2, we manipulated the gender and walking speed of surrounding walkers according to a previous study (Troje et al., 2006). Specifically, the surrounding biological-motion walkers were presented with different walking speeds (fast: 60 frames per second, natural: 30 frames per second, slow: 15 frames per second) and genders (feminine, gender neutral, masculine) in separate locations, which were randomly assigned across trials. In Experiment 4, stereoscopic rotating balls (i.e., object motion) served as the surrounding stimuli, and they were projected on the 2D plane. Each of them was composed of 100 dots that rolled forward around a virtual horizontal axis at an angular velocity of 60° per second, similar to that of the biological-motion walker. In Experiment 5, the surrounding stimuli were spatially scrambled biological-motion walkers. They were achieved by randomizing the initial position of each point within the same region covered by the intact biological-motion walker. Such manipulation destroys the global form of the biological-motion walker but keeps the local motion trajectory of each dot invariant. In Experiment 6, the surrounding stimuli were snapshots of the biological-motion walker (i.e., static biological motion), which were generated by capturing a frame from the biological-motion sequence when the footstep of the walker reached its farthest.

Procedure

When projected onto a 2D plane, the biological-motion walkers and rotating balls may cause a bistable perception because of loss of depth information. But in most cases, biological-motion walkers are perceived as facing toward the observers because of their social relevance, known as facing bias (Schouten et al., 2010). To ensure that all participants could steadily perceive the direction of biological-motion walkers and the rotating balls, we asked them to complete a practice block before the formal experiment. Only participants who steadily perceived these stimuli as moving toward themselves and who could identify the left-right direction of them were allowed to continue the subsequent experiments. Moreover, when participants perceived the stimuli as moving away from themselves in the formal experiment, they were instructed to terminate the experiment by pressing a button. In fact, no participant was excluded during the formal experiment as long as they had passed the practice test.

In the formal experiments, we adopted a walking-direction-discrimination task in a psychophysical procedure (see Fig. 1b). More specifically, the central biological-motion walkers were presented with seven different viewpoints in separate trials (left −9°, −6°, −3°, front 0°, right 3°, 6°, 9°), whereas the surrounding inducers were uniformly presented toward the left side (−15°) or the right side (15°), corresponding to the leftward-context or the rightward-context condition, respectively. In total, each viewpoint was repeated 20 times for each condition, which resulted in 280 trials, distributed in four separate blocks. Each trial began with a 500-ms fixation cross (0.8° × 0.8°). After it disappeared, the central biological-motion walker and the four surrounding inducers were simultaneously displayed for 300 ms. Participants were instructed to discriminate the central walker's direction and make a forced-choice judgment (toward the left side or the right side) via button press as accurately as possible. The intertrial interval was between 800 ms and 1,200 ms randomly. To avoid any possible visual residuals, we spatially jittered all stimuli within an area of 0.5° for each trial. All experiments followed the same aforementioned procedure but with different surrounding inducers (as introduced in the Apparatus and Stimulus section), except for Experiment 3, in which an additional 300-ms interstimulus interval was inserted between the surrounding inducers and the central biological motion (for a schematic of the experimental procedure, see the demos in the Supplemental Material available online).

To verify that the context displays of our main Experiments 1 and 2 can change the perceived social bonds, we recruited another two independent groups of participants and asked them to explicitly perform a social-bond rating task. Participants were asked to judge the perceived strength of the social bonds between the central and surrounding walkers. The results revealed that the central walkers who moved in a more cohesive direction with the surrounding walkers were judged as more tightly bounded with others in social relations, confirming the validity of the context displays (more details about the rating tasks can be found in the Supplemental Material).

Data analysis

We calculated the proportion of responses indicating that the central biological-motion walker was walking rightward. Each individual data point was fitted with a Boltzmann sigmoid function $f(x) = 1/(1 + \exp[x - x_0)/\omega])$, where x represents the actual walking direction, and x_0 indicates the point of subjective equality (PSE). The PSE corresponds to the walking direction at which the probabilities of leftward and rightward judgments are equal. If the average PSE under the leftward-context condition is significantly greater than that under the rightward-context condition, it indicates a contextual-attraction effect, whereas the opposite indicates a contextual-repulsion effect. Moreover, the difference limen corresponds to half the interquartile range of the fitted function and is taken to evaluate the direction discrimination sensitivity. In addition, we computed the Jeffreys-Zellner-Siow Bayesian factor (BF_{10}, Hypothesis 1 vs. Hypothesis 0) using the *bayesFactor* package (Krekelberg, 2021) for MATLAB.

Results

Experiment 1: a contextual-attraction effect of biological-motion walking direction

In Experiment 1, we found that the PSE in the leftward-context trials was significantly higher than that in the rightward-context trials (1.42° vs. −0.62°), *t*(11) = 4.63, $p < .001$, Cohen's $d = 1.34$, 95% confidence interval (CI) for mean difference = [1.07, 3.02], $\text{BF}_{10} = 52.18$ (see Fig. 2a). This effect could not be interpreted by the difference in participants' discrimination sensitivity, as they had comparable difference limens between these two conditions, *t*(11) = 0.02, $p = .986$, $d = 0.01$, $\text{BF}_{10} = 0.29$. These findings provided initial evidence that a central walker's direction was perceptually attracted toward its surrounding walkers' direction. In other words, when the surrounding biological-motion walkers were walking leftward, participants tended to judge the central biological-motion walker as walking leftward, and vice versa.

Experiment 2: the contextual-attraction effect regardless of the walker's gender and walking speed

To explore the generalization of the contextual-attraction effect, we tested in Experiment 2 whether such an effect could transfer to a situation in which the central and surrounding walkers differed in both gender and walking speed. As shown in Figure 2b, the PSE in the leftward-context condition was significantly higher than that in the rightward-context condition (0.62° vs. −0.84°), *t*(11) = 4.82, $p < .001$, $d = 1.39$, 95% CI for mean difference = [0.79, 2.13], $\text{BF}_{10} = 68.44$ (see Fig. 2b). Similarly, the observers' discrimination sensitivity (i.e., difference limen) was not significantly different between conditions, *t*(11) = −1.34, $p = .208$, $d = -0.39$, $\text{BF}_{10} = 0.59$. These results demonstrated that the contextual-attraction effect was not affected by the similarities between the surrounding and central biological-motion walkers.

Experiment 3: the contextual-attraction effect specialized for a simultaneously walking context

We further tested whether the contextual effect depended on a simultaneous context. In Experiment 3, the surrounding walkers were presented before the central biological-motion walker. Surprisingly, results showed that there was no significant difference between the leftward-context and rightward-context conditions in PSE (−0.34° vs. 0.13°), *t*(11) = −1.05, $p = .317$, $d = -0.30$, 95% CI for mean difference = [−1.45, 0.51], $\text{BF}_{10} = 0.45$ (see Fig. 2c), and difference limen, *t*(11) = 0.33, $p = .748$, $d = 0.10$, $\text{BF}_{10} = 0.30$. The results indicated that the contextual-attraction effect cannot be generalized to an asynchronous context, thereby ruling out the possibility that such an effect was caused by a perceptual-priming mechanism.

Experiment 4: the contextual-attraction effect specialized for a biological-motion context

We assumed that the contextual-attraction effect is specialized for a biological-motion context. To examine this issue, we adopted the stereoscopic rotating sphere as surrounding stimuli, which lacks biosocial information but still conveys moving direction information. As expected, observers' judgments were not significantly different between the two conditions, as reflected by the PSE (0.36° vs. 0.22°), *t*(11) = 0.62, $p = .551$, $d = 0.18$, 95% CI for mean difference = [−0.36, 0.64], $\text{BF}_{10} = 0.34$ (see Fig. 2d). Again, there was no significant difference in difference limen, *t*(11) = −0.74, $p = .472$, $d = -0.21$, $\text{BF}_{10} = 0.36$. These results corroborated that the observed effect was essentially attributed to the biological characteristics embedded in biological motion. Accordingly, we next explored the role of two component features (local motion and global configuration) contained in biological motion in eliciting this contextual-attraction effect by adopting scrambled biological motion (Experiment 5) and static biological motion (Experiment 6) as inducers.

Experiment 5: the contextual-attraction effect mildly preserved by local kinematic cues

Recent studies have provided compelling evidence that biological-motion information can be retained by spatially scrambled displays or the feet because some fundamental motion properties relevant to animacy, such as acceleration and gravity, were not disturbed in local motion processing (Troje & Westhoff, 2006; L. Wang & Jiang, 2012; L. Wang et al., 2014; L. Wang et al., 2010). Hence, Experiment 5 examined the contribution of local motion in the observed contextual effect by using spatially scrambled biological-motion stimuli as inducers. As illustrated in Figure 2e, our results showed a marginally significant contextual-attraction effect (0.20° vs. −0.27°), *t*(11) = 2.20, $p = .050$, $d = 0.63$, 95% CI for mean difference = [−0.0003, 0.94], $\text{BF}_{10} = 1.65$. The discrimination sensitivity was again not significantly different from each other, as indexed by comparable difference limens, *t*(11) = 0.76, $p = .463$, $d = 0.22$, $\text{BF}_{10} = 0.37$. These results showed that the local kinematics of biological-motion signals play a partial role in the observed effect.

Experiment 6: no contextual-attraction effect elicited by static figures

Some readers may argue that the observed effect highly relies on the viewpoint information of the point-light figures (e.g., a point-light figure facing left or right). To

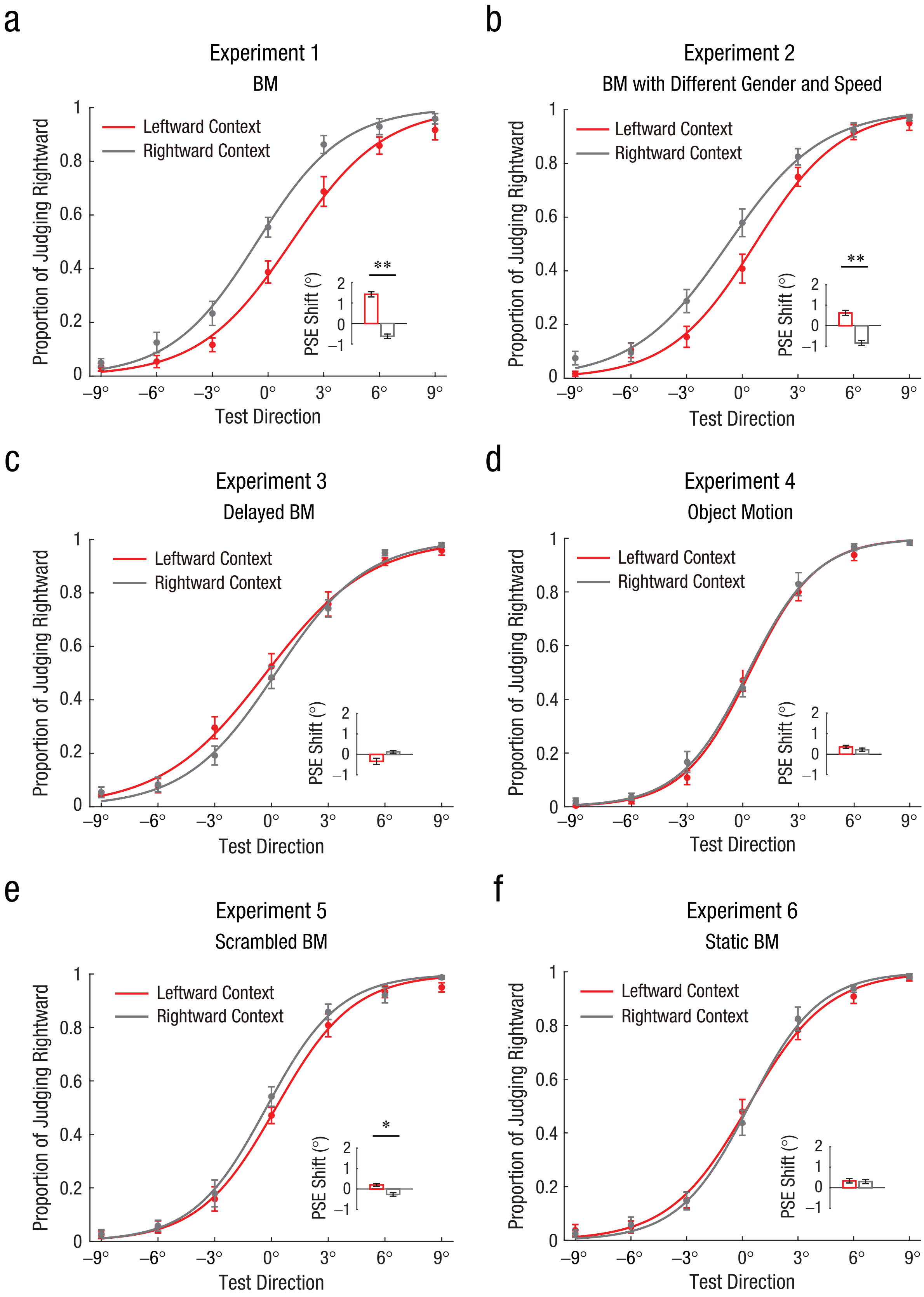

Fig. 2. Results from Experiments 1 to 6 (a–f, respectively). The proportion of responses in which observers reported rightward motion is plotted as a function of the physical walking direction. Data are illustrated for the rightward-context and the leftward-context conditions. Insets indicate the corresponding points of subjective equality (PSEs) for each context condition. Error bars show ±1 *SEM*. Asterisks indicate significant differences between context conditions (**p* = .05, ***p* < .001). BM = biological motion.

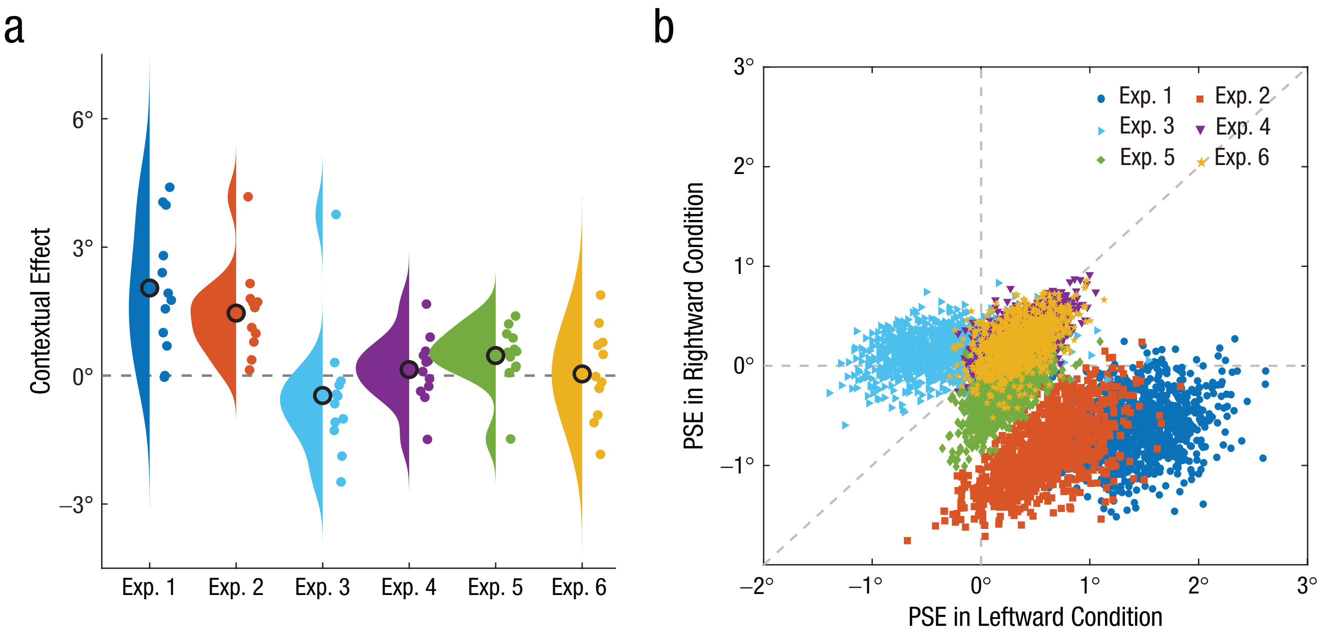

Fig. 3. Comparison for the contextual-attraction effect across all experiments. The contextual effect (a) is shown separately for each of the six experiments. The small colored circles and large open circles respectively represent individual data and the means of the contextual effect. The distribution of individual data (shaded region) was plotted for each experiment using the *Raincloud* plots package (Allen et al., 2019) in MATLAB (The MathWorks, Natick, MA). Bootstrapped points of subjective equality (PSEs) in the leftward- and rightward-context conditions (b) are shown in relation to each other, separately for each experiment.

test this hypothesis, we designed Experiment 6, in which a static biological-motion context was presented. Results showed that both the PSE and difference limen had no significant difference between conditions—PSE: 0.34° vs. 0.30°, $t(11) = 0.13$, $p = .899$, $d = 0.04$, 95% CI for mean difference = [−0.62, 0.70], $BF_{10} = 0.29$ (see Fig. 2f); difference limen: $t(11) = 1.54$, $p = .151$, $d = 0.45$, $BF_{10} = 0.74$. Apparently, the contextual effect was ruined when the surrounding walkers were replaced by static figures.

Comparison for the contextual-attraction effect across all experiments

To further compare the strength of the contextual-attraction effects across experiments, we first calculated the contextual-modulation index for each experiment by subtracting the PSE in the rightward condition from that in the leftward condition (a positive value indicates an attraction effect). Then, we compared the contextual-modulation index across experiments using a one-way analysis of variance, which revealed significant differences, $F(5, 66) = 8.04$, $p < .001$, $\eta^2 = .38$. Post hoc analysis confirmed that the contextual-attraction effects in Experiments 1 and 2 were both significantly larger than those in Experiments 3 to 6 (see Fig. 3a; Experiments 1 and 2 vs. other experiments: all ts > 2.68, all ps < .014, all BF_{10}s > 4.12). For illustration, we constructed a distribution for the PSEs from 1,000 bootstrapped samples of the original data in each experiment (Davison & Hinkley, 1997). As shown in Figure 3b, the PSEs formed two distinct clusters: The bootstrapped sample means in Experiments 1 and 2 completely fell in the lower of the diagonal line, indicating a robust contextual-attraction effect, whereas those in Experiments 3 to 6 lay close to the diagonal line, suggesting a null or weak effect.

Discussion

Perceived social bonds not only affect our daily behavior but also implicitly reshape our perceptual system (Cheng et al., 2021; Liu et al., 2018; Vestner et al., 2019). The present study is the first systematic investigation into the contextual effect of implicitly perceived social bonds. Employing point-light biological-motion stimuli, we found a novel contextual-attraction effect: The perceived direction of a central walker was attractive to the direction of surrounding walkers. Such a contextual-attraction effect was not affected by the similarities between walkers because it occurred regardless of their gender and walking speed. Neither perceptual priming nor response bias was responsible for this effect because it disappeared when the surrounding walkers were presented ahead of the target or were substituted by object motion. Furthermore, this effect partially persisted in a context of local motion but totally vanished in a static figure context. Taken together, these findings verify that the perception of biological behavior highly relies on the social context to which it belongs.

Prior work of contextual modulation has mostly focused on physical relations between objects. It has been well documented that those basic visual properties exhibited a classical repulsion effect, as exemplified by the tilt illusion (Mareschal & Colin, 2012), Ebbinghaus illusion (Chen et al., 2018), and simultaneous brightness contrast illusion (Harris et al., 2011). Specifically, the surrounding environment typically induces a repulsive bias in the percept of a central stimulus. This repulsion effect, which enhances the saliency of the target, could be explained by selective inhibition of the neurons' gain within the primary visual cortex (Clifford, 2014). In contrast to those low-level physical properties, our study demonstrated that the collective motion of biological entities yields a contextual-attraction effect on the perception of walking direction, and this differential effect points to a special mechanism of contextual effect tuned to perceived social bonds.

Biological-motion walking direction should not be simply categorized into a low-level visual feature but essentially reflects the social bonds between group members. The agents who walk toward the same direction are seen as collective motion, ranging from close friends walking at a synchronized pace to soldiers marching in a unified direction, which is ubiquitous in our daily life (Warren, 2018). Thus, the visual system is frequently exposed to a myriad of collective motion. This excessive exposure forms a strong prior experience, which may influence perceptual processing especially when observers are confronted with ambiguous sensory inputs. Specifically speaking, when the direction in which someone walks is ambiguous, humans are inclined to perceptually align their walking direction with that of the crowd. This perceptual bias corresponds to the prior knowledge in their mind, consequently leading to an attraction rather than a repulsion effect.

In addition, given the prevalence of collective motion, it is more parsimonious to encode all the individuals as a whole and generate an ensemble representation. The visual system conforms to a "common fate" principle: Individuals who move together come to be seen as a whole unit (Wagemans et al., 2012). A previous study found that humans are adept at pooling the movement direction from multiple walkers into a cohesive perception. Moreover, to form a harmonious representation of the crowd, they are tolerant of someone's walking direction slightly deviating from the group mean (Sweeny et al., 2013). Researchers have shown that a functional brain mechanism tailored to process collective movement might exist (Cracco et al., 2022). Thus, the observed contextual-attraction effect could also be explained by ensemble representation, which may sacrifice the perceptual accuracy of the central walker in order to maintain the perceived social bonds of the group members.

Notably, we also found that the contextual-attraction effect was partly maintained when the local biological-motion walkers were adopted as inducers (Experiment 5). A wealth of previous research has shown that humans are endowed with an extraordinary ability to detect life motion signals (Thornton & Vuong, 2004), and local kinematic cues rather than global configuration provide more crucial clues in this process (Troje & Westhoff, 2006; L. Wang et al., 2010; Y. Wang et al., 2018). Such ability is conserved across species and even develops early in life (Vallortigara et al., 2005; Vallortigara & Regolin, 2006). Because the local biological-motion cues, which preserve biological significance, can be automatically processed (Troje & Westhoff, 2006; L. Wang & Jiang, 2012; L. Wang et al., 2014; L. Wang et al., 2010), it is therefore possible that the contextual-attraction effect may partly rely on animacy perception. On the other hand, the contextual-attraction effects induced by intact biological-motion contexts (Experiments 1 and 2) were significantly larger than that induced by the local biological-motion context. Thus, the implicitly perceived social bonds in the collective movement of multiple walkers probably play a more prominent role in the observed effect than the animacy perception. Intriguingly, these intangible social bonds triggered by collective behavior are not specific to humankind but are pervasive among many other species, such as a school of fish, a flock of birds, and gregarious primates (Herbert-Read et al., 2011; Strandburg-Peshkin et al., 2015). It would be interesting to investigate whether the contextual-attraction effect can be extended to biological entities of other social species that exhibit collective motion. In addition, although we adopted minimalist stimuli—point-light displays—we believe that the cognitive processing involved in these experiments was not influenced by materials. Accordingly, we expect our results to generalize to more naturalistic stimuli. However, given that our participants were all healthy college students, it is probable that people with social-cognitive disorders such as autism would not perceive them in the same manner (Liu et al., 2018).

More generally, the current study has important implications for understanding higher order social phenomena such as group alignment. Evolutionarily, humans have an instinct to coordinate their behaviors with surrounding crowds, which forms the basis for adaptive survival and social connection (Rennung & Göritz, 2016; Shamay-Tsoory et al., 2019). Similarly, this tremendous power of social bonds to implicitly modify visual perception is most likely attributed to its evolutionary importance. For example, in emergency-escape situations, rapidly detecting the whole direction of a crowd, rather than putting too much weight on an individual's movement, is more helpful for individuals to follow others' steps and initiate the escape response.

In conclusion, we reported a novel contextual-attraction effect that perception of one's walking direction was attracted toward the direction of his or her neighboring walkers. The current findings indicate a specialized contextual mechanism tuned to perceived social bonds, which may essentially reflect an evolutionary-adaptive mechanism that favors implicit perceptual biases in accordance with social alignment.

Transparency

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Author Contributions

All the authors contributed to the study design. Y. Cheng collected and analyzed the data under the supervision of X. Yuan and Y. Jiang. Y. Cheng drafted the manuscript, and W. Liu, X. Yuan, and Y. Jiang provided critical revisions. All the authors approved the final manuscript for submission.

Declaration of Conflicting Interests

The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

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Open Practices

All data and experimental demos have been made publicly available via the Institutional Knowledge Repository, Institute of Psychology, Chinese Academy of Sciences, and can be accessed at http://ir.psych.ac.cn/handle/311026/39958. The design and analysis plans for the study were not preregistered.

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Supplemental Material

Additional supporting information can be found at http://journals.sagepub.com/doi/suppl/10.1177/09567976221091211

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