# Elucidating the Causes of Eye Effect Inconsistency: From the Perspective of Subjective and Objective Factors and Psychological Mechanisms

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## Abstract

The eye effect refers to the phenomenon where individuals' behavioral responses change significantly when presented with direct-gaze eye cues. Existing research has demonstrated that eye cues produce positive effects, including promoting prosocial behavior, reducing antisocial behavior, and enhancing self-awareness. However, the eye effect does not consistently emerge across all studies. Factors contributing to its instability include physiological characteristics of the eyes, emotion types, presentation duration, gaze direction, task interaction format, ambient population size and noise levels, individual self-awareness, group identity, and behavioral costs. The psychological mechanisms underlying the eye effect encompass reputation mechanisms and rule mechanisms, among others. Explaining the causes of the eye effect's instability from the perspectives of influencing factors and psychological mechanisms can provide theoretical insights for achieving stable beneficial outcomes. Future research could further refine the categorization of eye cues to expand the scope of application, integrate cognitive neuroscience techniques to deeply investigate the relevant neural mechanisms, conduct longitudinal comparisons across different developmental stages, and implement field studies to enhance the ecological validity of research in this area.

## Full Text

### The Causes of Eye Effect Instability: A Perspective Based on Subjective and Objective Factors and Psychological Mechanisms

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**Abstract**

The eye effect refers to the phenomenon where individuals' behavioral responses change significantly when presented with direct eye gaze cues. Previous research has demonstrated that eye cues can promote prosocial behavior, reduce antisocial behavior, and enhance self-awareness. However, the eye effect does not always emerge consistently across studies, leading to concerns about its replicability. Factors contributing to this instability include the physiological characteristics of eyes, emotional expression types, presentation duration, gaze direction, task interaction format, number of bystanders, ambient noise, individual self-consciousness, group identity, and behavioral costs. The underlying psychological mechanisms involve reputation mechanisms and rule-based mechanisms. Examining the causes of eye effect instability through the lenses of influencing factors and psychological mechanisms can provide theoretical insights for generating stable beneficial outcomes. Future research should further differentiate types of eye cues to expand applicability, integrate cognitive neuroscience techniques to investigate neural mechanisms, conduct longitudinal comparisons across developmental stages, and carry out field studies to enhance ecological validity.

**Keywords:** eye cues, watching eyes effect, reputation, self-consciousness, psychological mechanisms

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Eye contact plays a pivotal role in social interaction (Hessels, 2020). When individuals feel observed, their behavior changes in various ways. For example, people are more willing to cooperate in public than in private settings (Van Lange & Rand, 2022) and exhibit higher levels of social mindfulness (Van Doesum et al., 2018). Research indicates that even without an actual observer, the mere presence of eye images automatically activates a sense of being watched, putting individuals in an aroused state (Jarick & Bencic, 2019; Prinsen & Alaerts, 2019), enhancing memory (Chen et al., 2022), reducing antisocial behavior (Ayal et al., 2021), and increasing prosocial behaviors such as cooperation (Baillon et al., 2013; Cañigueral & Hamilton, 2019; Dear et al., 2019; Manesi et al., 2016). For instance, displaying an eye-like image on a computer wallpaper (Haley & Fessler, 2005) or posting eye photographs on laboratory partitions (Fenzl & Brudermann, 2021) can increase the amount participants share in dictator games. In real-world settings, eye images produce similar effects: posting eye posters reduces littering (Van Doesum et al., 2021), and individuals voluntarily perform tedious typing tasks to reduce the workload for others (Manesi et al., 2016).

This phenomenon—where presenting direct eye gaze cues leads to significant behavioral changes—is known as the "watching eyes effect" (Nettle et al., 2013). Scholars have progressively refined its definition. Some researchers interpret the effect as a "gaze cueing effect" (GCE), suggesting that eye cues can rapidly shift attention regardless of whether gaze direction matches target location (Zhao Yajun, Zhang Zhijun, 2009). This definition emphasizes how pre-presented gaze cues influence subsequent visual spatial attention, involving both gaze direction and the temporal effects of eye stimuli on behavior. Building on this, Senju and Johnson (2009) proposed the "eye contact effect," referring to how perceived eye contact modulates ongoing and/or subsequent cognitive processes and behavioral responses. This more comprehensive definition encompasses the previous ones, indicating that eye cues affect both immediate and subsequent behaviors or cognition.

However, the eye effect exhibits instability—it is observable in some experiments (Ayal et al., 2021; Baillon et al., 2013; Chen et al., 2022) but absent in others (Rotella et al., 2021; Sparks & Barclay, 2015), raising concerns about its replicability (Northover et al., 2017). For example, some studies found that neither short nor long exposure to eyes influenced moral condemnation (Sparks & Barclay, 2015), that participants' contributions in dictator games did not differ regardless of whether the Eye of Horus was presented (Rotella et al., 2021), and that participants exposed to eyes with different emotions showed no significant difference in risk option selection compared to control groups (Xu Hui et al., 2022). Some researchers attribute this instability to unmeasured moderating variables (Rotella et al., 2021), though which variables specifically cause instability remains unclear.

Although numerous laboratory and field studies on the eye effect exist abroad, empirical research in this direction remains limited in China, with most studies focusing on how eye cues promote cooperation and other prosocial behaviors (Wu Qin, Cui Liying, 2020; Zhang Xuejiao, Liu Conghui, 2017). China's earliest empirical study on the eye effect used a spatial Stroop paradigm to reveal that eye cues involve endogenous attention (Zhao Yajun, Zhang Zhijun, 2009). This experiment established the attentional system underlying eye cues, providing a foundation for subsequent research. However, as typical social cues, eye cues should carry different meanings in specific social interaction contexts. This experimental setting lacked social context, and gaze cues were presented as cartoon faces rather than real human models, limiting ecological validity and failing to fully explain how eye cues affect attentional characteristics in real interactions. Only recently have Chinese studies begun examining the real-time effects of eye cues on social interaction behavior, though more laboratory and field experiments are needed to enrich this research area. This article explores the causes of eye effect instability from the perspectives of influencing factors and underlying mechanisms, revealing reliable pathways to achieve stable benefits. It also analyzes applicable scenarios for eye cues in social life, providing a low-cost, simple, and efficient practical strategy for positively guiding individuals to maintain social harmony.

### 2.1.1 Physiological Characteristics and Emotional Types of Eyes

The physiological characteristics of eyes affect the robustness of the eye effect. From a physiological perspective, individuals take different actions based on eye size, pupil color, scleral exposure index, and other features (Tian Jiayuan et al., 2022; Kret & De Dreu, 2019; Lau et al., 2022). For example, individuals are more willing to approach eyes with large pupils than small ones (Brambilla et al., 2019). This occurs partly because people infer personality traits, trustworthiness, and intentions from faces (Sutherland & Young, 2022; Todorov & Oh, 2021), leading to different decisions. Additionally, varying evaluations of eye attractiveness cause behavioral differences after exposure to different eye cues (Russell et al., 2019). For instance, people perceive individuals wearing square glasses as more competent (Okamura & Ura, 2020) and consequently trust them more. Therefore, to enhance the robustness of the eye effect, experiments should avoid selecting eye cues with polarized physiological characteristics, as alternating such stimuli during presentation may cause cognitive and emotional dissonance that substantially affects behavior.

Eye emotion type also differentially influences behavior. Xu et al. (2022) exposed participants to neutral, positive, or negative emotional eyes and had them make risk decisions under gain and loss frames, finding a moderating effect of negative emotion. Specifically, in the loss frame, participants in the negative emotion eye condition made significantly more risky choices than the other two groups, demonstrating that emotional information conveyed by eyes affects behavior to varying degrees. Two factors may explain this effect. First, different facial emotions evoke distinct brain activation patterns. Stephani et al. (2020) observed that angry faces elicited smaller N170 amplitudes than happy and neutral faces. Second, social interaction constantly involves inferring intentions, personality, and other information, with facial emotion being a common cue for conveying individual intentions (Li Yaning et al., 2021; Liang et al., 2021), attractiveness, and trustworthiness (Calvo et al., 2019; Olszanowski et al., 2019). Individuals respond by inferring information conveyed by different emotional eye cues. Therefore, researchers should consider whether to control for eye emotion type as an extraneous variable in their experimental design.

### 2.1.2 Stimulus Presentation Duration

Stimulus presentation time affects the robustness of the eye effect, which only occurs with brief exposure. Sparks and Barclay (2013) used a dictator game task to find that participants exposed briefly to eye cues gave significantly more money on average than those with continuous exposure, while no significant difference existed between the no-eye and continuous-exposure groups. Three factors may explain this effect. First, when stimuli are repeatedly or continuously presented, individuals gradually habituate to them (Lloyd et al., 2014), weakening their responses. Lapolla et al. (2023) measured skin conductance responses (SCR) and found that SCR decreased as exposure frequency to eye cues increased, confirming a habituation effect. Second, eye cues initially activate individuals' monitoring mechanisms, but as monitoring continues, individuals realize these are false cues that will not substantially affect their behavior and cancel their responses (Haley & Fessler, 2005). Third, the eye effect may be counteracted when gaze direction becomes dissociated from the feeling of being observed (Conty et al., 2016). Direct gaze automatically triggers a sense of being watched upon presentation, but as individuals focus on the image for extended periods, the picture becomes separated from the experience of being observed, diminishing the eye cue's effect. For example, Xu et al. (2022) found no main effect of eye cues on risk decision-making, likely because the long exposure time during instruction reading substantially weakened the eye effect. Additionally, when eye images serve as background stimuli in experiments, extensive internet experience enables individuals to filter irrelevant information, causing eye cues to be processed as inconsequential.

### 2.1.3 Gaze Direction and Experimental Interaction Format

Gaze direction influences the robustness of the eye effect, with direct gaze producing more stable effects than closed or averted eyes. Manesi et al. (2016) found that participants exposed to eye images voluntarily completed all typing tasks to minimize their partner's workload, whereas among those who did not finish all tasks, participants in the direct gaze condition left fewer typing tasks for their partner than those in the closed-eye condition. Different gaze directions not only affect behavior differently but also activate distinct brain regions. Direct gaze elicits stronger activation in the amygdala (associated with fear), orbitofrontal cortex (OFC, associated with anger), medial prefrontal cortex (mPFC, associated with sadness), as well as the fusiform gyrus, posterior superior temporal sulcus (pSTS), and anterior superior temporal sulcus (aSTS) (Zhu Qian et al., 2019). Although gaze direction affects multiple brain regions, how it influences individual regions requires further investigation. For instance, some researchers found that direct gaze elicited larger N170 amplitudes than averted gaze in the anterior superior temporal sulcus (Burra et al., 2017), while others reported the opposite result (Stephani et al., 2020).

Experimental interaction format also affects the eye effect's robustness, with stronger effects occurring during real-person interaction and when participants perceive genuine interaction (i.e., when participants believe they are being observed, regardless of actual interaction). First, the eye effect is stronger in real-person interactions. Behaviorally, Baillon et al. (2013) found that only participants who interacted with eye images gave more money to strangers. Hietanen and Hietanen (2017) similarly confirmed that self-awareness differed only when participants viewed real people with direct or averted gaze, not when watching corresponding video clips. Neurophysiologically, Myllyneva and Hietanen (2015) found that when real persons' faces served as stimuli, participants showed greater autonomic arousal, faster heart rate deceleration, and larger cortical P3 responses to direct versus averted gaze, effects absent when faces were displayed only on computer screens. This suggests that Xu et al.'s (2022) failure to find an eye effect may partly stem from the lack of genuine interaction. Second, perceived genuine interaction produces effects equivalent to real-person interaction. Hietanen et al. (2020) found that real-time video interaction elicited the same autonomic arousal as live interaction, whereas unidirectional video viewing did not enhance arousal. Thus, the eye effect's varying responses depend on observers' psychological attributions, with the crucial factor being participants' belief that they are being observed during interaction. This phenomenon also occurs in children: Okumura et al. (2023) found that children allocated more stickers to others when observed by an interactive robot than by a non-interactive robot or in a control condition, indicating that even young children can distinguish between being observed in interactive versus non-interactive contexts. To address the eye effect's instability, researchers should use direct gaze stimuli and ensure participants believe they are engaged in genuine interaction.

#### 2.1.4 Behavioral Costs

Behavioral costs influence the robustness of the eye effect, which is more pronounced when costs are low. Social interactions, particularly prosocial behaviors, inevitably involve behavioral costs (Engel & Van Lange, 2021; Van Lange & Manesi, 2023), such as money, resources, and potential risks (Manesi et al., 2019). When behavioral costs are low, actors can benefit directly with minimal effort—so-called "effortless actions." When costs are high, substantial effort may not yield obvious benefits (Van Doesum et al., 2021). Research on prosocial behavior finds that various manipulations are more effective at increasing prosocial behavior when costs are low rather than high. The eye effect is no exception: eye cues more effectively enhance low-cost prosocial behaviors, explaining why the effect is sometimes unobservable in prosocial experiments (Manesi et al., 2019). To improve the eye effect's stability, researchers should maintain low behavioral costs when studying prosocial behavior.

#### 2.1.5 Number of Bystanders and Ambient Noise

The number of bystanders affects the eye effect's robustness, with fewer people producing more significant effects. For example, posting eye-image posters in university cafeterias increased the likelihood that people would clean up after meals, with the effect being stronger when fewer people were present (Ernest-Jones et al., 2011). In supermarkets, cartoon eye images increased customer donations by 48% compared to star images, with stronger effects during quiet rather than busy periods (Powell et al., 2012). Two factors may explain this effect. First, stimulus saturation occurs when the mere presence of others provides strong surveillance, weakening the eye cue's effect (Ernest-Jones et al., 2011). Second, the bystander effect suggests that large crowds lead to diffusion of responsibility, so individuals do not change their behavior even when feeling observed (Guo Qingqing et al., 2020). Conversely, when crowds are too large, individuals may believe they are unnoticeable in the chaos. When anonymity is too high (Van Lange & Manesi, 2023), eye cues lose their effect.

Ambient noise also influences eye cue effectiveness. In Haley and Fessler's (2005) experiment, researchers controlled noise by asking participants to wear noise-canceling headphones during a one-shot dictator game, finding that low-level artificial noise enhanced the eye effect. This may be because laboratory noise implies the presence of others, reducing anonymity and making individuals feel potentially observable. If participants believe they are in a completely anonymous condition, eye cues have no effect. Amrish et al. (2017) supported the importance of anonymity, finding that attention to eyes increased generosity only when donations were public rather than anonymous. Additionally, noise as a subtle social cue combines with eye cues to increase the feeling of being observed. However, excessive noise can impair cognition (Kruglanski & Webster, 1991), causing participants to focus on the most salient aspects of the situation and ignore subtle eye cues. The noise threshold that affects the eye effect remains unknown.

### 2.2.1 Individual Self-Consciousness

Even in strictly controlled laboratory experiments, the eye effect remains unstable because it is also influenced by individual self-consciousness. Self-consciousness refers to individuals' awareness of their internal or external environment (Duval, 1976), comprising private self-consciousness (attention to one's inner feelings, thoughts, and memories) and public self-consciousness (concern with how others view oneself) (Fenigstein et al., 1975). Public self-consciousness is the primary component affecting the eye effect, as individuals high in public self-consciousness care more about their performance in front of others. For example, Pfattheicher and Keller (2015) told participants they could anonymously donate any portion of their earnings to help AIDS patients, finding that eye cues significantly increased donations among those with high public self-consciousness but had no effect on those with low public self-consciousness.

In addition to between-individual differences in self-consciousness, the same individual's level of self-consciousness can vary across situations. The previously mentioned self-consciousness is a relatively stable trait, whereas another form of self-consciousness (self-awareness) can be activated situationally. To distinguish them, we refer to the former as "trait self-consciousness" and the latter as "state self-consciousness" (Govern & Marsch, 2001). Sun et al. (2020) examined how eye cues affect altruistic behavior in a dictator game and activated participants' state public self-consciousness through a sentence-unscrambling task. They found that participants exposed to eye images allocated more tokens to others than those exposed to cloud images, demonstrating that eye cues promote altruistic behavior. Activating state public self-consciousness produced the same effect, supporting the finding that the eye effect is more pronounced for individuals with stronger public self-consciousness (Pfattheicher & Keller, 2015). However, this experiment used the Eye of Horus, a stimulus commonly used in early foreign research but lacking ecological validity compared to later widely used real human eye images. Additionally, Park et al. (2022) presented eye icons in news website comment sections to observe whether eye cues affect users' self-attention, finding that eye cues enhanced women's self-awareness compared to no-eye conditions. Thus, the subtle eye effect emerges partly because exposure to eye cues activates state self-consciousness to varying degrees across individuals.

Currently, no research has examined both types of self-consciousness and the eye effect within a unified framework. This article preliminarily establishes a relationship diagram between the eye effect and self-consciousness (see Figure 1 [Figure 1: see original paper]). As shown, trait self-consciousness influences the eye effect, while activation of state self-consciousness is an outcome of eye cues. Different levels of state self-consciousness activation subsequently produce different behavioral effects. This supports Pfattheicher and Keller's (2015) suggestion that inconsistent behavioral effects of eye cues may result from differences in individuals' trait self-consciousness or varying activation levels of state self-consciousness.

### 2.2.2 Group Identity

From the individual's perspective, group identity among interaction members is another factor influencing eye effect instability. Eye cues only enhance altruistic behavior toward in-group members; the eye effect appears when interacting with in-group members but disappears with out-group members. For example, Mifune et al. (2010) divided participants into in-group and out-group members and had them play a dictator game with or without eye cues. Results showed that in the eye condition, participants allocated more money to in-group than out-group members, whereas no such difference appeared in the control condition. Although people generally treat in-group members more kindly and cooperatively than out-group members (in-group bias; Xu et al., 2020), the absence of in-group bias in the no-eye condition in this experiment rules out this alternative explanation.

Group identity affects the eye effect likely because eye cues as surveillance signals make individuals concerned about the consequences of their actions, such as whether they will gain a good reputation (Mifune et al., 2010). When individuals realize the other person is not an in-group member, reputation concerns diminish, rendering eye cues ineffective. However, differential treatment of in-group versus out-group members cannot be entirely attributed to reputation concerns. Everett et al. (2015) found that even when decisions were completely anonymous and could not yield reputation benefits, participants were still more prosocial toward in-group than out-group members. This can be explained by the social heuristics hypothesis, which posits that past successful behaviors become internalized and automatically activate when individuals enter corresponding situations (Shi Rong, Liu Chang, 2019), with eye cues facilitating this process. Therefore, when studying the eye effect in groups or collecting data from multiple participants simultaneously, researchers should assess participants' perceptions of group identity. If some individuals in the same study classify interaction partners as out-group members while others classify them as in-group members, and researchers fail to account for this factor or differentiate the results accordingly, eye effect instability may result.

### 2.3 Summary

In summary, factors causing eye effect instability include eye emotion type, physiological characteristics, presentation duration, gaze direction, experimental interaction format, behavioral costs, number of bystanders, ambient noise, group identity, and individual self-consciousness. Moreover, potential interactions may exist among these factors, such as between group identity and self-consciousness. Individuals whose state public self-consciousness is activated by eye cues may better follow social norms or, from a reputation maintenance perspective, act prosocially toward in-group members. Interactions also exist between gaze direction and self-consciousness, as people automatically follow others' gaze (Niedźwiecka, 2020). Averted gaze directs attention to the environment, so individuals' public self-consciousness is not enhanced (Hietanen & Hietanen, 2017), whereas direct gaze signals attention, directs focus inward, and increases self-consciousness, producing the effect. Additionally, connections exist between the number of bystanders and noise, as these factors are difficult to separate in field experiments—places with more people typically have more noise, making it challenging to determine whether crowd size or noise causes eye effect instability.

Overall, in social interactions, people tend to obtain information by observing others' eyes, inferring characteristics, attention, and intentions from eyes' physiological features, emotional types, and gaze direction (Lau et al., 2022). When direct gaze is presented, individuals redirect attention to themselves, enhancing state self-consciousness and prompting greater attention to and reflection on their performance. This demonstrates that eye cues play an important role in shaping individual consciousness and self-perception. Controlling for eye emotion type and physiological characteristics as extraneous variables in experiments can help resolve eye effect instability. To produce more obvious behavioral changes, direct gaze is more effective than averted gaze.

When eye cues are continuously presented, individuals realize they are not actually being supervised or attended to, weakening responses to irrelevant cues and causing the eye effect to disappear. This reveals individuals' adaptive capacity to eye cues, which can be attributed to mechanisms for filtering and processing environmental cues. After processing, individuals cancel responses to non-substantive cues (Haley & Fessler, 2005) to focus on task-relevant information. This may also relate to attentional resource allocation mechanisms—when the brain recognizes eye cues as irrelevant, it no longer allocates attentional resources. Therefore, to address eye effect instability, researchers should focus on individuals' feeling of being observed and present stimuli only when participants need to respond, avoiding overly long presentations.

In the internet era, the human brain automatically blocks numerous online distractors, a skill that transfers smoothly to offline environments. When individuals know they are performing an individual task rather than interacting with a real person, or when too many people are present or noise is excessive, they realize they are not the focus of attention. The subtle sense of being observed provided by eye cues no longer influences individuals, and eye cues are treated as irrelevant information, making the eye effect unstable. Experiments should avoid overly crowded locations and maintain moderate ambient noise. Table 1 summarizes the factors affecting the eye effect and proposes measures to improve its instability.

### 3.1 Reputation Mechanism

The most widely accepted mechanism for how the eye effect increases cooperation and other prosocial behaviors is that eye cues trigger a sense of being watched, activating the reputation mechanism and prompting reputation concerns that lead to behavioral changes. This can be decomposed into two perceptual processes: first, generating a sense of being watched, and second, activating the reputation mechanism and triggering reputation concerns. Only when both conditions are met does the eye effect operate through the reputation mechanism.

First, eye cues trigger a sense of being watched that leads to behavioral changes. For example, Pfattheicher and Keller (2015), building on the spotlight effect, confirmed that subtle eye cues indeed induce a sense of being observed. This may relate to human evolution: in the past, people observed eyes to detect whether opponents were targeting them; today, during social interaction, we first perceive others' emotions and states through their eyes. Consequently, eye cues have gained unique advantages over other facial regions, with the brain selectively prioritizing their processing (Guy & Pertzov, 2023; Wang et al., 2019). Over time, eyes have become special social surveillance cues, with mere exposure creating a sense of being supervised. Similarly, Kelsey, Vaish, and Grossmann (2018) posted posters with eyes, noses, mouths, or chairs behind transparent donation boxes in a museum and, comparing 28 weeks of data, found that average donations per person were highest in the eye poster condition. This demonstrates that eyes have a specific influence on humans beyond other facial features.

Second, eye cues activate the reputation mechanism and trigger reputation concerns that lead to behavioral changes. Reputation is a social construct based on how we believe others view us and our desire to make good impressions. When being watched, acting in ways that benefit others or conform to social norms not only brings direct benefits such as recognition and praise but also potential gains like maintaining a good reputation and expecting future help or rewards (Xin et al., 2016). Accordingly, Botto and Rochat (2019) proposed that people care about reputation due to evaluative audience perception (EAP)—the tendency to seek positive evaluation. When people view others as evaluators, they attend to their reputation and adjust their behavior. According to the evolutionary legacy hypothesis, adjusting behavior when observed initially evolved to prevent aggression and later transformed into protecting our reputation in social groups (Zhan Youlong et al., 2022). We can infer that if individuals' reputations are not at stake or if some individuals do not care about others' evaluations, the eye effect becomes unstable. For example, Everett et al. (2015) had participants play modified dictator games under public and anonymous conditions, finding more prosocial behavior in public than anonymous decisions. Therefore, if individuals clearly know they are in a completely anonymous state where their reputation is not threatened, eye cues cannot function. If participants have sufficient time or energy before decision-making to repeatedly remind themselves that behavioral outcomes will not be observed, the reputation impact of eyes is counteracted. Additionally, if individuals are highly independent or self-interested individualists who do not attend to others' evaluations, eye cues become ineffective (Luo et al., 2016). Based on this, when applying eye cues, researchers should consider limiting response time and preventing individuals from realizing they are completely anonymous if the eye effect shows instability. They can also use scales or interviews to differentiate individuals with different traits. In daily life, this principle can be used in reverse: given online anonymity and group polarization, netizens hold diverse views on controversial issues and easily argue. To prevent public opinion from escalating and affecting normal development of events, adding eye images in comment sections of trending topics can reduce users' anonymity, trigger reputation concerns, and promote perspective-taking to maintain a harmonious online environment.

### 3.2 Rule Mechanism

Another common explanation for the eye effect is rule psychology: humans have evolved psychological mechanisms for learning and following social norms (House et al., 2020) and punish norm violations (Yang Shasha, Chen Sijing, 2022). Eye images not only make people tend to act according to environmental norms but also reduce tolerance for norm-violating behavior. Therefore, when feeling observed, people prioritize norm compliance (Bateson et al., 2015), such as becoming less likely to litter where eye posters are displayed (Bateson et al., 2015; Ernest-Jones et al., 2011) and showing improved waste sorting accuracy when eye images are added to recycling signs (Lotti et al., 2023). However, eye cues are more effective at reducing littering than improving recycling, possibly because littering is a more obvious norm violation with greater potential negative consequences than improper waste sorting. Beyond reducing norm violations, eye cues can promote proactive contributions even at personal cost. For example, Sénémeaud et al. (2017) found that printing eye photos on blood donation flyers tripled students' likelihood of donating blood.

However, some individuals' perceived norms may differ from actual norms, creating normative misperception (Cox et al., 2019). Individuals with normative misperception who act according to their perceived norms will show different behavioral effects than others, leading to eye effect instability (Shi Huiying et al., 2022). For example, in various economic games, Northover et al. (2017) treated any sharing as the social norm, meaning the amount shared was irrelevant. In contrast, Andreoni and Bernheim (2009) considered the amount shared, arguing that the norm in game tasks was fairness—minimizing inequality between giver and receiver. Given that norm perception is not uniform, results vary, causing fluctuations in the eye effect's robustness. Additionally, according to innovation diffusion theory, varying prevalence of prosocial norms across populations leads to inconsistent eye cue effects across individuals (Shi Huiying et al., 2022). The eye effect is particularly unstable when everyone believes a behavior's prevalence is low. Therefore, practice should assess individuals' perceived norms and consider behavioral prevalence. The eye effect is more stable when a behavior is widely practiced and norm perception is consistent. Furthermore, rule mechanisms can be applied in daily life: in rural intersections without surveillance cameras, appropriate placement of eye cues can make drivers more likely to follow traffic rules and hesitate before violations.

Reputation and rule mechanisms complement each other: people both avoid punishment and seek rewards. For example, Oda et al. (2011) surveyed participants in dictator games and found that the eye effect's influence was not driven by fear of punishment but was moderated by expectation of rewards. However, more research indicates that the negative motivation to avoid potential punishment from norm violations far outweighs the positive motivation to seek rewards. For instance, the eye effect appears more consistently in reducing undesirable behaviors than in increasing prosocial behavior (Rotella et al., 2021). Prosocial lies occur frequently in daily life, but Oda et al. (2015) found that people's tendency to tell prosocial lies disappeared under eye conditions. Although prosocial lies benefit others, they are essentially lies, and lying is considered a norm-violating undesirable behavior. Therefore, when seeking rewards requires risking norm violation under eye cues, altruistic motivation weakens and rule mechanisms dominate. Additionally, Nettle et al. (2013) found in a dictator game that eye cues only increased the likelihood of donation without changing the overall average donation amount. This suggests that eye cues made people who normally would not donate start donating, but those who already donated did not donate more due to eye cues. Those unlikely to donate, when feeling observed, changed from not donating to donating due to concerns about negative evaluation (e.g., being seen as "unsympathetic" or "selfish").

## 4 Research Outlook

In summary, eye cues significantly affect social behavior under interactive conditions. This article provides important insights for generating stable benefits from eye cues based on perspectives of influencing factors and psychological mechanisms. While it is clear that eye cue presentation duration and ambient noise affect the eye effect's robustness, the threshold values for noise and boundary values for presentation time remain unknown and require future exploration to improve stability. Additionally, future research can enhance the eye effect's robustness in four further aspects.

### 4.1 Distinguishing Stimulus Differences and Enriching Cue Types

The types of eye cues require further enrichment. First, future research should differentiate real human eyes from cartoon eyes and robot eyes to examine whether real eye images have specific effects or whether different categories of eye elements can consistently influence behavior. Studies have found that posting animal eye images on zoo trees can reduce littering (Van Doesum et al., 2021). However, cartoon figures and robots lack the animacy of animals, and whether their eyes produce similar effects requires future investigation. Second, previous studies used only static eye images. To better match ecological contexts, future research could dynamically process static eye images, such as brief gaze shifts back to direct gaze and blinking (Stephani et al., 2020), to observe whether more natural eye stimuli can produce the eye effect.

Additionally, whether differences in individuals' comprehension of eye stimuli affect the eye effect's robustness requires further study. Early research used the Eye of Horus from foreign mythology, which symbolizes divinity. If participants do not understand its meaning and interpret the icon as random lines, this may cause eye effect instability. However, Xin et al. (2016) used minimal social cues to minimize the social 暗示强度 of eye cues and still found the eye effect. Participants exposed to a face-like three-dot pattern " " showed higher trust in others during imagined and actual game tasks than those exposed to a neutral three-dot pattern " ", suggesting that processing face-like cues may be an unconscious and automatic cognitive process (Jin Hua et al., 2022; Breil et al., 2022). However, whether processing of explicit eye cues differs from processing of ambiguous face-like cues requires more direct comparison within the same study.

### 4.2 Combining Individual Differences to Investigate Neural Mechanisms

The neural mechanisms underlying the eye effect require deeper investigation. Both anticipation of future rewards and fear of social punishment can cause behavioral changes, but which dominates in the eye effect remains unclear. If the motivational avoidance system is activated, EEG shows higher activation in the right frontal cortex than the left; conversely, activation of the motivational approach system shows the opposite pattern (Hassan et al., 2020). Some research found that direct gaze leads to higher left frontal alpha activation, suggesting the eye effect operates through the motivational approach system (Hietanen et al., 2008). However, Niedźwiecka (2020) proposed that the eye effect's approach-avoidance outcomes relate to individual traits: individuals lower in neuroticism activate approach motivation after eye cue exposure, while those higher in neuroticism activate avoidance motivation. Thus, different traits lead to different dominant systems, and varying degrees of system activation may cause eye effect instability. Future research should combine individual differences with cognitive neuroscience techniques to explore the degree of involvement of different motivational systems.

Beyond motivational system differences, the neural mechanisms underlying group identity and self-consciousness also require investigation. The brain automatically groups self and others and classifies members as in-group or out-group (Ma & Tan, 2023). However, different individuals may have varying levels of group involvement after automatic classification, leading to decision differences. Therefore, when multiple participants are present in a room, investigating the neural mechanisms related to group belonging can clarify different individuals' attitudes toward group identity and observe how this affects the eye effect, thereby improving its stability. Additionally, although state self-consciousness is activated by situations, why different individuals show varying activation levels under the same experimental setup requires future cognitive neuroscience research to further understand the neural mechanisms underlying eye effect instability.

### 4.3 Distinguishing Developmental Stages for Longitudinal Comparison

The eye effect should be studied separately across developmental stages. Research has found the eye effect is strongest among middle school and university students but non-significant in middle-aged and elderly populations (Wang et al., 2023), indicating that the eye effect's robustness is influenced by participants' age. If the eye effect is learned through experience, it should not affect children with limited social experience but should strengthen as social experiences accumulate. However, studies show that even three-year-old children are more prosocial after eye exposure than after flower exposure (Kelsey, Grossmann & Vaish, 2018), and infants also show eye effects: different facial regions affect infants' word learning (Belteki et al., 2022). Thus, the eye contact effect may be a universal phenomenon in early life. Nevertheless, different mechanisms may operate at different developmental stages (Niedźwiecka, 2020), though how these mechanisms affect the eye effect remains unclear. Future research could use more fine-grained age groups to investigate the mechanisms behind the eye effect across developmental stages, thereby improving its stability.

### 4.4 Combining Cultural Differences and Conducting Field Studies

Research indicates that the eye effect is moderated by participants' cultural backgrounds (Zhang et al., 2021), suggesting that East-West cultural differences may affect the eye effect's robustness in Chinese field settings. Highly independent cultures encourage people to act according to their own will, whereas collectivist cultures emphasize following group norms, making individuals more concerned about how others view their behavior (Markus & Kitayama, 1991). These cultural differences lead to varying tendencies to manage reputation, thereby affecting the eye effect's robustness. Chinese people in collectivist cultures pay more attention to the impressions they leave on others and have higher public self-consciousness than Westerners, potentially making the eye effect more pronounced in some contexts. While many field studies on the eye effect exist abroad, domestic field research remains underdeveloped. Future research should advance field investigations in China to improve ecological validity and conduct cross-cultural comparisons with foreign studies to clarify the degree to which cultural differences affect the eye effect's robustness. For example, researchers could add eye images to posters reminding people to "reduce waste" in cafeterias and observe whether food waste decreases, quantifying and comparing East-West differences. Alternatively, they could place eye cues at unmonitored intersections to observe whether vehicles stop at red lights when no one is present, comparing behavioral change frequencies across cultures.

Beyond different tendencies to manage reputation, people from different cultures may experience different emotions after eye cue exposure. Chatterjee and Vartanian (2014) found that direct gaze can cause higher activation in the ventral striatum, a brain region associated with reward and positive emotion (Zhu Qian et al., 2019), suggesting eye cues may operate through positive emotion. However, Hadjikhani et al. (2017) found that individuals making eye contact show enhanced amygdala activation, which is associated with fear and negative emotion, suggesting eye cues may induce fear. Which emotion mediates the eye effect remains unresolved. More importantly, while previous studies converted eyes to grayscale to eliminate color-related emotional responses, gray-white faces may more easily evoke negative emotions such as sadness or fear in Chinese contexts. Therefore, future research should investigate the emotional mechanisms related to the eye effect across different cultural groups, which can also broaden the eye effect's applicability in China and uncover its deeper social significance.

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*Note: Figure translations are in progress. See original paper for figures.*