Ocular Cues and Their Effects in Facial Personality Perception

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Abstract

People often make personality inferences based on others' facial features. Among the facial features that influence face-personality perception, eye features are the most complex. Overall, eye cues can be divided into two major categories: changeable and unchangeable. Changeable cues include gaze direction, eyelid openness, and expressions in the eye region, among others; unchangeable cues include eye size, degree of sclera coloration, iris color, and sclera exposure index, among others. From the perspective of the underlying mechanisms of these cue effects, eye cues can be further categorized into three types: those influenced by pathological factors, those associated with specific groups, and those regulated by subjective consciousness or physiological factors. Furthermore, it also identifies other eye feature effects that warrant consideration in future research, along with research perspectives requiring further expansion and in-depth investigation.

Full Text

Eye Cues and Their Effects in Face-Personality Perception

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Abstract

People often make personality inferences based on others' facial features. Among the facial features that influence face-personality perception, eye features are the most complex. Overall, eye cues can be divided into two broad categories: changeable and invariant. Changeable cues include gaze direction, eyelid openness, and eye region expressions, etc.; invariant cues include eye size, sclera

coloration, iris color, and sclera exposure index, etc. From the perspective of underlying mechanisms, eye cues can be categorized into three major types: cues affected by pathological factors, cues associated with specific groups, and cues regulated by subjective awareness or physiological factors. Additionally, we point out that future research needs to consider effects of other eye characteristics and expand research perspectives.

Keywords: face, personality perception, eye

"The eyes are the windows to the soul," and observing a person' s eyes is a preferred way to understand their psychological states and characteristics. Research on face perception has confirmed the special importance of the eye region. For instance, people are particularly sensitive to changes in eye cues when processing faces (王哲等, 2022; Tanaka et al., 2014), and face integration perception is centered on the eye region (Rossion, 2009). Moreover, compared to other local features (such as nose, mouth, and chin), eyes have the greatest influence on face perception (Diego-Mas et al., 2020). When people make personality inferences based on others' faces (face-personality perception) (李东等, 2022), they conduct more complex analyses of eye cues. This paper reviews eye cues and their effects in face-personality perception. The eye region is defined following Calvo et al. (2013) (as shown in Figure 1 [Figure 1: see original paper]).

According to Haxby et al.' s (2000) distributed neural system theory for face perception, facial features are divided into changeable and invariant features. Regarding the brain regions that process facial features, changeable features are processed by the superior temporal sulcus, while invariant features are processed by the lateral fusiform gyrus. In terms of the function of facial features themselves, changeable features (such as gaze direction, expression, and lip movements) can convey various social signals (Pitcher & Ungerleider, 2021), whereas invariant features indicate individual identity information (Haxby et al., 2000). In appearance, individuals can voluntarily alter changeable features through movement; in other words, changeable features are regulated by subjective awareness (e.g., gaze direction and expression) or physiological factors (e.g., pupils), while invariant features are relatively static. The essence of face-personality perception is that perceivers make inferences about the personality of the perceived based on the perception of facial identity (invariant features) and recognition of facial social signals (changeable features). Therefore, dividing eye cues into changeable and invariant cues helps further understand the similarities and differences in their effects. In this paper, changeable eye cues include gaze direction, eyelid openness, eye expression, and pupil size; invariant eye cues include iris color, eye size, sclera exposure index, limbal ring, sclera coloration, and eye adornments (Figure 2 [Figure 2: see original paper] illustrates some lesser-known eye cues).

Regarding the perceptual effects triggered by eye cues, this paper mainly discusses two types of perceptual content. The first is personality inference, which

includes dimensions or traits representing intention (such as trustworthiness, approachability, honesty, and warmth) and dimensions or traits representing the ability to fulfill intentions (such as dominance, competence, and intelligence) (李东等, 2022; Todorov et al., 2005). The second is attractiveness evaluation; although attractiveness evaluation is not personality inference, it has an important influence on personality inference (Zebrowitz & Montepare, 2008). Additionally, while age and health judgments are not personality inferences either, they are important factors influencing facial attractiveness (张超等, 2022; Brown & Sacco, 2018) and will also be mentioned in this paper.

2.1 Gaze Direction

Research shows that faces with direct gaze are perceived as more trustworthy, approachable, and attractive than those with averted gaze (Montoya et al., 2018; Willis et al., 2011; Wyland et al., 2010). The neural mechanisms underlying this effect have been partially revealed. Hietanen et al. (2008) found that direct gaze conditions evoked higher activation of the left frontal α-wave, whereas averted gaze conditions showed higher activation of the right frontal α-wave. Higher EEG activation in the left frontal cortex compared to the right reflects activation of the approach motivation system; conversely, higher right-side activation indicates activation of the avoidance motivation system (Hietanen et al., 2008; Hassan et al., 2020). These findings suggest that a perceived person' s gaze direction can influence the perceiver' s approach-avoidance motivation, which in turn reflects the perceiver' s evaluation of the perceived' s trustworthiness and approachability (Todorov, 2008). Furthermore, Kampe et al. (2001) discovered that direct gaze elicited higher activation in the perceiver' s ventral striatum compared to averted gaze. The ventral striatum, as part of the reward-related neural circuit, may underlie positive emotional experiences (朱千等, 2019). For perceivers, facial attractiveness refers to the positive and pleasant emotional experience evoked by a target' s face and the motivation to approach (尚俊辰等, 2018).

2.2 Eyelid Openness

Eyelid openness (as shown in Figure 3 [Figure 3: see original paper]) is defined as the ratio of the distance from the pupil center to the upper eyelid (vertical white line) to the distance from the left to right eye corner (diagonal white line) (Talamas et al., 2016). Research indicates that sleep deprivation reduces eyelid openness, causing drooping eyelids (Talamas et al., 2016), and sleep-deprived individuals tend to receive lower ratings of health and facial attractiveness (Axelsson et al., 2010). Accordingly, perceivers likely make generalized judgments about others' health based solely on eyelid openness, which in turn influences their evaluation of facial attractiveness—a hypothesis that awaits experimental investigation.

Eyelid openness can indirectly influence perceivers' judgments of intelligence

traits through the halo effect of facial attractiveness (de Houwer et al., 2019; Talamas et al., 2016; Zebrowitz & Montepare, 2008), but it can also directly affect intelligence assessments (Talamas et al., 2016). Talamas et al. (2016) manipulated eyelid openness for faces of the same identity and asked participants to rate intelligence traits, finding that lower eyelid openness received lower intelligence ratings. To strengthen their case, the researchers had participants rate faces of the same individual in different states (normal sleep vs. sleep-deprived), revealing that sleep-deprived states showed lower eyelid openness and consequently lower intelligence ratings. Perceivers can accurately judge others' intelligence from eyelid openness likely due to overgeneralization—the belief that droopy-eyed individuals are tired and unintelligent (Talamas et al., 2016). In reality, sleep-deprived individuals do have smaller eyelid openness than well-rested people (Sundelin et al., 2013; Talamas et al., 2016), and sleep deprivation does cause cognitive decline (Galván, 2020; Newbury et al., 2021; Talamas et al., 2016).

2.3 Eye Expression

Changes in eye expression involve cues such as eyebrows, pupils, eye whites, periorbital muscles (李帅霞等, 2017), and variations in eyelid openness (Kruger & Piglowski, 2012). Since both eyes (Duan et al., 2020) and expressions (Liang et al., 2021) can reveal individual intentions, eye expression serves as an important cue for reflecting intentionality. In the two-dimensional model of face-personality perception, the dimension reflecting the perceived's intention constitutes the first dimension, with trustworthiness being the most typical trait within it (Todorov & Oh, 2021). Thus, eye expression cues are also crucial for facial trustworthiness judgments.

For example, Fernández-Martín et al. (2017) presented participants with a 1-second smiling expression, followed by a 1-second mixed eye expression created by blending one of six eye expressions (surprise, fear, sadness, etc.) with a smiling eye expression at 50% intensity each, while keeping other facial regions constant. Participants rated the face's trustworthiness. Results showed that smiling eyes blended with surprise or neutral expressions received the highest trustworthiness ratings, while blending with angry expressions received the lowest. Ratings for blends with fear, sadness, and disgust fell between these extremes with no significant differences among them (Fernández-Martín et al., 2017). This rating hierarchy likely occurs because surprise and neutral expressions are neutral in valence and non-threatening compared to fear and sadness (negative but non-threatening) or anger and disgust (negative and threatening). Trustworthiness evaluation precisely involves overgeneralized perception of positive and negative emotions (Oosterhof & Todorov, 2008). Of course, eye expression cue effects are not limited to trustworthiness evaluation. Researchers have found that genuine smiles produce higher ratings of attractiveness and intelligence than fake smiles when other facial regions remain unchanged (Quadflieg et al., 2013).

2.4 Pupil Size

Hess (1975) showed male perceivers images of the same female identity with different pupil sizes and asked for descriptive evaluations, finding that men perceived women with larger pupils as more attractive. This phenomenon can be explained from two perspectives. First, dilated pupils are one manifestation of increased sexual interest, which perceivers interpret as sexual attractiveness, leading to higher facial attractiveness ratings (Hess, 1975). However, this conclusion is based on male perception of female faces; whether the same holds for female perception of male faces remains to be explored. Second, the cause of pupil constriction is associated with aging phenomena such as atrophy of the Edinger-Westphal nucleus and sleep disorders. Therefore, pupil size may influence perceivers' judgments of the perceived' s age, thereby affecting facial attractiveness evaluations (Gründl et al., 2012).

3.1 Iris Color

In daily life, we use the term "blond hair and blue eyes" to describe Caucasian appearance, where "blue eyes" actually refers to iris color. Iris color is a genetic marker of race and heredity (Mackey, 2022). Recognizing iris color helps individuals avoid making erroneous investments in others' offspring (Bressan, 2021; Laeng et al., 2007). For example, research has found that light-eyed men perceive light-eyed women as more facially attractive than brown-eyed women, particularly when considering them as long-term partners. Moreover, light-eyed men fear light-eyed male competitors more than brown-eyed men do (Bressan, 2021). Another perspective suggests that individual preferences for iris color represent an imprinting-like phenomenon (Štěrbová et al., 2019). Imprinting refers to the tendency of newborn animals to follow and become attached to the first moving creature they see (刘良华, 2019). For instance, individuals prefer partners with eye colors similar to their parents' , especially under long-term mating strategies (Štěrbová et al., 2019).

On the other hand, because iris color marks race, and different races have different facial characteristics, iris color itself may have no direct effect on face-personality perception but rather exerts its influence through specific facial features. Kleisner et al. (2010) found that although brown-eyed male faces were perceived as more dominant than blue-eyed male faces, the cause of higher dominance ratings was not iris color itself but rather facial features associated with brown eyes (as shown in Figure 4 [Figure 4: see original paper]), and this result was not affected by the perceiver' s own eye color. Subsequently, Kleisner et al. (2013) further discovered that eye color itself had no significant effect on trustworthiness ratings, but male faces with blue eyes were perceived as less trustworthy, while those with brown eyes were perceived as more trustworthy. The researchers suggested that compared to brown-eyed men, blue-eyed men may have been exposed to higher prenatal estrogen levels, resulting in lower facial masculinization (Kleisner et al., 2013). Lower masculinized faces receive lower dominance ratings (Richardson et al., 2021; Torrance et al., 2018). Addi-

tionally, blue-eyed male faces have downward-turned mouth corners and smaller eyes, leading to lower trustworthiness ratings (Kleisner et al., 2013).

3.2 Eye Size

Eye size is measured as the ratio of the vertical distance between eyelids (sum of distances from pupil center to upper and lower eyelids) to face length (distance from hairline to chin), multiplied by the ratio of eye width (distance between left and right eye corners) to face width (distance between cheekbone vertices) (Cunningham, 1986; Talamas et al., 2016). Since eye expression affects eye size measurement, this measurement should be taken when the perceived person displays a neutral expression.

Eye size influences evaluations of dominance and honesty traits (Keating, 1985; Zebrowitz et al., 1996). Research shows that adults with larger eyes may trigger the baby-face effect, leading perceivers to infer lower dominance and higher honesty (Keating, 1985; Wang et al., 2013; Zebrowitz et al., 1996). The baby-face effect refers to a universal, evolved social-cognitive response triggered by infant facial features (or baby schema), including preferential responses to infant faces and generalized cognition of adults with babyish features—people often associate baby-faced adults with traits like naivety, honesty, weakness, and submissiveness (窦东徽等, 2014). However, some studies have found that eye size positively correlates with competence dimension ratings (Gonçalves et al., 2015). This may be because larger eyes only trigger the baby-face effect in faces with lower facial maturity, but not in more mature faces.

Regarding facial attractiveness, Cunningham et al. (1995) argue that individuals with larger eyes are often more facially attractive because those with prenatal and genetic diseases (such as fetal alcohol syndrome) tend to have smaller eyes. Larger eyes may thus symbolize good genes and health status.

3.3 Sclera Coloration

The sclera, commonly known as the white of the eye, exhibits yellowing as a pathological manifestation (Markovic et al., 2021; Russell et al., 2014; Xiao et al., 2021). Additionally, irritation from allergies, fatigue, or infection causes dilation of blood vessels covering the conjunctiva, making the sclera appear red (Bonini, 2021; Russell et al., 2014; Singh et al., 2021). Moreover, individuals with darker sclerae tend to be older in both actual and perceived age (Gründl et al., 2012). Sclera coloration is considered a cue for judging facial attractiveness. Researchers have experimentally manipulated sclera coloration in the same face and asked participants to rate attractiveness and health. Results showed that faces with redder, yellower, or darker sclerae were rated as older, less healthy, and less attractive compared to faces with normal white sclerae (Provine et al., 2011; Russell et al., 2014).

3.4 Sclera Exposure Index

The sclera exposure index (as shown in Figure 5 [Figure 5: see original paper]) is the ratio between the exposed width of the eyeball and the iris diameter (Kobayashi & Kohshima, 1997). After comparing eye features across 88 primate species, researchers found that humans have the largest sclera exposure index and are the only species with white sclerae (Kobayashi & Kohshima, 1997). They argued that as body size increased, expanding visual field through eye movement became faster and more efficient than through head or body movement, so humans evolved a larger sclera exposure index to facilitate environmental observation. Human white sclerae represent an adaptation that enhances gaze signaling (Kobayashi & Kohshima, 2001).

Subsequently, scholars proposed the cooperative eye hypothesis, suggesting that eye morphology has evolved to support cooperative or reciprocal behaviors (Tomasello et al., 2007). For example, in hunter-gatherer times, our ancestors could use gaze direction and facial expressions to quickly alert companions to danger, thereby increasing survival chances. Danel et al. (2018) hypothesized that humans would perceive conspecifics with larger sclera exposure indices as more trustworthy partners in cooperative tasks and would thus give them higher trustworthiness ratings in first impressions. However, this hypothesis was not supported experimentally. The reason may be that increased sclera exposure means more visible white sclera, and the amygdala is highly sensitive to the amount of white sclera—excessive white sclera may trigger fear in perceivers (Barrett, 2018), thereby reducing trustworthiness ratings. In other words, if larger sclera exposure indices in the perceived increase the perceiver' s survival chances, this might be perceived as a form of competence, while the trustworthiness assessment in this experiment may have encompassed both competence/dominance evaluation and cognitive evaluation of emotional valence/warmth. This broad conceptualization likely caused semantic ambiguity (陈少华等, 2013), which may explain the inconsistent findings regarding the relationship between sclera exposure index and trustworthiness ratings. More stable results might be obtained through more fine-grained trait evaluations.

3.5 Limbal Ring

The limbal ring is a dark ring surrounding the iris (Brown et al., 2019; Brown et al., 2020). Previous research indicates that individuals without chronic health problems and who are younger have clearer, more distinct limbal rings (Brown & Sacco, 2018; Lewis & Buss, 2021; Wong et al., 2017). Brown and Sacco (2018) found that female perceivers rated individuals with limbal rings as healthier than those without, and were more willing to consider individuals with limbal rings as short-term mating partners.

3.6 Eye Adornments

Eye adornments include glasses and eye makeup. Glasses (whether regular or sunglasses) affect face-personality perception (Fetscherin et al., 2020; Graham & Ritchie, 2019). Building on previous metaphor-concept research and the stereotype content model, Okamura and Ura (2020) proposed that round shapes are associated with warmth and square shapes with competence. They designed three conditions (no glasses, round glasses, square glasses) and found that virtual characters wearing round glasses received higher warmth ratings than those wearing square glasses or no glasses, while characters wearing square glasses received higher competence ratings than those wearing round glasses or no glasses (Okamura & Ura, 2020).

Research shows that perceivers consider women wearing eye makeup more attractive than those without (Mulhern et al., 2003). Russell et al. (2019) argue that makeup influences facial attractiveness by altering three visual features: skin homogeneity, facial contrast, and facial feature size. This principle applies to eye makeup as well. For example, pigmentation and wrinkles, as signs of aging (Samson et al., 2010), negatively affect skin homogeneity, while foundation and concealer can enhance skin homogeneity, making women appear younger, healthier, and more attractive (Russell et al., 2019). Regarding facial contrast, women show greater luminance differences between eyes and surrounding skin compared to men (Aguinaldo & Peissig, 2021; Russell et al., 2019), and dark eyeshadow leverages this principle to enhance femininity and attractiveness (Russell et al., 2019). In terms of facial feature size, eyeshadow, mascara, and eyeliner can all make eyes appear larger (Matsushita et al., 2015; Morikawa et al., 2015; Russell et al., 2019). However, eye makeup should be applied in moderation. Researchers found that women wearing heavy eye makeup received lower warmth and competence ratings compared to those without makeup (Bernard et al., 2020), possibly because heavy eye makeup evokes associations with marginalized social groups, such as sex workers.

4 Mechanisms of Eye Cue Effects

From the perspective of underlying mechanisms, eye cues can be divided into three major categories: cues affected by pathological factors, cues associated with specific groups, and cues regulated by subjective awareness or physiological factors. However, some cues may not be limited to just one category.

Cues affected by pathological factors include eye size, sclera coloration, limbal ring, pupil size, eye makeup, eyelid openness, and glasses. The evolutionary-cognitive perspective emphasizes perceivers' recognition of the perceived's health and genetic status (张超等, 2022), and many scholars have provided theoretical foundations in pathology for the causes of small eye size, sclera coloration, limbal rings, and pupil constriction. Consequently, research on how these cues affect facial attractiveness often adopts an evolutionary-cognitive perspective. Additionally, eye makeup employs appearance enhancement principles (Lewis & Buss,

2021) that essentially emphasize health, youth, and attractiveness. Reduced eyelid openness due to sleep deprivation (Talamas et al., 2016) or inflammatory episodes (Axelsson et al., 2018; Sarolidou et al., 2019) also has pathological characteristics, and scholars have explained the reduced facial attractiveness of wearing glasses and having poor vision from an evolutionary-cognitive perspective (Okamura & Ura, 2020). Therefore, eye makeup, eyelid openness, and glasses can also be included in this category.

Eye cues associated with specific groups are those that can indicate information about gender, age, race, ethnicity, nationality, social class, etc. (佐斌等, 2019; Fiske et al., 2002). Such cues include eye size, glasses, and eye makeup. Larger eyes may trigger the baby-face effect, which may convey age information; glasses (Guéguen, 2015) and heavy eye makeup can lead individuals to associate them with certain social or occupational groups. These cues often result in stereotypical cognition. Additionally, iris color also indicates race information and could be studied from a stereotyping perspective in the future.

Eye cues regulated by subjective awareness or physiological factors include eye expression, gaze direction, and pupil size. Eye expression can be studied through the behavioral tendencies conveyed by expressions and the emotions they evoke in perceivers (李雅宁等, 2021). Pupil size and gaze direction can be explained using the adaptive-gain theory (杨晓梦等, 2020) and approach-avoidance motivational brain systems (Hietanen et al., 2008), respectively. Eyelid openness is influenced not only by pathological factors but also regulated by subjective awareness, such as opening eyes wide or squinting (Kruger & Piglowski, 2012). Future research could treat subjectively regulated eyelid openness as a form of expression, though its specific metrics require further definition.

The above viewpoints are summarized in Table 1 .

Table 1 Effects of Eye Cues and Research Perspectives

Category of Eye Cues	Dimensions and Traits Affected	Underlying Mechanism
Subjective awareness or physiological regulation	Intention, competence, attractiveness	Emotional evocation and behavioral tendency transmission by expression; Approach-avoidance motivation theory; Adaptive-gain theory
Pathological factors	Competence, attractiveness	Evolutionary-cognitive perspective
Group association	Intention, competence	Stereotyping perspective

Note: For brevity, any influence on dimensions or traits representing intention (trustworthiness, approachability, honesty, warmth) is abbreviated as "intention," and any influence on dimensions or traits representing ability to fulfill intentions (dominance, competence, intelligence) is abbreviated as "competence."

Future Directions

In summary, many eye behavior cues in daily life await exploration, such as avoiding eye contact and frequent blinking. Current research rarely addresses interactions among multiple eye cues. Eye cues affected by pathological factors could be further subdivided into infectious disease cues and non-infectious disease cues. Most existing research adopts the perspective of the perceived person, while differences in perceivers' own personality traits and their resulting effects remain to be explored. Although some argue that eye morphology has evolved to support cooperative or reciprocal behaviors (Tomasello et al., 2007), face cues related to cooperation have not been clearly defined within the evolutionary-cognitive perspective. Therefore, we propose the following future research directions.

First, investigate the accuracy of personality inference from eye behavior cues. Research shows that individuals with different personalities exhibit different eye region behavioral cues. For example, individuals with internal locus of control blink more frequently during interviews (Declerck et al., 2006); individuals higher in neuroticism show longer gaze duration at fearful faces (Perlman et al., 2009); and individuals with higher social trait anxiety make less eye contact during interviews (Howell et al., 2016). Whether perceivers can use such behavioral cues to infer personality and how accurate these inferences are remain unexplored.

Second, explore the core issues involved in eye cue interactions, specifically the temporal sequence and relative importance of different mechanisms in integrated perception. Additionally, research suggests that face perception processing integrates information in an "eye-centered, from center to periphery" manner (王哲等, 2022). Does the eye region play the same central integrative role in face-personality perception? These questions require multi-factor designs, sophisticated techniques (such as eye-tracking and brain imaging), and advanced data analysis.

Third, reveal similarities and differences between infectious and non-infectious disease eye cues. Research shows that perceivers are highly sensitive to facial cues of individuals with infectious diseases and may exhibit avoidance behavior (Sarolidou et al., 2019). From this perspective, conjunctivitis, as an infectious disease causing scleral redness, may directly affect trustworthiness ratings. Cardiovascular disease, as a non-infectious disease (Beale & Demaio, 2019), often results in less distinct limbal rings (Brown & Sacco, 2018), which indirectly affect trustworthiness through the halo effect of facial attractiveness. These hypotheses await experimental verification.

Fourth, the same eye cues in face-personality perception may have different effects depending on perceivers' personality traits. For instance, eye contact produces approach motivation in individuals lower in neuroticism but avoidance motivation in those higher in neuroticism (Helminen et al., 2011; Niedźwiecka, 2020). Compared to smaller eyes, perceivers perceive larger eyes as warmer, and this warmth perception correlates with perceivers' self-rated warmth (Sacco & Brown, 2018). Exploring such phenomena could further explain variation in inter-rater agreement.

Finally, the special characteristics of eye cues from an evolutionary-cognitive perspective require further investigation. The current evolutionary-cognitive perspective emphasizes that perceivers identify cues related to health, survival, reproduction, and environmental adaptation based on evolutionary needs (张超等, 2022). These cues represent the perceived person' s adaptation to the environment and are "self-serving" from the perceived' s perspective. However, humans' prominent white sclera evolved to help companions better adapt to the environment (Tomasello et al., 2007), representing "other-serving"cues that help perceivers adapt. From this perspective, certain "other-serving" eye cues (such as the aforementioned sclera exposure index) indeed differ from "self-serving" cues like limbal rings and sclera coloration, and this altruistic quality may be unique to eye features compared to nose or mouth features. Whether perceivers can identify "other-serving"cues and produce stable effects, and what similarities and differences exist between effects of "self-serving" and "other-serving" cues, await exploration.

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