Integrating Metacognition and Face Cognition: Approaches and Methods

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Abstract

Metacognition is cognition about cognition that encompasses various aspects of cognition. In recent years, the integration of metacognition and facial cognition has begun to attract attention. The entry points for this integration include the applicability of metacognitive illusions (the Dunning-Kruger effect and egocentric bias) in facial cognition, as well as the applicability of facial cognition phenomena (the other-race effect and familiarity advantage) in metacognition. Research methods vary in their emphasis depending on the selection of measurement time points and evaluation targets. Current research remains at the level of metacognitive monitoring, and future directions may expand to include metacognitive control of facial cognition, integration with machine learning, and other avenues, providing novel perspectives for understanding facial cognition and expanding its applied value.

Full Text

The Combination of Metacognition and Face Cognition: Cut-in Points and Methods

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Abstract

Metacognition is cognition about cognition, encompassing all aspects of cognitive processes. In recent years, research combining metacognition with face cognition has begun to attract attention. The primary entry points for this integration include examining the applicability of metacognitive illusions (such as the Dunning-Kruger effect and egocentric bias) in face cognition, and investigating whether classic face cognition phenomena (such as the own-race effect and familiarity advantage) manifest at the metacognitive level. Research methods in this area emphasize different aspects depending on when measurements are taken and what evaluation targets are selected. Current studies have primarily focused on metacognitive monitoring, but future research could expand into metacognitive control of face cognition and integration with machine learning. This line of inquiry offers new perspectives for understanding face cognition and extends its applied value.

Keywords: face cognition, metacognition, Dunning-Kruger effect, egocentric bias, own-race effect, familiarity advantage

1. Introduction

Successful task performance in daily life requires planning commensurate with ability, which underscores the importance of metacognition— "cognition about cognition" (Fleming et al., 2012; Jost et al., 1998). Metacognition has long been a popular topic in psychology, representing a higher-order cognitive process. Previous research, both domestic (e.g., Hu & Liang, 1999; Gong & Liu, 2003) and international (e.g., Goh, 2018; Martinez, 2006), has predominantly focused on learning and education. Recently, researchers have begun combining metacognition with face cognition, which not only broadens metacognitive research but also extends the practical applications of face cognition research from clinical treatment (DeGutis et al., 2014) and judicial procedures (Grabman et al., 2019) to social interaction (Bègue et al., 2019).

Both face cognition and metacognition constitute important components of human cognitive function and play crucial roles in practical applications such as social interaction. Integrating metacognition with face cognition can expand research in both fields and explore whether phenomena well-established at the face cognition level also apply at the metacognitive level of face processing, and whether metacognitive illusions documented in numerous non-face domains similarly emerge in face cognition. For instance, the famous metacognitive illusion —the Dunning-Kruger effect, where incompetent individuals tend to overestimate their abilities due to an inability to recognize their own inadequacy—has been widely demonstrated in domains requiring certain cognitive and executive abilities, such as reasoning (Pennycook et al., 2017), grammar (Kruger & Dunning, 1999), and political knowledge (Anson, 2018). The originators of this effect, Dunning and colleagues (2003), posed a thought-provoking question: Is there a special cognitive domain where the Dunning-Kruger effect does not exist, where people can consciously recognize their own potential cognitive biases? How would such a domain differ from those where the effect has been found? Face cognition might constitute such a "special" domain because it possesses innate, automatic, and specific characteristics (Farah et al., 1998), heritability (Wilmer, 2017), and dedicated neural circuits (Riddoch et al., 2008). Face processing relies primarily on holistic, configural encoding, whereas recognition of other objects is based on local, featural analysis (Biederman, 1987). The face structure hypothesis posits that individuals process upright faces configurally, while inverted faces disrupt this configural processing, resulting in poorer recognition of inverted faces—the inversion effect. This effect does not occur for other objects such as houses (Rossion, 2008), making it one indicator of the holistic processing advantage in face perception. Additionally, individuals show differential cognitive abilities for familiar versus unfamiliar faces (familiarity advantage; see review by Young & Burton, 2017) and for own-race versus other-race faces (own-race effect; see review by Meissner & Brigham, 2001), representing special phenomena that distinguish face processing from object processing. Of course, some have questioned the "specialness" of face processing, arguing that face-specific visual mechanisms might actually be mechanisms for specific skills not exclusive to faces (see McKone & Robbins, 2011, for discussion). Similarly, in metacognition research, the debate between domain-generality (strong metacognitive ability in one domain predicts strength in others) and domain-specificity (strong metacognitive ability in one domain does not necessarily transfer to others) has been a longstanding controversy. If metacognitive illusions persist in face cognition and classic face cognition phenomena remain at the metacognitive level, this would theoretically support domain-generality of metacognition while also providing metacognitive evidence against the "specialness" of face processing. Such findings would enable further comparisons between face and other domains' metacognitive performance. Moreover, judging others' gaze direction and perceiving facial emotional expressions both relate to cognitive insight, requiring inference of mental states from behavior (Calder et al., 2002). The ability to infer mental states appears related to metacognition (Carruthers, 2009), so understanding metacognitive abilities can better reveal characteristics of facial expression cognition, particularly for special populations with emotion recognition deficits due to neurodegenerative diseases (Garcia-Cordero et al., 2021). Clinically, this integration would first benefit treatment, as unreliable self-assessment may affect treatment-seeking motivation. Research shows that individuals with developmental prosopagnosia often have limited awareness of their impaired face recognition abilities (Fine, 2012), and autism spectrum disorder (ASD) patients may not recognize their difficulties in reading social signals from faces (see Bishop & Seltzer, 2012; Schriber et al., 2014, for discussions on self-insight in ASD). If people are unaware that their abilities fall outside the normal range, they may not seek appropriate help (Yardley et al., 2008). Second, understanding metacognitive illusions in others' face cognition can improve social interactions by helping us understand others' unintentional mistakes and may even serve as an entry point for eliminating stereotypes (Banaji & Dasgupta, 1998). In judicial contexts, eyewitness confidence in suspect identification often serves as an important indicator for evaluating identification reliability (Seale-Carlisle et al., 2019), making understanding metacognitive patterns in face recognition valuable for judicial work.

Previous research rarely directly connected these two domains. In recent years, domestic studies on metacognition in face cognition seldom use the term "metacognition," instead employing related concepts and focusing primarily on judgments of learning in face memory (e.g., Zhang et al., 2014; Wu & Huang, 2018). While international face cognition experiments have expressed metacognitive concepts through "estimating others' performance" or "awareness of one' s own abilities" (Ritchie et al., 2015; Palermo et al., 2017), some studies have begun using the term "metacognition" directly, such as metamemory research in face recognition (Hourihan et al., 2012) and metacognitive studies of emotional face recognition (Kelly & Metcalfe, 2011). International psychologists' research on eyewitness confidence judgments has been applied in judicial settings (Busey & Loftus, 2007; Dobolyi & Dodson, 2013), while domestic research on metacognition in face cognition remains in its infancy. Building on previous work, this paper systematically reviews existing domestic and international research on integrating metacognition and face cognition, summarizes the main research methods, and proposes future research directions to provide scholars with additional perspectives and promote further empirical development.

2. Cut-in Points for Combining Metacognition and Face Cognition

Metacognition and face cognition have long been studied independently, so recent integrative research primarily examines classic phenomena from each domain to explore their applicability in the other field. This section reviews recent studies on the applicability of typical metacognitive illusions such as the Dunning-Kruger effect and egocentric bias in face cognition, as well as the applicability of face cognition phenomena such as the own-race effect and familiarity advantage in metacognition, discussing the characteristics and trends of these integration approaches.

2.1 Applicability of Metacognitive Illusions in Face Cognition

Metacognitive illusions fall into two main categories corresponding to two aspects of metacognition' s definition. Regarding metacognition' s definition, researchers have long debated whether it includes only thinking about one' s own cognition (e.g., Flavell, 1979; Martinez, 2006) or more broadly encompasses any thoughts about thoughts, including thinking about both self and others (e.g., Jost et al., 1998; Wright, 2002). Tauber et al. (2013) included peer judgment—estimating others' performance—as part of metacognition. Couchman et al. (2009) considered metacognition a prerequisite for understanding others' thoughts and accepting others' perspectives. It is important to distinguish that the ability to understand others' thoughts and use this information to predict their behavior is called mentalizing (also known as theory of mind; see review by Wellman, 2018). Thus, estimating others' performance in metacognition can be understood as a prerequisite step for theory of mind. Theory of mind is widely used in psychological development research because it focuses on children' s developing ability to differentiate their own beliefs from others' (Grazzani et al., 2018). However, self-evaluation and other-evaluation often have a chicken-and-egg relationship; by understanding others, we can also better understand ourselves (Tokuhama-Espinosa, 2014). Moreover, brain research has found that these two evaluation modes involve similar neural networks (Legrand & Ruby, 2009; Valk et al., 2016). Therefore, this paper adopts a broad definition of metacognition as cognition about both self and others' performance.

2.1.1 Dunning-Kruger Effect Regarding self-insight, the typical metacognitive illusion is the Dunning-Kruger effect (Kruger & Dunning, 1999), which emphasizes that due to lack of metacognitive skills, people tend to overestimate their abilities. Researchers measured participants' performance on humor tests, logical reasoning tests, and English grammar tests, combined with participants' self-assessments of their performance, and found that low performers (those in the bottom quartile) overestimated their percentile ranking (relative performance) and test scores (absolute performance) by nearly 40-50 percentage points, even believing they performed better than most people. Conversely, high performers (those in the top quartile) were typically more conservative, underestimating their performance. A significant contribution of the Dunning-Kruger effect is its examination of metacognitive performance from an individual differences perspective, revealing differences in metacognitive abilities between high and low performers. Some individuals are more inclined toward introspection than others (Stanovich, 2012), and understanding the distinction between those who are aware of their performance and those who are not can help improve metacognitive abilities and enhance cognitive outcomes. Kruger and Dunning' s (1999) "unskilled and unaware"effect represents a landmark discovery in how people view themselves and has been replicated across many research areas, including face cognition. Estudillo and Wong (2021) found similar Dunning-Kruger patterns in face memory recognition tasks, where self-reported face recognition ability was inversely correlated with objective performance among both high and low face recognition ability groups. Zhou and Jenkins (2020) found through a series of face matching experiments that participants showed clear Dunning-Kruger effects in familiar face identification, unfamiliar face identification, gaze direction identification, and facial expression identification. Interestingly, they found participants' metacognitive performance was more stable than their actual cognitive performance, demonstrating domain-generality of metacognition in face cognition—the tendency to overestimate or underestimate one' s performance does not strictly depend on the specific face cognition task. This also indirectly suggests that face processing is not a special domain in terms of metacognitive performance, as the Dunning-Kruger effect persists, though this conclusion awaits further verification through comparisons between face and non-face domains.

Current findings seem to indicate that regardless of face cognition level, individuals cannot accurately make metacognitive estimates. However, due to differences in test populations, measurement methods, data processing approaches, experimental materials, and face cognition domains, researchers do not fully agree that metacognitive abilities are inadequate in face cognition. Kramer et al. (2022) found the Dunning-Kruger effect in unfamiliar face recognition experiments, but through detailed analysis of participants' confidence in correct versus incorrect trials, they found that the difference in confidence between correct and incorrect responses increased with ability. Low-ability individuals showed equal confidence in correct and incorrect answers, whereas high-ability participants were more confident in their correct responses. Palermo et al. (2017) disagreed that low performers lack insight into their abilities; they found that adults with typical face recognition abilities have only limited awareness of their face recognition skills, while congenital prosopagnosics—extreme "low performers"—accurately anticipated poor performance and indeed performed poorly. Therefore, findings on the accuracy of self-insight into one' s own abilities have not reached consensus across face cognition domains. Deng and Liu (2017), in their review of domain-generality and domain-specificity of metacognition, called for future research to expand comparisons of metacognitive module tasks under the same general theme, as domain consistency and specificity of metacognitive performance in face cognition require further investigation. Additionally, exploring whether more metacognitive patterns or typical illusions exist beyond the Dunning-Kruger effect when people evaluate their own face cognition abilities will help deepen understanding of the mechanisms underlying metacognition in face cognition.

2.1.2 Egocentric Bias Regarding other-insight, the typical metacognitive illusion is egocentric bias—the tendency to perceive events from one' s own perspective and view others in a self-centered manner (Greenwald, 1980). Although egocentric bias is a typical cognitive bias, it also exists at the metacognitive level because its core involves metacognitive concepts, namely, speculating about others' behavior. For example, a study proposing a comprehensive model of narcissistic personality identified this metacognitive deficit as the model' s core, finding that narcissistic patients have limited ability to understand others' thoughts due to their own egocentric bias (Dimaggio et al., 2002). Egocentric bias is often considered the primary mechanism underlying several related cognitive biases, including the spotlight effect (overestimating how much others notice or care about one' s appearance and behavior; e.g., Inchauspe, 2016), the false consensus effect (believing one' s views and beliefs are more common in the population than they actually are; e.g., Collisson et al., 2021), and blind spot bias (the tendency to believe one is less susceptible to bias than peers; e.g., Jones et al., 2018). Given that egocentric bias can strongly influence how we process information and make decisions, it has been extensively explored across psychological domains (Scoville, 2017; Samuel et al., 2018) and described as "ubiquitous" (Nickerson, 1998), leading to its preliminary verification in face cognition. In face matching tasks, Ritchie et al. (2015) found that when predicting others' performance, participants believed others would be more accurate at matching faces familiar to the participants themselves compared to unfamiliar faces. More interestingly, they found that predictions of others' face cognition abilities were also influenced by the target' s identity, such as believing passport officers have stronger face recognition abilities than students. However, the researchers did not directly use the terms "egocentric bias" and "metacognition" to explain this phenomenon. Zhou and Jenkins (2020) explicitly proposed egocentric bias in metacognitive performance in face cognition, finding that high performers' estimates of others' task performance were significantly higher than low performers' estimates across familiar face identification, unfamiliar face identification, gaze direction identification, and facial expression identification tasks. Because participants predicted others' behavior from their own perspective—high performers estimated their own abilities higher than low performers—they believed others also possessed higher abilities. Similarly, when predicting the number of thoughts evoked by faces, participants showed egocentric bias, believing that faces evoking more associations in themselves would also evoke more associations in others, and vice versa. When predicting the content of associations evoked by faces, participants showed false consensus effects, greatly overestimating how similar others' thoughts were to their own. These egocentric bias and false consensus effects persisted when predicting both the quantity and overlap of person associations evoked by faces (Zhou & Jenkins, 2022). In face memory recognition, blind spot bias has also been demonstrated, with people believing that race influences others' face memory performance more than it influences their own (Zhou et al., 2021). Overall, research on evaluating others' task performance in face cognition domains remains exploratory. Although many domains have been investigated, the basic theoretical framework is still incomplete. Whether other illusions beyond egocentric bias exist in the process of evaluating others' behavior remains unknown, such as whether typical biases exist when estimating the behavior of different "others" (e.g., ordinary students vs. passport officers). Predicting others' behavior is often the most neglected part of metacognition research, but given its rich theoretical and practical significance, this area deserves deeper and broader exploration in face cognition.

Furthermore, current research on the Dunning-Kruger effect and egocentric bias in face cognition is primarily based on Western data. Since people in collectivist Eastern cultures are often considered modest and reserved (Benjamin & Guan, 2020), will the tendency to overestimate one' s own face cognition abilities in the Dunning-Kruger effect diminish among Easterners? Will Easterners be less influenced by blind spot bias when estimating their own and others' own-race effects? Future research could explore cross-cultural similarities and differences in metacognition of face cognition from a cultural psychology perspective to better understand the underlying mechanisms. Additionally, attention must be paid to the connections and distinctions between self-estimation and other-estimation. Although different metacognitive biases exist for self and other evaluation, as stated in the broad definition of metacognition, self- and other-estimation influence each other, and their corresponding brain regions are related (Valk et al., 2016). However, the relationship between the two has not been studied in face cognition. Future research should particularly focus on comparing and connecting individuals' estimates of their relative performance (their percentile ranking in the group) and absolute performance (their raw scores), thereby exploring how self-ability estimates and other-ability estimates influence each other.

2.2 Applicability of Face Cognition Phenomena in Metacognition

The own-race effect and familiarity advantage are two stable phenomena repeatedly verified in face cognition and represent the two primary face cognition phenomena currently investigated in metacognitive research.

2.2.1 Own-Race Effect The own-race effect refers to the phenomenon that faces of other races are more difficult to recognize than faces of one' s own race, representing one of the most common phenomena in face cognition and having been widely demonstrated (Meissner & Brigham, 2001). In recent years, some researchers have begun exploring whether the own-race effect exists at the metacognitive level, which has broad practical significance, particularly in evaluating eyewitnesses' accuracy judgments when identifying same-race versus other-race suspects. Smith et al. (2004) found that White participants were more confident when identifying suspects of their own race than when identifying Black suspects. Hourihan et al. (2012) found that the accuracy of face recognition predictions was influenced by race, with participants showing higher metacognitive accuracy for memory of own-race faces compared to other-race faces. Chen and Zhu (2019) used software to morph Asian and White faces into racially ambiguous faces, finding that Chinese participants believed they were best at remembering Asian faces and predicted their memory ability for racially ambiguous faces would be higher than for White faces, when in reality their memory performance showed no difference between the two. Wu and Huang (2018) found similar own-race effects when measuring judgment of learning accuracy in Chinese and German participants. In addition to trial-by-trial estimates, Estudillo (2021) used questionnaires to have participants self-report their comprehensive recognition abilities for own-race and other-race faces and compared these with their actual test scores. Results showed more consistent and reliable insight for own-race face recognition, while self-reported ability to recognize other-race faces deviated from actual performance. Therefore, researchers recommend using more objective measurement methods when evaluating eyewitness accuracy in identifying other-race faces. Overall, existing research on metacognition in face cognition generally supports that the own-race effect persists at the metacognitive level.

2.2.2 Familiarity Advantage The familiarity advantage in face cognition refers to the theoretical model (Bruce & Young, 1986; Burton et al., 1999) that people have superior face cognition abilities for familiar versus unfamiliar faces, a point verified in numerous studies. However, does this familiarity advantage apply at the metacognitive level? Although research on the metacognitive aspect of familiarity advantage is limited, it involves various domains of face cognition. While Zhou and Jenkins (2020) did not directly compare metacognitive levels for familiar and unfamiliar faces within subjects, they found in face matching tasks that even when familiar face matching accuracy was significantly higher than unfamiliar face matching accuracy at the cognitive level, the Dunning-Kruger effect and egocentric bias still appeared in familiar face tests. Similarly, in free association experiments evoked by faces, both familiar and unfamiliar faces produced false consensus effects, with participants overestimating how many others would think of the same content when seeing a face (Zhou & Jenkins, 2022). In face memory tests, Zhou et al. (2021) found that people expressed greater confidence in their ability to remember familiar faces, whether through judgments of learning (JOL) during the learning phase, overall confidence calculated from trial-by-trial feedback during the test phase, or retrospective estimates after the entire test. However, this study did not further compare metacognitive accuracy between familiar and unfamiliar faces, as its primary purpose was to compare the influence of familiarity and race on face memory at both cognitive and metacognitive levels. At the cognitive level, familiarity’ s impact on face recognition performance was significantly greater than race’ s impact—face recognition accuracy depends more on whether you know the person’ s face than whether you share their race. At the metacognitive level, self-assessment results showed that participants recognized familiarity influenced their performance more than race, but when evaluating others’ performance, although they agreed familiarity influenced others’ face recognition, they overestimated race’ s influence on others’ face recognition performance. In summary, the familiarity advantage in face cognition domains awaits further direct verification, and differences in familiarity advantage between cognitive and metacognitive levels remain an interesting direction for future research.

Many other classic phenomena in face cognition have not yet been explored at the metacognitive applicability level. Based on existing research on metacognition of other classic effects in face processing, we speculate that individuals can recognize the existence of holistic processing advantages and other face processing effects, but their judgments of these effects’ strength may contain certain biases. Moreover, measurement methods may also influence individuals’ metacognitive levels. For example, the composite face paradigm and part-whole paradigm are common methods for measuring holistic processing advantage, and their measurement results have been found to have only low correlations at the cognitive level (Rezlescu et al., 2017), with their metacognitive performance awaiting future exploration. Additionally, many factors influence metacognitive accuracy in face cognition. Domestic research has examined factors such as emotional face valence and arousal (Zhang, 2018), face presentation angle (Zhang et al., 2014), and the social adaptive significance of face-related memory content (Xu et al., 2017). Many more directions combining face cognition and metacognition deserve in-depth exploration in the future.

3. Methods for Combining Metacognition and Face Cognition

The combination of metacognition and face cognition primarily involves adding metacognitive measurement methods to existing face cognition tests. Historically, metacognitive measurement methods have varied across different cognitive domains. Research integrating the two fields must select appropriate metacognitive measurement methods and face cognition tests according to different face cognition domains (e.g., face identification, face memory, first impressions), research topics, and metacognitive components. This paper summarizes two typical classification approaches:

3.1 Classification by Measurement Time Point

Based on when metacognitive measurements are taken during face cognition tests, three main types can be distinguished. The first measurement time point occurs before the formal cognitive test. For example, Gray et al. (2017) had participants complete the PI20 scale (a standard self-report tool assessing overall face perception ability through 20 prosopagnosia indicators; see Shah et al., 2015) before the Cambridge Face Memory Test (CFMT). McCaffery et al. (2018) also had participants complete self-assessment questionnaires covering three aspects of face recognition ability before measuring these abilities. Such pre-test predictions are called judgments of learning (JOL) in traditional memory-recognition paradigms. In face memory experiments, participants typically complete two phases: a face learning phase and a formal old/new face test phase. JOL refers to the learning phase when experimenters ask participants to predict their learning effectiveness—that is, to judge their confidence in successfully remembering a specific face during the subsequent test phase (e.g., Xu et al., 2017; Witherby & Tauber, 2018). This time point prevents participants' estimates from being influenced by their perceptions of their performance in the subsequent formal test, but it cannot measure participants' actual estimates of their performance in the formal experiment.

The second measurement time point occurs during the formal test, typically measured simultaneously on a trial-by-trial basis. For example, Hopkins and Lyle (2020) had participants make confidence estimates on a five-point scale after each same/different face matching judgment in the Glasgow Face Matching Test (GFMT). Travers et al. (2020), in a study examining whether participants realized they typically perceived faces with typical African features as having darker skin than actual, asked participants how confident they were in their answer after each judgment of which face was lighter. In face-name memory recognition paradigms, a special concurrent estimate called feeling of knowing (FOK) testing occurs when participants see a face but cannot recall the corresponding name, predicting the likelihood they could recognize the answer from a list of alternatives (Irak et al., 2019; Cansever & Irak, 2020). FOK is closely related to the tip-of-the-tongue phenomenon—when you cannot recall a person' s name but are certain you know the person and their name (Cleary, 2019). This immediate measurement method provides direct reflection of participants' estimates of their performance on each trial but cannot directly yield participants' overall evaluation of their performance, which requires subsequent statistical methods to calculate an overall estimate.

The third measurement time point occurs after the entire test as a retrospective estimate. This commonly appears in research on eyewitnesses' estimates of their memory accuracy, where witnesses estimate their confidence in selecting the correct suspect from a group of faces, which further affects whether their testimony is considered credible in court (e.g., Dianiska & Manley, 2021; Wixted & Wells, 2017). In series experiments on face identification, gaze direction identification, and facial expression identification, Zhou and Jenkins (2020) also used retrospective assessment, asking participants to estimate their percentile ranking on the test they just completed (100 = better than everyone, 0 = worse than everyone, 50 = average). Earlier metacognition research in non-face domains often relied on this method (e.g., Dunning & Kruger, 1999; Feld et al., 2017; for more discussion of this method' s issues see Gignac & Zajenkowski, 2020). This approach can measure participants' overall estimates of their formal test performance but places high demands on participants' retrospective memory abilities. Face cognition experiments typically contain dozens of items or trials, each subjectively varying in difficulty. Recalling performance across all items and integrating them into a single score is clearly challenging. More complexly, this overall impression may also be influenced by primacy and recency effects (Haugtvedt & Wegener, 1994).

It is important to note that different measurement times assess different metacognitive components. Pre-test predictions rely on one' s previous experiences to make overall speculations about upcoming test performance. This metacognitive component is primarily influenced by prior experience, reflecting individuals' macro-level feelings about their own or others' previous face cognition abilities. Trial-by-trial estimates during formal testing are immediate reactions to performance on each trial of the current test. Retrospective estimates after the entire test reflect estimates of overall performance on the formal test. The latter two time points are not influenced by prior experience. Therefore, the specific metacognitive component' s requirements for globality and experientiality can serve as a basis for selecting measurement time points. Additionally, different face cognition domains have different measurement methods at each time point when combined with metacognition. For example, in face memory, metacognitive levels are reflected by measuring JOL and FOK corresponding to the two test phases of the memory-recognition paradigm.

3.2 Classification by Evaluation Target

According to the two aspects of metacognition's definition—estimating one's own performance and estimating others' performance—measurement methods combining metacognition and face cognition also differ based on these two aspects. For self-estimation, besides the PI20 and other self-report scales mentioned above, as well as confidence judgments used across multiple domains, another common method is estimating one' s specific test performance. For example, in spatial memory experiments, participants estimate whether they hit the target after clicking, allowing researchers to derive their self-estimated performance across the entire test (Mclntosh et al., 2019). In face memory experiments, participants are asked to memorize four types of faces to compare the influence of familiarity (familiar/unfamiliar) and race (own-race/other-race) on face memory performance. After the entire test, researchers re-present these four types of faces and ask participants to circle the two groups they believe they performed best on, directly revealing which factor participants believe influenced them most (Zhou et al., 2021).

Such estimates of specific test performance also serve as the primary means for measuring participants' estimates of others' performance. Because people cannot estimate others' performance through confidence estimates or self-report scales, they can instead be asked, after being informed of the total number, how many or what proportion of people they believe could answer correctly (e.g., Ritchie et al., 2015; Zhou & Jenkins, 2020, in face identification tests; Zhou et al., 2021, in face memory tests). Other similar indirect measurement indices include having participants write down their speculations and then estimate how many items others could infer when seeing the face, as in Zhou and Jenkins' s (2022) face information inference experiment.

It is important to note that although metacognition has been widely studied across various domains, measurement methods from one domain may not directly apply to another. Moreover, depending on research goals, measurements can reach three levels: face cognition performance, self-performance estimation, and other-performance estimation. Appropriate methods should be selected based on specific questions. Because each method has advantages and disadvantages, some studies combine multiple methods. For example, Estudillo and Wong (2021) balanced the order of metacognitive and face identification tests, while Saoud (2020) measured metacognitive levels both before and after face tests. As metacognitive research in face cognition is still in its early stages, more measurement methods suitable for face cognition domains await future exploration.

4. Future Directions

Faces convey important identity and social information. Combining face cognition with metacognition can not only expand theoretical research in both fields but also has rich practical significance in social, clinical, and judicial domains. This paper has elaborated on existing main cut-in points for combining the two fields from each domain' s perspective and summarized typical research methods according to different classification approaches. However, metacognitive research in face cognition remains in its early stages, and future research should continue in-depth investigation at both theoretical and applied levels.

4.1 Theoretical Level

First, future integrative research can expand according to the two levels of metacognition research. According to Nelson and Narens (1990), regulating cognitive activities (metacognitive control) requires evaluating their current state (metacognitive monitoring). Previous face cognition metacognition research has focused primarily on metacognitive monitoring, but future research could further explore metacognitive control—that is, whether metacognitive judgments influence subsequent behavior. For example, when low performers become aware of their incompetence in face cognition, will they seek help? When people lack confidence in their ability to estimate others' social signals, will they directly seek explanation or remain silent? Metacognitive control has been widely studied in learning and education and in clinical mental health (e.g., Roebers & Spiess, 2017; Wells, 2019), and researchers could expand its investigation in face cognition to improve understanding of how performance assessments affect subsequent behavior after revealing the accuracy of people' s current task performance evaluations.

As face cognition domains continue to expand, more metacognitive research can be integrated. Currently, domestic metacognitive research on face cognition mostly focuses on judgments of learning in face memory (e.g., Xu et al., 2017; Zhang, 2018), possibly because previous metacognitive research has been more concentrated in learning and education. International research on the combination has also mostly remained at the objective perception level, such as face identification and face memory (e.g., Zhou & Jenkins, 2020; Zhou et al., 2021). In recent years, increasing face cognition research has begun focusing on subjective thoughts evoked by faces. For example, Sutherland et al. (2013) found that trait inferences from faces primarily involve three dimensions: attractiveness, trustworthiness, and dominance. Personal preferences formed from individual experience are usually the main determinants of face trait judgments (e.g., Hehman et al., 2017; Sutherland, Burton, et al., 2020; Sutherland, Rhodes, et al., 2020). Zhou and Jenkins (2022) expanded research on face-evoked subjective judgments from personality traits to natural associations, with metacognitive results showing that people greatly overestimated how similar others' thoughts were to their own, demonstrating a typical false consensus effect and revealing potential biases in social interaction. Future metacognitive research on subjective aspects will have rich theoretical and practical significance as subjective-level face cognition research continues to expand.

Finally, current research combining face cognition and metacognition remains in its early stages, staying at the behavioral research level, but could expand to cognitive neuroscience mechanisms in the future. Research has found that both domains can activate specific cortical regions or EEG components. For example, face cognition research generally supports that the fusiform face area is specialized for face identification (Kanwisher et al., 1997), the occipital face area identifies facial parts such as eyes, nose, and mouth (Pitcher et al., 2011), and the posterior superior temporal sulcus processes dynamic aspects such as facial expressions and eye gaze (Puce et al., 1998). Event-related potential (ERP) studies have found that a negative wave with approximately 172ms latency in occipito-temporal regions (N170) is related to structural encoding of facial features (Bentin et al., 1996). Metacognitive processing research suggests that the lateral prefrontal cortex has specific connections with metacognitive processing in visual identification, while the anterior medial prefrontal cortex has specific connections with metacognitive processing in memory retrieval (Deng & Liu, 2017). Future research could focus on how different face processing (identification, memory, etc.) interacts with metacognitive brain networks or regions, whether EEG components evoked by faces differ under different metacognitive monitoring conditions (self vs. other behavior estimation), etc. Neuroscience-level metacognitive research could also compare face cognition with non-face cognition domains to further investigate face specificity and domain-generality of metacognition.

4.2 Individual Differences Level

Currently, metacognitive research in face cognition primarily involves preliminary exploration of phenomena, finding that metacognitive illusions exist in face cognition and that classic face cognition phenomena persist at the metacognitive level. Two possible reasons underlying these phenomena warrant further investigation. First, domain-generality of metacognition could be further verified through comparisons with non-face domains. Second, the relationship between this domain-generality and personality traits could be explored. Currently, no within-subject comparison studies directly compare metacognitive performance between face cognition and non-face cognition domains. Different experimental paradigms and metacognitive measurement methods result in findings that are not directly comparable. Future research could investigate whether people who overestimate their performance in unfamiliar face matching tasks also overestimate their performance in non-face domains using the same matching task and data processing approach, and whether the degree of metacognitive illusions differs across domains.

The influence of personality traits on self-assessment has been reported in non-face domains (e.g., narcissism, Ames & Kammrath, 2004; Big Five personality, Soh & Jacobs, 2013). Some underlying personality traits may also play important roles in self-assessment across face cognition domains. Within face cognition, Zhou and Jenkins (2020) found cross-domain consistency in the Dunning-Kruger effect (across face identification, gaze direction identification, expression identification). Future research combining relevant personality measures with metacognitive measures in face cognition could help explain the cross-domain consistency in self-assessment found in current research. An interesting question is whether the same personality traits predict self-assessment across domains or whether any domain specificity emerges. For example, narcissists may generally exaggerate self-evaluations, while extraverts may only exaggerate self-evaluations of socially relevant abilities. Future research should also distinguish between these possibilities.

4.3 Intervention Level

Future research could further explore how to improve metacognitive abilities in face cognition to avoid the negative consequences of the Dunning-Kruger effect and egocentric bias. Regarding improving self-performance estimation, one view suggests that metacognitive level can be improved by improving cognitive level—that is, by turning low performers into high performers, their ability self-assessments would correspondingly improve. Kruger and Dunning (1999) verified this view in logical reasoning tasks, but this has not been addressed in face cognition research, possibly because researchers have not yet reached consensus on how to effectively improve face cognition abilities. For example, regarding whether feedback can improve face identification ability, Alenezi and Bindemann (2013) found no significant effect of feedback, while White et al. (2014) found that providing feedback while faces remained on screen could improve accuracy by 10%. Regarding professional training courses, Towler et al. (2019) found that professional facial image comparison training courses did not improve identification accuracy. Towler et al. (2021) encouraged researchers to further explore feature-based training methods that promote strategies for extracting identity information from faces based on features. These strategies relate to cognition about cognition—that is, they operate at the metacognitive level. Some non-face domain researchers have also emphasized the importance of improving metacognitive levels. For example, Butler et al. (2008) proposed through two experiments testing general knowledge facts that feedback helps correct metacognitive errors. Although whether feedback can improve face cognition ability remains controversial, whether feedback can improve metacognitive levels in face cognition deserves future investigation.

Regarding improving other-performance estimation levels, no suitable methods have been identified. In non-face recognition research, some studies have found that certain special contexts can eliminate egocentric bias, such as when one option is clearly superior to another (Poeppel et al., 2021), or when considering others' event experiences rather than functionally equivalent but abstract rules (Samuel et al., 2020). However, Krueger and Clement (1994) noted that egocentric bias remains ineradicable even when standard debiasing strategies such as feedback and education are employed. Since egocentric bias means people evaluate others' performance based on their own performance, if people have already made incorrect judgments about their own performance, how can they correctly evaluate others' performance? Therefore, whether bias in peer evaluation can be eliminated by improving self-evaluation will be an interesting direction for future research.

4.4 Application Level

Future research could also expand the estimation target from humans to computers. Research on human face recognition has been applied to designing machine face recognition systems and has been implemented in practical scenarios such as airports (see Chellappa et al., 2010, for a review of human and computer face recognition). With the rapid development of face recognition algorithms, increasing evidence shows that computers surpass humans in face matching under some conditions (Tang & Wang, 2004). Of course, algorithms also make mistakes and even show own-race effects (see review by Cavazos et al., 2020). For example, algorithms developed in Western countries identify Caucasian faces more accurately, while algorithms developed in East Asia identify East Asian faces more accurately (Phillips et al., 2011). Besides race, other demographic covariates such as gender and age also affect face recognition system performance to some extent (see review by Abdurrahim et al., 2018). According to Towler et al. (2017), many unfamiliar face recognition application scenarios involve human-computer collaboration. For instance, investigators first submit suspect facial images, then face matching algorithms search databases and send highly similar matches to facial examiners, who review them and feed back several potential matches to investigators. Importantly, White et al. (2015) found that the final step of manual inspection of algorithm output produces errors, with error rates as high as 50%. Therefore, estimating the accuracy of machine recognition feedback results during manual inspection becomes particularly important. This estimation resembles the metacognitive concept of estimating others' performance, except the evaluation target is a computer algorithm. How do people' s estimates of human face recognition performance differ from their estimates of machine recognition performance? How to reduce error rates in estimating machine recognition performance will become important topics. Furthermore, police and passport officers are often super-recognizers—individuals with extraordinary face recognition abilities—selected through professional screening tests (e.g., UNSW Face Test, Dunn et al., 2020; Ramon et al., 2019). Both computers and human super-recognizers demonstrate excellent performance in face recognition and frequently need to collaborate. When their face recognition judgments differ, do people trust machine ability or human expert ability more? This involves the connection between self-ability evaluation and "other" -ability evaluation mentioned earlier. As computer face recognition systems become increasingly widespread, studying humans' estimates of their face cognition accuracy becomes more practically significant.

In conclusion, the combination of face cognition and metacognition provides new perspectives for research development in both fields and represents a vast area awaiting cultivation. Future research needs to address practical problems, innovate methods, and conduct more in-depth and comprehensive investigations.

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