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Preferential access to awareness of attractive faces in a breaking continuous flash suppression paradigm

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ABSTRACT

Facial attractiveness is a core facial attribute in social interactions. This study used a breaking continuous flash suppression (b-CFS) paradigm to investigate whether facial attractiveness can be processed unconsciously. In the b-CFS paradigm, a monocularly viewed visual stimulus is erased from visual awareness by rapidly flashing, high-contrast masks presented to the other eye. Faces with different levels of attractiveness but an emotionally neutral expression were presented under CFS, and the time taken to break CFS was measured. Our results demonstrated that attractive faces were detected more quickly than unattractive ones, indicating privileged processing of attractive faces (Experiment 1). This effect dissipated when facial images were scrambled to disrupt the face-like configuration (Experiment 2) but was still observed in cases of inverted faces (Experiment 3). These results indicate that preconscious processing of facial attractiveness requires a face-like configuration but does not necessarily require information about precise metrical relationships between facial features.

1. Introduction

Among various other facial attributes, people are extremely sensitive to facial attractiveness as a result of its important role in biological and social signals (Oosterhof & Todorov, 2008; Thornhill & Gangestad, 1999). Facial attractiveness has profound and wide-ranging effects on social behaviors, including mate choices (Rhodes, Simmons, & Peters, 2005), trait inferences (Dion, Berscheid, & Walster, 1972), hiring decisions (Agthe, Spörrle, & Maner, 2011), and juror selection (Sigall & Ostrove, 1975). The preference for physically attractive faces is universal, and people agree on which faces are attractive across cultures and sexes (Cunningham, Roberts, Barbee, Druen, & Wu, 1995; Langlois et al., 2000). Further, this preference for attractive faces originates early in development, and even newborn infants look longer at an attractive than at an unattractive face (Slater, Quinn, Hayes, & Brown, 2000; Slater et al., 1998). From the perspective of evolutionary psychology, faces with morphological features signaling high genetic quality and fecundity are evaluated as attractive (Fink & Penton-Voak, 2002; Little, 2014; Little, Jones, & DeBruine, 2011; Rhodes, 2006; Thornhill & Gangestad, 1999). As such, people have become more sensitive to the facial features that make a face attractive in order to achieve successful detection of attractive potential mates or rivals during mate choice (Langlois & Roggman, 1990). It is now widely believed that humans have a universal and innate mechanism for efficiently detecting attractive faces.

In the field of cognitive psychology, the mechanisms used for evaluating facial attractiveness have been widely investigated over

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the last decade; facial attractiveness is assessed in a rapid and effortless manner. For instance, facial attractiveness is judged reliably even for a face presented for less than 150 ms (Goldstein & Papageorge, 1980; Willis & Todorov, 2006), and more recent work has shown that approximately 20 ms is sufficient to judge facial attractiveness (Olson & Marshuetz, 2005; Saegusa & Watanabe, 2016). Additionally, people are capable of discriminating facial attractiveness using parafoveal (Sui & Liu, 2009) and even peripheral vision (Guo, Liu, & Roebuck, 2011), indicating that coarse-scale facial information can be sufficient for an appraisal of facial attractiveness (Bachmann, 2007).

While these findings have confirmed that facial attractiveness is assessed in a rapid and spontaneous manner, a new direction in the field is beginning to test whether the evaluation of facial attractiveness must involve conscious awareness. In fact, some recent studies have reported that facial attractiveness can be assessed even in the complete absence of conscious awareness of the face (Hung, Nieh, & Hsieh, 2016; Olson & Marshuetz, 2005). Olson and Marshuetz (2005) indicate that attractiveness is assessed even when the viewer is consciously unaware of the face because of an extremely short presentation time (13 ms). More recently, Hung et al. (2016) have shown using a continuous flash suppression paradigm (CFS; Tsuchiya & Koch, 2005) that facial attractiveness can be processed even for invisible faces. CFS is a powerful, widely-employed visual presentation technique that strongly suppresses visual awareness of target stimuli for up to a few seconds (Tsuchiya & Koch, 2005). This technique renders visual stimuli temporarily invisible on the basis of binocular rivalry, wherein a monocularly-viewed visual stimulus is erased from visual awareness because of rapidly-flashing, high-contrast masks presented to the other eye. Using this technique, Hung et al. (2016) presented a set of faces that differed in attractiveness and measured the time taken for the faces to break CFS and emerge into awareness; this experimental technique is now known as the breaking continuous flash suppression paradigm (b-CFS; Gayet, Van der Stigchel, & Paffen, 2014; Jiang, Costello, & He, 2007; Stein, Hebart, & Sterzer, 2011). Hung et al.'s (2016) results showed that attractive faces break CFS faster than do unattractive faces, suggesting that more attractive faces gain access to conscious awareness more quickly.

Previous b-CFS studies have repeatedly shown that the time taken for an initially-suppressed visual stimulus (e.g., face or body image, or emotional picture) to break CFS is modulated by the emotional valence of the stimulus: specifically, emotion-laden stimuli are typically detected more quickly than non-emotional ones, which is attributed to the ecological importance of the former to survival (Gayet, Paffen, Belopolsky, Theeuwes, & Van der Stigchel, 2016; Yang, Zald, & Blake, 2007). As such, detection latency in this paradigm is often used as an index of the preconscious processing of emotional salience under CFS (Chen & Yeh, 2012; Gobbini, Gors, Halchenko, Hughes, & Cipolli, 2013; Gobbini, Gors, Halchenko, Rogers, et al., 2013; Jiang et al., 2007; Rabovsky, Stein, & Abdel Rahman, 2016; Yang et al., 2007).

However, despite recent evidence that facial attractiveness can be processed even in the complete absence of awareness (Hung et al., 2016), it remains a matter of debate as to whether attractiveness is genuinely processed under CFS (for detail, see Gayet et al., 2014). To ascertain whether the detection latency of target stimuli in the b-CFS paradigm genuinely reflects prioritized processing for the stimuli on a preconscious level, a methodological review of b-CFS (Yang, Brascamp, Kang, & Blake, 2014) recommends two control conditions to be included when using this paradigm: a non-CFS condition and a stimulus control condition. The non-CFS condition is adopted to ascertain whether the faster detection for emotionally salient stimuli actually reflects faster access to conscious awareness. In a typical b-CFS paradigm, emotion-laden stimuli are found to break CFS faster, and thus the delay before detection is thought to be shorter. However, this effect might partially stem from a speeded response to emotional stimuli, and therefore does not necessarily reflect faster breaking of CFS. This issue can be solved by also presenting target stimuli in a non-CFS condition, and comparing detection latencies when the target is not suppressed by CFS.

The other type of control condition involves controlling for properties of the stimulus images. Some b-CFS studies (Chen & Yeh, 2012; Stein, Sterzer, & Peelen, 2012; Yang et al., 2007) have included this kind of stimulus control condition to dissociate relatively high levels of processing (emotional salience, conceptual meaning, etc.) from low levels of processing (color intensity, orientation, spatial frequency, etc.). With regard to faces, scrambled or inverted faces are often used as control stimuli for this purpose (Lê, Raufaste, & Démonet, 2003). Scrambling a face eliminates the face-like configuration (referred to as first-order structure), and makes facial recognition impossible, while face inversion selectively disturbs perception of the precise metrical relationships between facial features (referred to as second-order structure), leading to degraded facial identity recognition (Tanaka & Gordon, 2011; Yin, 1969). If faster detection of attractive faces under CFS depends on preconscious processing of the holistic facial configuration, the effect should be expected to vanish, or at least become weaker, when faces are scrambled or inverted. Regarding face inversion, it has been already demonstrated that a human face is detected more quickly when presented upright rather than when inverted because the upright view of a face is more prototypical than the inverted view (Jiang et al., 2007; Stein et al., 2012; Stein, Senju, Peelen, & Sterzer, 2011).

In the current study, we aimed to replicate Hung et al.'s (2016) results with appropriate control conditions, and to test whether faster detection of attractive faces in the b-CFS paradigm is genuinely attributable to high-level configural processing of the invisible face, through three experiments. Throughout these experiments, we presented a set of faces that differed in attractiveness under CFS and measured the time taken for the faces to break through CFS and emerge into awareness. We anticipated that privileged perceptual and attentional processing of attractive faces, due to their biological importance, would cause them to break through CFS more quickly than would unattractive faces. In Experiment 1, to ascertain whether faster detection of attractive faces is due to faster breaking of CFS, and not merely a speeded response to attractive faces, we also measured simple face detection latency in a non-CFS condition (Stein et al., 2012). In Experiment 2, we presented both intact and scrambled faces to confirm whether faster detection of attractive faces is due to the low-level visual properties of the components of the facial image. In Experiment 3, we examined whether faster detection of attractive faces under CFS dissipates in the case of inverted faces.