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Colored hair affects the facial attractiveness judgment and identification at different time courses

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Abstract

Although faces usually include hair of various colors, the effects of colored hair on face perception have received little attention. Because hair is a part of face in actual interpersonal situations, this study examined how colored hair influences the facial attractiveness judgment and identification with the short and long durations (60 and 1,700 ms). In Experiment 1, the facial attractiveness was relatively consistent across stimulus durations regardless of hair color. Moreover, the individual attractiveness was relatively consistent between blond and black hair at the short duration, but diversified in response to hair color at the long duration. In Experiment 2, the identification accuracy was lower for blond than for black hair only at the short duration. These findings suggest that hair color disrupts the identification of briefly presented faces, whereas it does not impair attractiveness judgments. Instead, hair color modulates perceived attractiveness when faces are viewed for a longer time. These results highlight how external facial features shape interpersonal evaluations depending on the time available for face processing. This temporal pattern may help explain how subtle biases related to physical appearance emerge during rapid social encounters.

Introduction

Faces are socially important cues that convey extensive information, enabling us to infer identity, emotional states, personality traits, and social or physical attributes such as gender, age, race, and health of others. In fact, faces form viewers' first impressions (Zebrowitz, 2017), which in turn influence important decisions in social life, for example, voting (e.g., Atkinson et al., 2009; Todorov et al., 2005), hiring (e.g., Dion et al., 1972; Zebrowitz et al., 1991), and criminal sentencing (e.g., Sigall & Ostrove, 1975; Blair et al.,2004; Jaeger et al., 2020). Although many studies have examined face perception because of its social significance (see Oruc et al., 2019; Young, 2021, for reviews), comparatively little research has focused on the effects of hair, which can be considered as a part of face, on face perception in cognitive psychology (e.g., Toseeb et al., 2012). This limited attention may stem from the view that hair constitutes noise or an extraneous variable that artificially distorts face perception. Consequently, much research has conventionally removed hair or controlled hair color using grayscale images to investigate the nature of face perception when presenting faces as experimental stimuli.

That said, most actual faces include hair of various colors, including gray and these differences may influence viewers' impressions in social contexts. For example, impressions of individuals with colored hair have shown consistent patterns across generations (Nakagawa, 2019). Given that a variety of hair colors are pervasive around us and that faces guide many social judgments, it is important to examine how hair color affects face perception. In Japan, black hair is standard and has traditionally been regarded as a sign of beauty for women. Although the number of people who dye their hair for fashion has increased since the 1990s (Matsuoka, 2002), colored hair remains relatively unpopular in public settings such as schools and workplaces and is often subject to stereotypes, which motivated this study. Under such everyday conditions, how is colored hair basically processed at the early stage of facial perception?

The present study examined how hair color affects facial perception, focusing on facial attractiveness and identification. Previous research (Wills & Todorov, 2006) investigated the time required for trait judgments from faces. Participants judged traits including facial attractiveness for a facial stimulus with the duration of either 100, 500, or 1,000 ms or with no limit of the presentation time. The trait judgment of faces even with 100-ms duration positively correlated with that with no limit of the presentation time. Furthermore, the subsequent study showed that participants could form steady judgments of preference after a mere 50-ms exposure to a female face (Rule & Ambady, 2008). These findings suggest that facial attractiveness can be judged very rapidly, within approximately 50–100 ms. Another study (Bar et al., 2006) examined the minimum duration required for facial identification. Participants were exposed to a facial stimulus of neutral expression with the duration of either 26, 39, or 1,700 ms, followed immediately by a recognition test. Recognition accuracy exceeded chance when duration of facial stimuli was as long as 39 ms. This result suggested that facial identification is possible at least with the duration of 39 ms.

Note, however, that these previous studies used facial stimuli lacking head or of grayscale images, meaning that the effects of hair color were strictly controlled. Building on this prior work, we examined whether facial attractiveness and identification are influenced by hair color when faces are presented for a brief duration. We predicted that colored hair would exogenously capture viewers' attention because of its salience or uniqueness (e.g., Rauschenberger, 2003; Theeuwes, 1994), which in turn would impair the attractiveness judgment and identification for faces shown for very short durations.

Experiment 1

Experiment 1 examined how the attractiveness judgment is influenced by colored hair, manipulating the duration of facial presentations.

Ethical statement

All experiments in this study were approved by the Research Ethics Committee of Chuo University (approval number: 2024-049). Written informed consent was obtained from each participant before the experiment.

Method

Participants

We recruited 32 participants (16 females, mean age = 21.5 years) who were naïve to the purpose of this study. All participants had normal or corrected-to-normal vision.

Apparatus

The stimuli were presented on a 23.8-inch monitor (GW2470, BenQ) with a refresh rate of 50 Hz and a resolution of 1,920 × 1,080 pixels. MATLAB with the PsychoPhysics Toolbox extensions (Brainard, 1997; Pelli, 1997) was used to control stimulus presentation and collection of data.

Stimuli

Color photographs of head-up shots of 80 Japanese models (40 females, aged 18-23) with neutral expressions were used as stimuli. They were controlled for distance, angle, and luminance. Each photograph subtended 5° × 5° of visual angle. The viewing distance was fixed at 57 cm using a chin rest.

We edited 80 photographs by changing color of hair (YouCam Make, Perfect Corp.), creating 80 black hair and 80 blond hair images (160 images in total). From these 160 images, we constructed 2 stimulus sets, each of which included 20 black hair images of men, 20 blond hair images of men, 20 black hair images of women, and 20 blond hair images of women without duplication of identity. One set was used for half of the participants, and the other set was for the other half.

Procedure

When participants pressed the response key on the keyboard, a fixation cross appeared for 500 ms (Figure 1). After that, one of the images appeared in the center of the screen for either 60 ms or 1,700 ms, followed by a color-noise mask of 1,000 ms. Participants were asked to rate the attractiveness of the presented face on a 5-point scale (1 = not attractive at all; 5 = very attractive for half of the participants, with the reverse scale used for the others). They were instructed in advance to judge the attractiveness by focusing on the face while ignoring the hair. After each rating, the next trial automatically began with an inter-trial interval of 500 ms. Hair color (blond or black) was manipulated within participants, with 40 black hair and 40 blond hair images presented in random order (80 trials in total). Stimulus duration (60 ms or 1,700 ms) was manipulated between participants (16 participants for each). Participants completed 10 practice trials followed by 80 experimental trials.

Results

The attractiveness scores were converted so that “5” would be the most attractive. We calculated the mean attractiveness rating made by all the participants for each image under each stimulus duration condition. First, the mean attractiveness ratings were significantly and positively correlated between the durations of 60 and 1,700 ms for both blond hair (N = 80, r = 0.60, p < .001, Figure 2a) and black hair images (N = 80, r = 0.54, p < .001, Figure 2b). The strength of these correlations did not differ significantly (N = 80, z = 0.55, p = .58).

Second, the mean attractiveness ratings were significantly and positively correlated between the blond and black hair images irrespective of whether the stimulus duration was 60 ms (N = 80, r = 0.81, p < .001, Figure 3a) or 1,700 ms (N = 80, r = 0.59, p < .001, Figure 3b). The correlation was significantly weaker at 1,700 ms than at 60 ms (N = 80, z = 2.72, p < .01).

To see whether blond hair increased or decreased the attractiveness ratings, we compared mean attractiveness scores for each image among conditions (Figure 4). A within-subject 2 (hair color: blond and black) × 2 (stimulus duration: 60 and 1,700 ms) two-way analysis of variance (ANOVA)

demonstrated a significant main effect of stimulus duration (F[1,79] = 71.58, p < .001, η_p^2 = .475). Neither the main effect of hair color (F[1,79] = 0.84, p = .36, η_p^2 = .011) nor the interaction (F[1,79] = 0.25, p = .62, η_p^2 = .003) was significant.

Discussion

We investigated how colored hair influences the attractiveness judgment for faces presented for short and long durations. First, the attractiveness ratings made for 60-ms faces with black hair were positively correlated with those for 1,700-ms faces, replicating previous findings (Rule & Ambady, 2008; Wills & Todorov, 2006). Second, even though the hair color was changed to blond, this rapid and stable evaluation was preserved, with the comparable equal effect size. Third, the attractiveness ratings made for individuals of blond hair were positively correlated with the same individuals of black hair, independently of the stimulus duration, though the correlation was weaker for long than for short duration. Fourth, the attractiveness ratings were lower for long than for short durations. Taken together, these results suggest that the attractiveness ratings are relatively fixed (but overestimated) at least for the duration of 60 ms immune to hair color, yet afterwards decreased (or corrected) by the longer duration of 1,700 ms in response to hair color.

Contrary to the prediction, current evidence that hair color did not influence the consistency of the attractiveness judgment between short and long durations suggested that participants were able to ignore colored hair in evaluating faces. However, given the relatively weaker correlation between the black and blond hair images in the long duration, participants spontaneously incorporated hair color into the facial evaluation with a long observation, correcting the attractiveness. Because the facial attractiveness is formed based on holistic processing (Rhodes, 2006; Rhodes et al., 2001), hair would have been automatically used in its formation as holistic information.

Experiment 2

Experiment 2 examined how identification judgments are influenced by colored hair, manipulating the duration of facial presentation.

Method

Participants

We recruited 32 participants (16 females, mean age = 20.6 years) who were naïve to the purpose of this study. All participants had normal or corrected-to-normal vision.

Apparatus and Stimuli

The apparatus and stimuli were the same as in Experiment 1, except that we additionally edited 80 photographs by removing head for the alternatives in the recognition test (Figure 5; see Procedure).

Procedure

The procedure was the same as in Experiment 1 except for the following changes. Instead of the attractiveness rating display used in Experiment 1, a test display consisting of 4 head-lacking faces (alternatives) was presented. Among these faces, one face was the “old” target whose identity was same as that of the immediately preceding face, and the other three faces were “new” distractors of the same gender as the target randomly selected from the other stimulus set. Participants were required to select the target from the test display.

Results

We calculated the mean recognition accuracy of each participant under each hair color and stimulus duration condition and then averaged across participants (Figure 6). First, conducting two-tailed one-sample *t*-tests (vs. chance level = 25 %), we found significantly higher accuracies under all the conditions ($t(15) = 6.86$, $p < .001$, $d = 1.71$; $t(15) = 10.15$, $p < .001$, $d = 2.54$; $t(15) = 39.74$, $p < .001$, $d = 9.93$; $t(15) = 6.86$, $p < .001$, $d = 32.78$).

Second, a mixed-design 2 (hair color: blond and black; a within-subjects factor) × 2 (stimulus duration: 60 and 1,700 ms; a between-subjects factor) ANOVA demonstrated significant main effects of stimulus duration ($F[1,30] = 122.00$, $p < .001$, $\eta_p^2 = .36$) and hair color ($F[1,30] = 16.80$, $p < .001$, $\eta_p^2 = .80$). The interaction was also significant ($F[1,30] = 22.70$, $p < .001$, $\eta_p^2 = .43$), which was derived from the lower accuracy for blond than for black hair images at the duration of 60 ms ($t[30] = 6.27$, $p < .001$) and no such difference at the duration of 1,700 ms ($t[30] = 0.47$, $p = .64$).

Discussion

We investigated how colored hair influenced the identity judgment for short and long durations. First, because the mean recognition accuracy was above chance irrespective of the hair color and stimulus duration, participants were able to identify faces of a 60-ms duration to some degree even with blond hair, replicating and extending previous findings with head-lacking faces (Bar et al., 2006). Second, mean recognition accuracy was lower for blond than for black hair images when they appeared for 60 ms, but not for 1,700 ms. This means that blond hair disrupted the identification judgment only in short duration, which is consistent with the prediction derived from exogenous attentional capture (e.g., Rauschenberger, 2003; Theeuwes, 1994). Participants’ attention would have been quickly and exogenously captured by salient hair color, which in turn disrupted visual processing regarding the identity. As for the long duration, they could have voluntarily ignored hair color.

General Discussion

Previous research on face perception has strictly controlled for hair even though hair is usually processed with the face in actual interpersonal situations. The present study investigated how colored hair influences face perception, especially the attractiveness judgment and identification, manipulating

the stimulus duration. In Experiment 1, we showed that the facial attractiveness rating was relatively consistent between the durations of 60 and 1,700 ms irrespective of hair color, replicating and extending previous findings (Rule & Ambady, 2008; Wills & Todorov, 2006). Moreover, the individual attractiveness was relatively consistent between blond and black hair images at the duration of 60 ms, but reduced and diversified in response to hair color at the duration of 1,700 ms. Therefore, the attractiveness rating would be overestimated with the short observation free from hair color, but subsequently corrected with the long observation with colored hair.

In Experiment 2, we showed that the identification accuracy was above chance whether hair color was blond or black and whether the stimulus duration was 60 or 1,700 ms, replicating and extending previous findings (Bar et al., 2006). However, the identification accuracy was lower for blond than for black hair images when they appeared for 60 ms, but not for 1,700 ms. Therefore, blond hair disrupted the identification only at the short duration, which was consistent with the prediction based on attentional capture. It is likely that visual attention was exogenously captured by blond hair due to its saliency or uniqueness (e.g., Rauschenberger, 2003; Theeuwes, 1994) at least in Japan, which disrupted the identification of the briefly visible face. Attention would have been endogenously directed to the face while ignoring the hair when there was sufficient time to observe the stimulus. One may argue that the observed effects of colored hair stem from artificiality introduced by image editing. However, this possibility is unlikely because we edited not only blond but also black hair images based on the original images in both Experiments 1 and 2.

Taken together, we found two distinct functions of hair color in face perception at different time courses. First, colored hair could exogenously disrupt the identification, but not the attractiveness judgment, of the briefly presented faces. Second, colored hair could be spontaneously incorporated into the facial attractiveness judgment, but not influential on identification, of the lengthily presented faces. Because object identification generally requires attention as proposed in the feature-integration theory (Treisman & Gelade, 1980) or the two-stage model on temporal visual processing (Chun & Potter, 1995), it is vulnerable to the disadvantage of visual attention as seen in various deficits in visual processing (Mack & Rock, 1998; Raymond et al., 1992; Simons et al., 1998; Treisman & Schmidt, 1982). By analogy, face identification in Experiment 2 would be disrupted by attention temporarily deprived by colored hair since it also requires attention (Lavie et al., 2003) based on not only holistic but also local processing (Bruce & Young, 1986; Maurer et al., 2002). On the other hand, the attractiveness judgment would be unaffected by temporary attentional deprivation in Experiment 1, which is consistent with previous evidence that the attractiveness judgment does not necessarily require attention (Hung et al., 2016; Olson & Marshuetz, 2005; Sasaki & Ariga, in press).

Interestingly, at the long duration, colored hair was automatically used for the facial attractiveness judgment in Experiment 1, even though participants were able to voluntarily direct their attention to the face while ignoring the hair. This is likely because the attractiveness judgment is primarily achieved through holistic processing (Rhodes, 2006; Rhodes et al., 2001). The longer observation allowed

participants to process the surrounding information holistically, perceiving the face and hair as a single unit. Therefore, the effects of hair are unavoidable in the facial attractiveness judgment.

Several limitations should be noted. First, it remains unclear that attention was indeed directed toward blond hair. To address this, future research should directly examine attentional allocation, for example using a dot-probe task (MacLeod et al., 1986). Second, cultural differences may have influenced present findings. In Japan, black hair has been traditionally standard and a sign of beauty, deviating blond hair. It would be interesting to investigate whether black hair disrupts facial identification in other countries where blond hair is standard. If it were the case, the current findings could not be explained by physical characteristics of hair color, but by social or cultural norms.

In sum, colored hair disrupts accurate identification at a quick glance, whereas it affects the attractiveness judgment during extended observation. Importantly, these processes occur automatically even though viewers try to ignore hair. Therefore, we should/could not ignore the effects of hair color when investigating face perception, especially under social situations.

Declarations

Acknowledgements

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Competing Interests

None.

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Figures

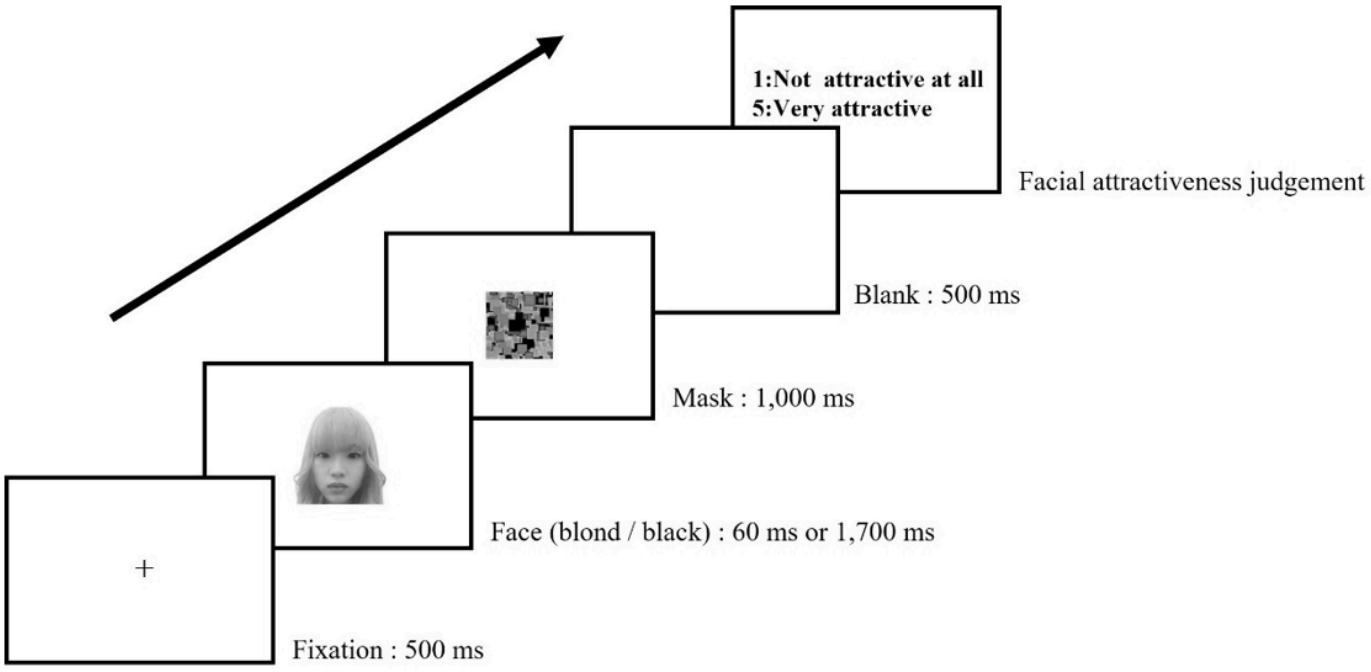


Figure 1

A schematic illustration of one trial in Experiment 1. The stimulus and mask were presented in color in the actual experiment.

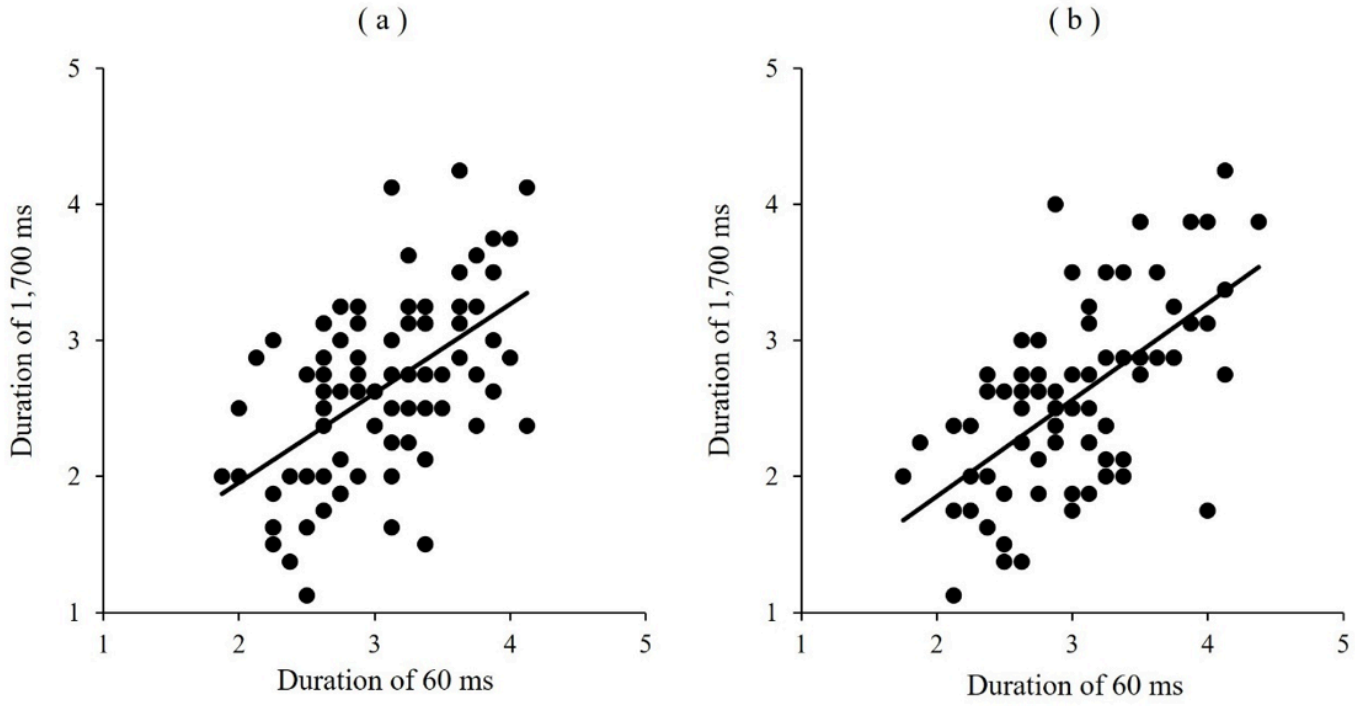


Figure 2

The correlations between the stimulus durations of 60 and 1,700 ms for blond hair images (a) and black hair images (b).

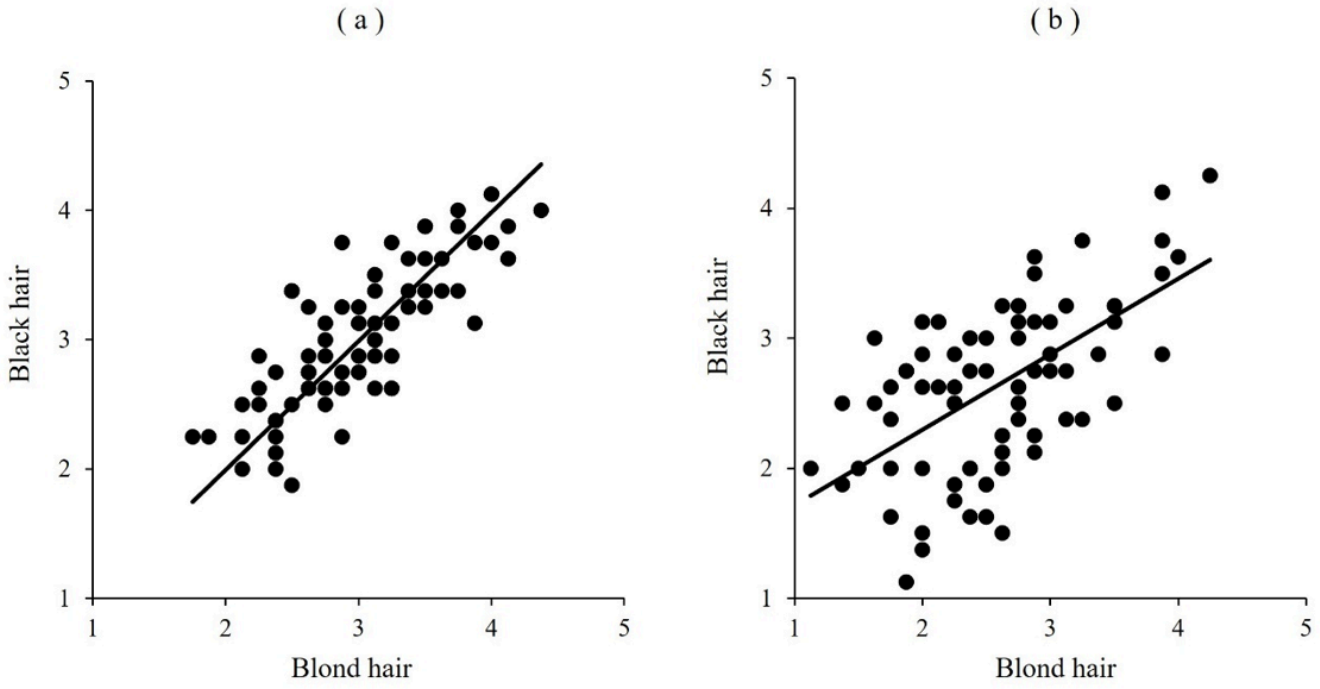


Figure 3

The correlations between the blond and black hair images for the stimulus duration of 60 ms (a) and 1,700 ms (b).

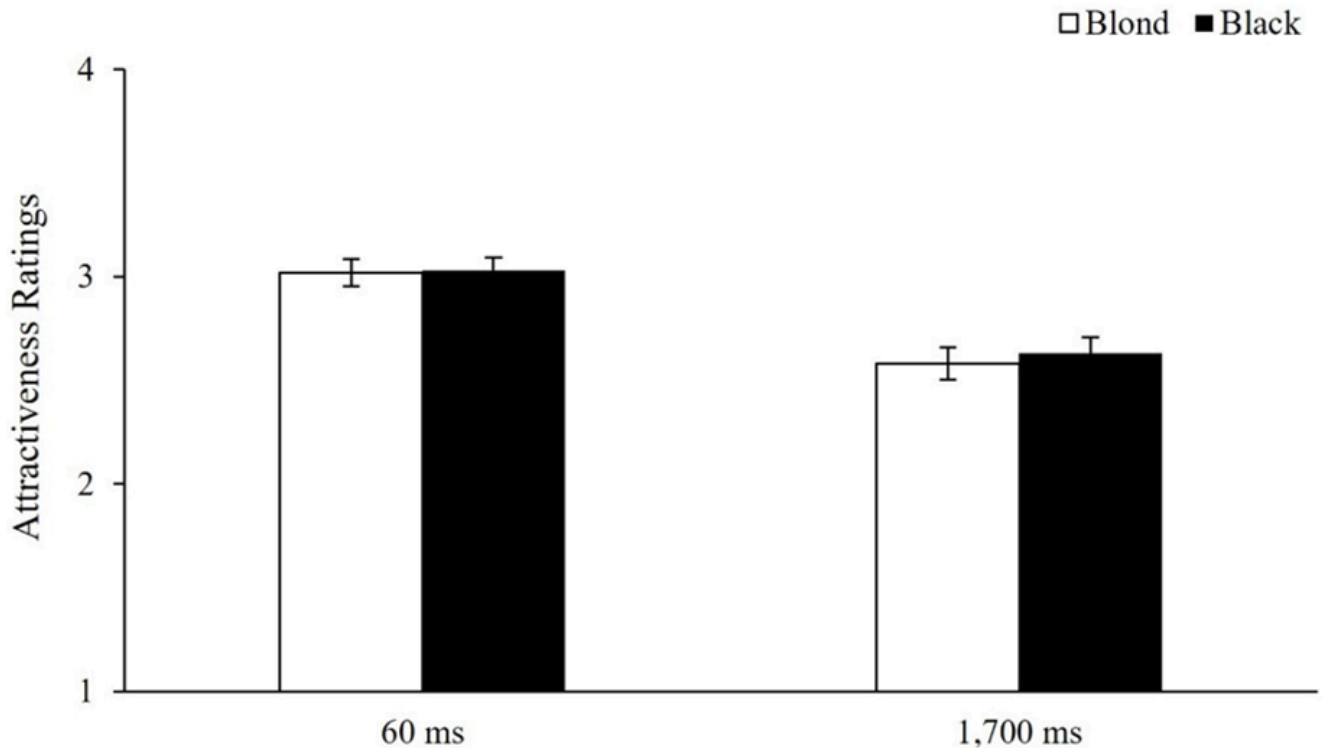


Figure 4

The mean attractiveness scores for blond and black hair images under stimulus durations of 60 and 1,700 ms.

Note. Error bars indicate the standard error of the mean.

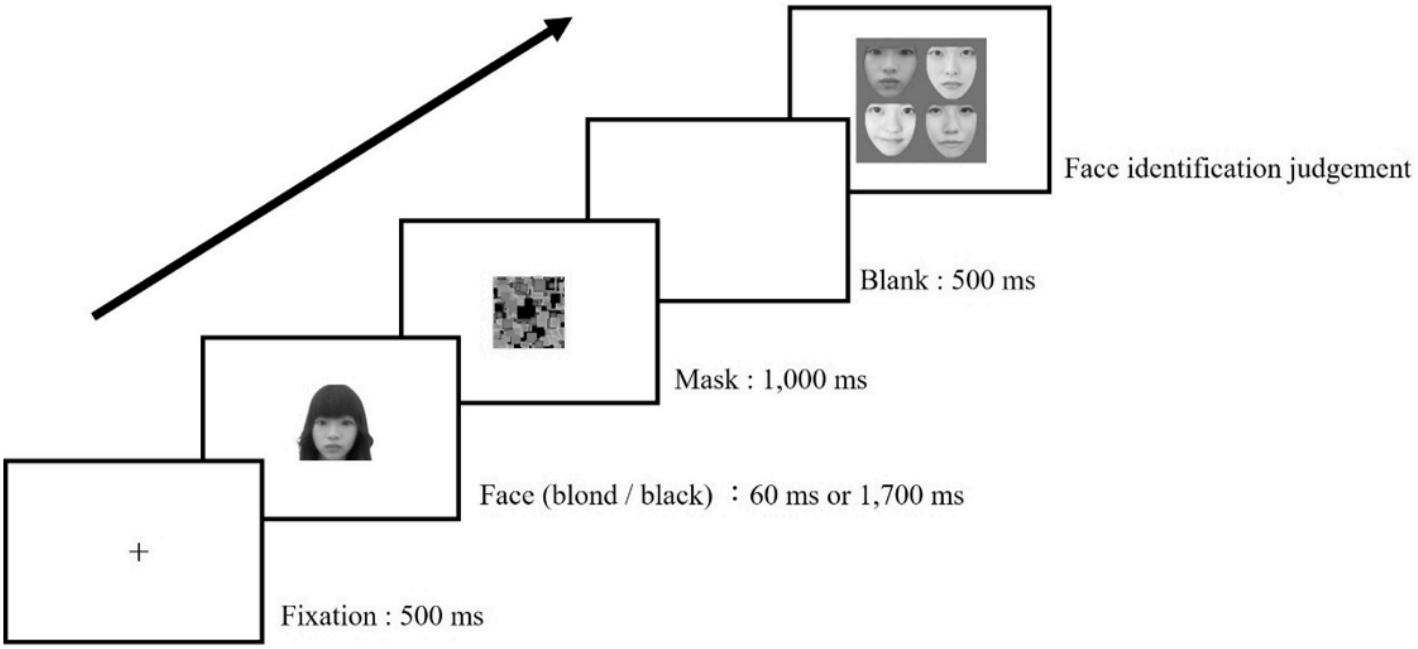


Figure 5

A schematic illustration of one trial in Experiment 2. The stimulus and mask were presented in color in the actual experiment.

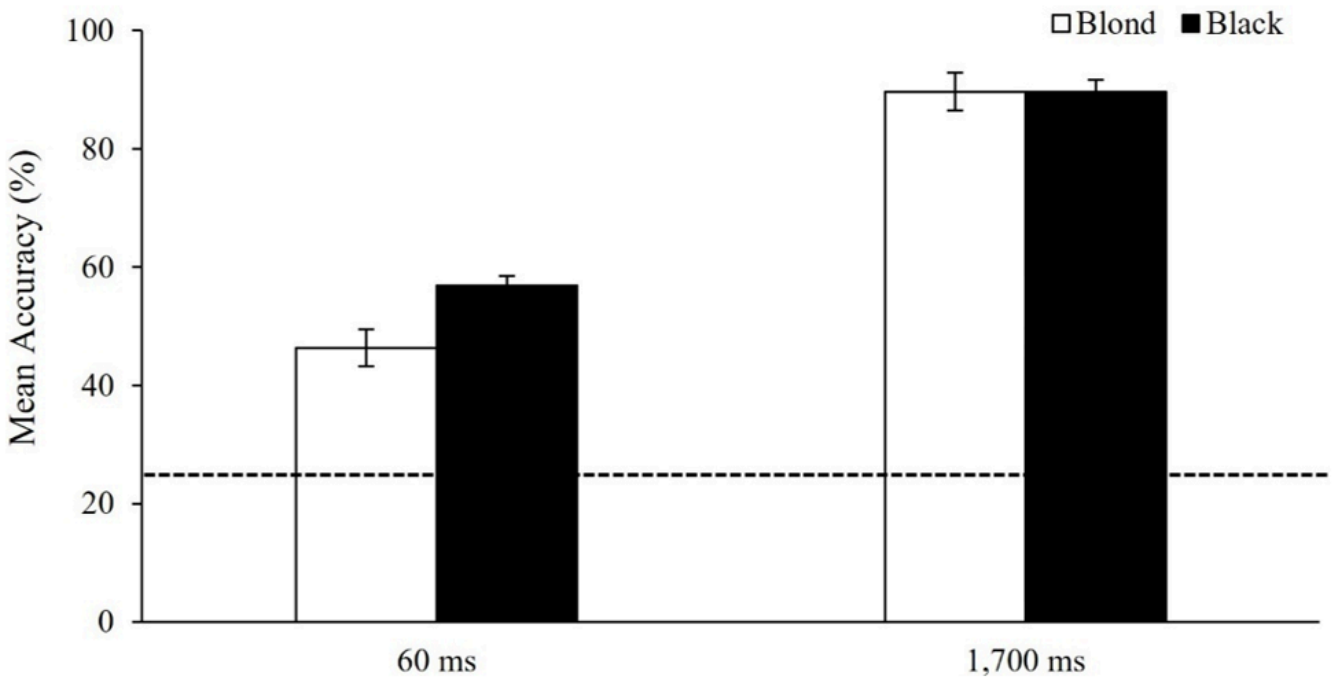


Figure 6

The mean recognition accuracy for blond and black hair images under stimulus durations of 60 and 1,700 ms.

Note. Error bars indicate the standard error of the mean.