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Abstract

Another individual’s gaze automatically shifts an observer’s attention to a location. This reflexive response occurs even when the gaze is presented subliminally over a short period. Another’s gaze also increases the preference level for items in the gaze direction; however, it was previously unclear if this effect occurs when the gaze is presented subliminally. This study showed that the preference levels for nonsense figures looked at by a subliminal gaze were significantly greater than those for items that were subliminally looked away from (Task 1). Targets that were looked at by a subliminal gaze were detected faster (Task 2); however, the participants were unable to detect the gaze direction (Task 3). These results indicate that another individual’s gaze automatically increases the preference levels for items in the gaze direction without conscious awareness.

Keywords: gaze, attention, subliminal, preference

Subliminal Gaze Cues Increase Preference Levels for Items in the Gaze Direction

People tend to follow another individual's gaze direction because it provides important information about the items or locations to which the person performing the gaze (i.e. the gaze sender) is paying attention. Previous studies have shown that people can detect a target that is in the direction of another individual's gaze faster than one in the opposite direction (Frischen, Bayliss, & Tipper, 2007; Posner, 1980). This tendency is referred to as a gaze-evoked shift of attention. Furthermore, this tendency occurs when the gaze appears subliminally over a short period (Al-Janabi & Finkbeiner, 2012; Bailey et al., 2014; Sato, Okada, & Toichi, 2007), indicating that people respond reflexively to another's gaze, which helps them to detect risks or events quickly.

Another individual's gaze not only shifts the observer's attention but also affects their preference levels for the items that are gazed at. Bayliss, Paul, Cannon, and Tipper (2006) showed that the preference level for an item in another's gaze direction was significantly greater than that of an item presented in the opposite direction. Many follow-on studies have also confirmed that another's gaze increases the preference levels for items that are gazed at (King, Rowe, & Leonards, 2011; Strick, Holland, & van Knippenberg, 2008; Treinen, Corneille, & Luypaert, 2012; Ulloa, Marchetti, Taffou, & George, 2015; van der Weiden, Veling, & Aarts, 2010). However, it is unclear whether subliminal gaze cues affect the preference levels for items in the gaze direction. Therefore, this issue was examined in the current study.

Preference changes without conscious awareness in response to subliminal visual stimuli have been shown in the mere exposure effect, in which repetitive subliminal exposure to an item increases the preference level for that item (Bornstein, Leone, & Galley, 1987). Therefore, subliminal gaze cues, which can shift an observer's attention without their conscious awareness, are also expected to affect the preference levels for items that are gazed at. However, the subliminal mere exposure effect has boundary conditions, especially in its use for advertisements or marketing; the effect depends on the observer's task context, habits, and desire (Smarandescu & Shimp, 2015; Verwijmeren, Karremans, Stroebe, & Wigboldus, 2011). The increase in preference levels for items that are gazed at by supraliminal faces also varies according to the experimental conditions, including trustworthiness (King et al., 2011; Treinen et al., 2012), facial expression (Bayliss, Frischen, Fenske, & Tipper, 2007), attractiveness (Strick et al., 2008), gender (Mitsuda & Yamamoto, 2015), and number of gaze senders (Capozzi, Bayliss, Elena, & Becchio, 2015). Even when gaze cues appear subliminally, facial expressions affect the observer's attention (Bailey et al., 2014) and their impressions of ideographs that are presented after the subliminal gaze cue (Sato, Kubota, & Toichi, 2014). Therefore, the effect on preference levels for items that are gazed at by subliminal faces may also vary by facial expression. In addition to the high sensitivity to the gaze senders, the smaller effect of subliminal gaze cues on preference levels for items that are gazed at might explain why, to date, no paper has reported this effect.

Bayliss, di Pellegrino, and Tipper (2005) showed that people respond more quickly to targets that are gazed at by female faces than male faces. Mitsuda and Yamamoto (2015) reported that the increase in preference levels for items that were gazed at was greater when the gaze senders were female than male, regardless of the observer's gender. Furthermore, more attractive (Strick et al., 2008) and happy faces (Bayliss et al., 2007) increase the preference levels for items that are gazed at. Therefore, this study used attractive smiling female faces, anticipating the greatest effect, to examine if subliminal gaze cues change preference levels for items that are gazed at. Investigating the effects of subliminal gaze cues contributes to understanding whether the mechanism underlying the preference increase by supraliminal gaze cues is a reflexive process or a higher-level cognitive process that operates consciously.

In this study, we conducted an experiment to examine our hypotheses that subliminal gaze cues not only shift an observer's attention but also increase the preference levels for items that are gazed at. The experiment contained three tasks. In Task 1, we examined the effect on preference levels for nonsense figures that were gazed at subliminally when participants rated the favourability of the figures. In Task 2, we recorded attentional shifts in response to subliminal gaze cues and investigated the correlation with increases in preference levels for items that were gazed at subliminally. In Task 3, we checked if participants were able to detect the gaze cues after informing them of the subliminal presentations.

Method

Participants

Thirty-two students from Ritsumeikan University (16 females and 16 males, M_{age} = 21.9 years, SD = 1.6) participated in this study voluntarily for no payment. All participants provided written informed consent. This experiment was approved by Ritsumeikan University ethics review committee for research involving human participants and was conducted in accordance with the Declaration of Helsinki.

Apparatus

The stimuli were presented on a 24-inch display monitor (XL2411Z; BenQ Corp., Taipei, Taiwan) located 70 cm from the participants using a homemade program written in C programming language. The display's refresh rate was 120 Hz.

Stimuli

We created 30 young East Asian female faces with a slight smile lifting the corners of their mouths using the FaceGen software (Singular Inversions Inc., Toronto, Canada). Eighteen students (nine females and nine males, M_{age} = 22.1 years, SD = 0.9) who did not participate in the experiment evaluated the faces' attractiveness (1: not attractive at all; 7: very attractive) and degree of smile (1: no smile at all; 7: smiling very much) on a 7-point scale. We used the top 10 faces, based on the average ratings of attractiveness and degree of smile (attractiveness: M = 4.45, SD = 0.46; smile M = 5.22, SD = 0.40), as the gaze senders in the experiment. For each of the selected faces, we used the same software to create a face looking ahead and two faces looking to the right or left without rotating the head (Figure 1). The image size of the faces was H 8.4 × V 8.4 degrees.

For the preference evaluation task, we used nonsense geometrical figures created by Endo, Saiki, Nakao, and Saito (2003). These figures comprise hand-drawn contours in which the lines do not cross over each other. We scanned 100 figures from the paper and changed the size to equal that of the face images. Ten students who did not participate in the experiment (M_{age} = 20.7 years, SD = 1.5) rated their preference level for each figure on a 7-point scale (1: not favourable at all; 7: very favourable). We then used 80 figures (preference level M = 4.00, SD = 0.32) out of the 100 figures for the experiment by eliminating the top 10 and lowest 10 figures in terms of ratings.

INSERT FIGURE 1 HERE

Procedure

Half of the participants performed a preference evaluation task (Task 1) followed by a target detection task (Task 2). The remaining participants performed these in reverse order. After performing the two tasks, the participants were informed about the subliminal gaze-cue stimuli and responded to a survey about whether they had noticed the subliminal presentation of gaze cues during the data collection. They then performed a gaze detection task (Task 3) and responded to the same survey.

Task 1. Figure 2a presents the time course of the stimuli presentation. A fixation cross (H 1.6 × V 1.6 degrees) appeared for 1,000 ms in the centre of the screen, followed by a face looking ahead. After 1,000 ms, the face changed into the same face looking right or left and, simultaneously, a nonsense figure appeared on one side of the face. The face changed into a mask image after 8 ms, and the same face then reappeared after 192 ms. This sequence was then repeated. The face appeared five times interleaved with mask images for 1,000 ms. Participants had to evaluate the preference level for the figure on a 7-point scale, ranging from -3 (*not favourable at all*) to 3 (*very favourable*), by clicking a number image on the screen after the mask image had disappeared. The nonsense figure remained until the participants had responded.

During the subliminal face presentations for 1,000 ms, the mask images were updated every 8 ms. Each mask image consisted of 5,000 white dots (H 0.1 × V 0.1 degrees) located at a randomised position on a black background of the same size as the face image. When participants pressed a key to register their response, the central fixation cross appeared for the next trial. Participants performed 80 trials in which the gaze sender looked to the right or left for 40 trials each. The subliminal faces gazed at a nonsense figure in 40 trials and looked away from the figure in 40 trials. The gaze direction and target position were determined randomly, appearing on the right or left side an equal number of times. The nonsense figures and face images were randomly paired in each trial, with each of the 10 faces appearing in 8 out of the 80 trials and each of the 80 nonsense figures appearing only once. Participants practised using dummy images until they were familiar with the task before the data collection began.

INSERT FIGURE 2 HERE

Task 2. Figure 2b presents the time course of the stimuli presentation. The presentation of the subliminal gaze cues was the same as in Task 1 but, in this task, a circular mark (1.6 degrees in diameter) appeared after the subliminal gaze cues and masks. Participants had to report the position of the mark as soon as possible by pressing the Z key (left) or X key (right). Participants performed 80 trials. The gaze position and position of the circular mark were determined randomly as in Task 1.

Task 3. After performing Tasks 1 and 2, participants were asked whether they had noticed that a face with an averted gaze was interleaved with the mask images. No participants reported having noticed the gaze cues. After the survey, participants were informed about the subliminal gaze cues. They then performed a gaze detection task. The presentation of the subliminal gaze cues was the same as in Task 1, but, in this task, no stimuli appeared after the subliminal gaze cues and masks. Participants had to report the gaze position by pressing the Z key (left) or X key (right) after the disappearance of the mask image. Even when they were unable to detect the gaze position, they had to press a key based on their estimation. Participants performed 40 trials in which the gaze position was on the right or left for 20 trials each. The order of the gaze positions was randomised. After the data collection, participants were asked whether they had been able to detect the gaze directions. The three tasks were performed with a break of approximately 5 minutes between each. The total data collection took approximately 50 minutes.

Results

Task 1. A two-way repeated measures analysis of variance of the target position and gender of the observers showed a significant main effect of the target position, $F(1,30) = 8.7$, $p < .01$, $\eta_p^2 = 0.23$. There was no significant main effect of gender, $F(1,30)$

< 0.1, or any interaction, $F(1,30) < 0.01$. The preference level for figures that were gazed at (M = -0.125, SEM = 0.092) was significantly greater than that of figures that were looked away from, M = -0.352, SEM = 0.089, $t(31) = 3.00$, $p = .0053$, $d_z = 0.53$. The difference in preference was significantly greater than chance for female observers, M = 0.231, SEM = 0.086, $t(15) = 2.68$, $p = .017$, $d_z = 0.67$, but not for male observers, M = 0.223, SEM = 0.128, $t(15) = 1.75$, $p = .101$, $d_z = 0.44$.

Task 2. A two-way repeated measures analysis of variance showed a significant main effect of the target position, $F(1,30) = 6.65$, $p < .05$, $\eta_p^2 = 0.181$. There was no significant main effect of gender, $F(1,30) < 0.1$, or any interaction, $F(1,30) < 1$. The response time to targets that were gazed at (M = 0.323 s, SEM = 0.007) was significantly shorter than that of items that were looked away from, M = 0.335 s, SEM = 0.008, $t(31) = 2.62$, $p = .013$, $d_z = 0.46$. The difference in response time was significantly greater than chance for female observers, M = 0.008 s, SEM = 0.004, $t(15) = 2.37$, $p = .031$, $d_z = 0.59$, but not for male observers, M = 0.014 s, SEM = 0.008, $t(15) = 1.79$, $p = .094$, $d_z = 0.45$.

Task 3. No participants reported that they had noticed a face with a gaze cue interleaved with the mask images before or after the recording of the gaze detection task. Furthermore, the likelihood of correctly detecting the gaze positions (M = 0.507, SEM = 0.015) did not differ from chance, $t(31) = 0.48$, $p = .63$, $d_z = 0.09$. The likelihood for male observers (M = 0.514, SEM = 0.023) did not differ from that of female observers, M = 0.500, SEM = 0.019, $t(30) = 0.48$, $p = .64$, $d = 0.17$.

Correlation analysis. The correlation between the increase in preference level in response to the subliminal gaze cues in Task 1 and the difference in response time according to the gaze directions in Task 2 was not significant ($r = 0.04$, $p = .83$). There was also no significant correlation between the correct ratio in Task 3 (i.e. the likelihood of correctly detecting the gaze positions) and the preference increase in Task 1 ($r = 0.20$, $p = .28$). The correlation between the correct ratio in Task 3 and the difference in response time according to the gaze directions in Task 2 was significant ($r = 0.54$, $p = .001$). However, when the three outliers regarded by the Grubbs' test (significance level .05) using the difference in response time were removed from the analysis, the significance almost disappeared ($r = 0.086$, $p = .66$). The participant for one of the three outliers detected the target in the gaze direction much faster (79 ms) than in the other direction. He was also able to detect the gaze direction at a high correct ratio (0 .675). However, another participant for an outlier demonstrated the opposite behaviour (difference in response time, -58; correct ratio, .375). Thus, some participants may have been able to detect the subliminal gaze cue unconsciously, but further investigation is required. We also checked if these outliers affected the results, and confirmed that the exception of the outliers did not change the significant difference in subliminal gaze cues in terms of preference, $t(28) = 3.34$, $p = .0024$, $d_z = 0.62$, in Task 1, or response time, $t(28) = 3.52$, $p = .0015$, $d_z = 0.65$, in Task 2.

Discussion

In accordance with our hypotheses, subliminal gaze cues not only shifted an observer's attention but also increased the preference levels for items that were gazed at. Additionally, targets that were looked at by a subliminal gaze were detected faster; however, the participants were unable to detect the gaze direction. These results demonstrate that another individual's gaze automatically increases the preference levels for items in the gaze direction without conscious awareness. In this study, we employed attractive smiling female faces as the gaze senders to enhance the effect. Furthermore, we presented subliminal gaze cues after displaying the supraliminal face with a straight gaze. Serially presenting the face with a straight gaze and the same face with an averted gaze may have enhanced the perception of gaze direction, in which the gaze is the only difference between the supraliminal face and subliminal faces. Simultaneously, prior knowledge of the face might have affected subliminal perception. We also presented a subliminal gaze cue interleaved with mask images that was repeated five times in a trial. The number of presentations of a gaze cue could change the magnitude of the effect.

However, previous studies that reported attentional shift by subliminal gaze cues (Al-Janabi & Finkbeiner, 2012; Bailey et al., 2014; Sato et al., 2007) did not present a supraliminal face, and presented the subliminal face just one time. Presenting a supraliminal face and increasing the repetition number are expected to enhance the gaze cue effect; however, further investigation is required.

Investigating individual differences in sensitivity to subliminal gaze cues is also an interesting issue for future research. Many studies have shown that attentional shifts in response to supraliminal gaze cues are stronger in female than in male observers (Alwall, Johansson, & Hansen, 2010; Bayliss et al., 2005; Deaner, Shepherd, & Platt, 2007; Feng et al., 2011; Merritt et al., 2007). Gender differences might exist in the effect of subliminal gaze cues on preference levels, in addition to the effect of supraliminal gaze cues (Mitsuda & Yamamoto, 2015).

The study results reconfirm that the response time to a target gazed at by others is shorter than that for targets that are looked away from. However, no correlation appeared between the shortening of the response time and the preference increase in response to subliminal gaze cues. Bayliss et al. (2006) showed that a shift of attention is caused not only when a gaze cue appears but also when an arrow marker appears. They also showed that the arrow marker does not increase the preference level for items to which it directs attention, which indicates that the mechanism for attentional shift in response to gaze cues or arrow markers may differ from the mechanism for preference increase in response to gaze cues. The lack of correlation between response time and preference increase observed in this study shows not only that the attentional shift and preference increase by gaze cues are based on different cognitive processes but also that the magnitude of the effects differ between participants. Similar to the effects of supraliminal arrow markers, subliminal arrow markers might not increase the preference levels for items to which they direct attention, which is an interesting topic for further study.

However, in future studies, we must interpret the significance of subliminal gaze cues carefully because the presentation method and stimuli can modulate the magnitude of the effect. In this study, we presented the subliminal gaze cues for 8 ms for all participants, which is shorter than in previous studies (Al-Janabi & Finkbeiner, 2012; Bailey et al., 2014; Sato et al., 2007). The duration of presenting subliminal stimuli not only switches the condition between supraliminal and subliminal but could also modulate the effect continuously. Therefore, the relation between the method of presenting subliminal stimuli and the effect should be investigated further.

Disclosure statement

The authors report no conflicts of interest.

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Figure Legends

Figure 1. An example of a straight gaze and an averted gaze toward an item presented on one side of the screen.

Figure 2. Schematics of (a) the preference evaluation task (Task 1) and (b) the target detection task (Task 2).

Figure 1 An example of a straight gaze and averted gazes toward an item presented on one side of the screen.

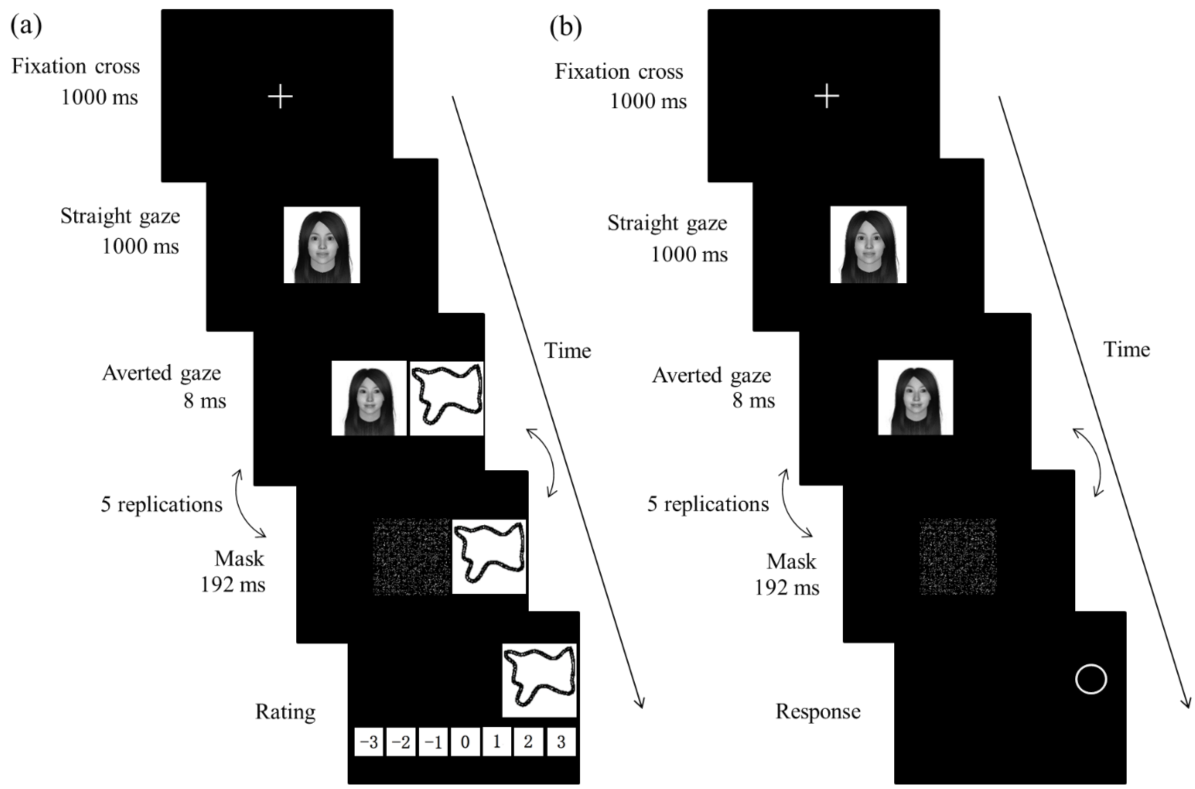

Figure 2 Schematics of (a) the preference evaluation task (Task 1) and (b) the target detection task (Task 2).