



Article

Face Preference in Infants at Six and Nine Months Old: The Effects of Facial Attractiveness and Observation Experience

Kana Kuraguchi ^{1,*}, Kosuke Taniguchi ² , Kei Kanari ³  and Shoji Itakura ⁴¹ Faculty of Psychology, Otomon Gakuin University, Osaka 567-8502, Japan² Faculty of Child Care and Education, Osaka University of Comprehensive Children Education, Osaka 546-0021, Japan; k-taniguchi@jonan.ac.jp³ Department of Fundamental Engineering, Utsunomiya University, Tochigi 321-8585, Japan; kanari@is.utsunomiya-u.ac.jp⁴ Center for Baby Science, Doshisha University, Kyoto 619-0225, Japan; sitakura@mail.doshisha.ac.jp

* Correspondence: k-kuraguchi@otomon.ac.jp or kanakuraguchi@gmail.com

Received: 24 May 2020; Accepted: 24 June 2020; Published: 1 July 2020



Abstract: Attractiveness is perceived based on both facial physical features and prior experience for adults. Infants also prefer attractive or familiar faces, but it is unclear whether facial physical features and prior experience affect their preference. In this study, we investigated whether infants' preference for faces was shaped by both facial physical features and facial looking experience. This experiment comprised two tasks, observation and preference looking. We manipulated fixation durations in the first task (observation experience) to differ between presented faces and measured the preference for faces in the second task right after the observation task. We conducted two experiments: the same faces in the same positions through both tasks in Experiment 1, and the same faces in different positions in Experiment 2, and analyzed the interaction between observation experience and attractiveness of face images in terms of preference. Observation experience and facial attractiveness only affected preference in Experiment 2: Infants generally looked longer at the flickered position but different face, but looked for the attractive face when the face in the flickered position changed from attractive to unattractive. We suggest that observation experience arouses spatial attention, and that facial attractiveness attracts infants' attention only when they notice changes of faces.

Keywords: face; infant; preference looking; attractiveness; observation experience

1. Introduction

Facial attractiveness is enhanced by some facial physical features such as symmetry [1,2], averageness [3], sexual dimorphism [4–7], large eyes [8–10], and facial expressive features [8,11,12]. Most of these features are suggested to have evolutionary advantages, especially in mate selection. For instance, facial symmetry relates to good health and potential heritable fitness, because symmetry in humans is an honest indicator of the ability to cope with developmental stress and of phenotypic and genotypic quality [13–15]. Preference for symmetry has also been suggested to appear as a result of avoiding asymmetry, indicating something ill, rather than choosing symmetry [16]. On the other hand, the observer's experience also enhances the attractiveness of a face. For example, the mere exposure effect is well known, whereby visual stimuli, including face images, observed beforehand are rated more attractive than new ones [17]. Mere repeating affects the attractiveness of a person in daily life, even if the observer did not interact with the person earlier [18]. Peskin and Newell [19] showed that more contact with a face increase its attractiveness, and Cooper and Maurer [20] found that preceding experience affected the attractive arrangement of face. In addition, the students at girls'

or boys' schools prefer the faces closer to their own sex prototype more than students at coeducational schools do [21]. Thus, humans tend to rate preceding or familiar faces as attractive.

Infants prefer attractive faces and tend to look longer at an attractive female face than an unattractive one, which arises at six months of age [22,23]. The preference for larger eyes in photographed faces emerges at five months of age [9]. Therefore, the discrimination of attractiveness is suggested to be an important ability for humans. On the other hand, experience also affects face preference. Four-day-old neonates looked longer at their mother's face than at a stranger's face [24], but it was suggested that they discriminate their mother's face from strangers based on features such as hair lines and outer contours [25]. Four-month-old infants prefer their mother with hairstyle absent [26]. Infants aged three to four months prefer female faces when their primary caregiver is a woman, and vice versa [27]. The preference for faces of own race than other races is also present in nine-month-olds [28]. Therefore, experience shapes infants' preference for faces in a similar way as in adults and then enlarges the preference category along with development, mainly centering on people who have frequent contact with them. The preference for attractive faces may be shaped by the interaction between the physical features of the face itself and observation experience of the face.

In this study, we investigated whether infants' preference for faces was affected by not only the face itself but also looking experience to the face. To generate the difference in observation experience, we manipulated fixation duration to a particular face among simultaneously presented faces by bottom-up attention. In addition, we investigated whether the interaction between observation experience and attractiveness of face images appeared in preference looking. Fixation duration to each stimulus during a paired comparison is an informative behavioral measure of infant attention. Longer fixation duration shows the infant's attention or preference for the stimulus. If infants prefer the face they looked at for longer before than the other one, this may indicate a familiarity preference but not a novelty preference. For adults, familiar faces were preferred [29], so this tendency may be found for infants. In this case, the influence of observation experience on face preference may be demonstrated. If infants prefer an attractive face regardless of observation experience, this may indicate the effect of attractiveness as it captures infants' attention. In this study, we targeted 6- and 9-month-old infants, because the discrimination of attractiveness arises at 6 months of age [30], and the preference based on experience arises at 9 months [28]. Therefore, the effect of attractiveness on face preference would occur even in 6-month-old infants, but the fixation duration at the face would be longer in 9-month-old infants and the effect of attractiveness on face preference would be more pronounced. In order to examine the relationship between attractiveness and observation experience, it is also necessary to ensure that the observation experience is attributed to the face itself rather than to the location of the face's presentation. We also conducted two experiments to investigate whether observation experience by bottom-up attention affects the face itself or the presentation position: the same faces in the same position through observation and preference looking tasks in Experiment 1, and the same faces in different positions in Experiment 2. If infants in Experiment 2 look at the same face in a different position for longer, it can be suggested that the observation experience is attributed to the face itself rather than the presentation position. Moreover, if the effects arise differently depending on attractiveness, we can suggest that a combination of attractiveness and observation experience shapes facial preferences.

2. Experiment 1

2.1. Methods

2.1.1. Participants

The participants consisted of 10 Japanese infants aged 6 months (five boys and five girls; $M = 198.00$ days, $SD = 8.92$) and 10 Japanese infants aged 9 months (five boys and five girls; $M = 282.30$ days, $SD = 6.94$). We recruited infants of relevant age from the list of participants at the Center for Baby Science, Doshisha University. Parents provided verbal confirmation of the infants' good health condition. We obtained written informed consent from the parents of all participants

before starting the experiment and paid a reward according to the standards of Doshisha University. This study was approved by the Ethics Committee of Doshisha University (Approved Number: 19038) and was conducted in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki).

2.1.2. Stimuli

The stimuli consisted of facial images of 20 Japanese women (18–25 years, undergraduate and graduate students) in frontal view with a neutral expression. All images were presented in greyscale. For the first observation, we used movie stimuli (10 s) where two faces were presented simultaneously and one of the faces was accompanied by a flickered outline of an image with a width of approximately 0.5 degrees of visual angle. The flicker interval was 0.5 s and the area outside the faces was filled with black color. The face images were presented with a size of 12×12 degrees at eight visual angles from the center of the screen to the center of the face image. For the second task, preference looking, we used image stimuli where the same two faces were presented in the same position and same size.

2.1.3. Procedure

The infants were seated on their parent's lap and the parent was seated on a chair in front of the monitor. The visual distance was about 60 cm. The parent was asked to sit still during the experiment.

This experiment consisted of two stages: first, observation, and second, preference looking (Figure 1). Calibration was performed prior to the start of the observation phase, with five-point attention getters. For both stages, all trials began with the attention-capturing stimulus in the center of the screen to attract the infants' attention. Following the stimulus, two faces were presented for 10 s on the right and left of the screen. We measured infants' gaze when observing faces by an eye tracker. In only the observation stage, one of the face images was accompanied by the flickered outline of the image. In the preference looking stage, the same faces were presented in the same position as the first observation. We set three conditions for face pairs: attractive-attractive, unattractive-unattractive, and attractive-unattractive. The mean attractiveness score of faces was 5.19 for attractive faces and 2.75 for unattractive faces in a pilot study where adults rated facial images on a 7-point scale. Participants observed 15 pairs (5 pairs \times 3 conditions) total. Pairs of faces and presented position (left or right) were counterbalanced between participants but consistent in the two stages.

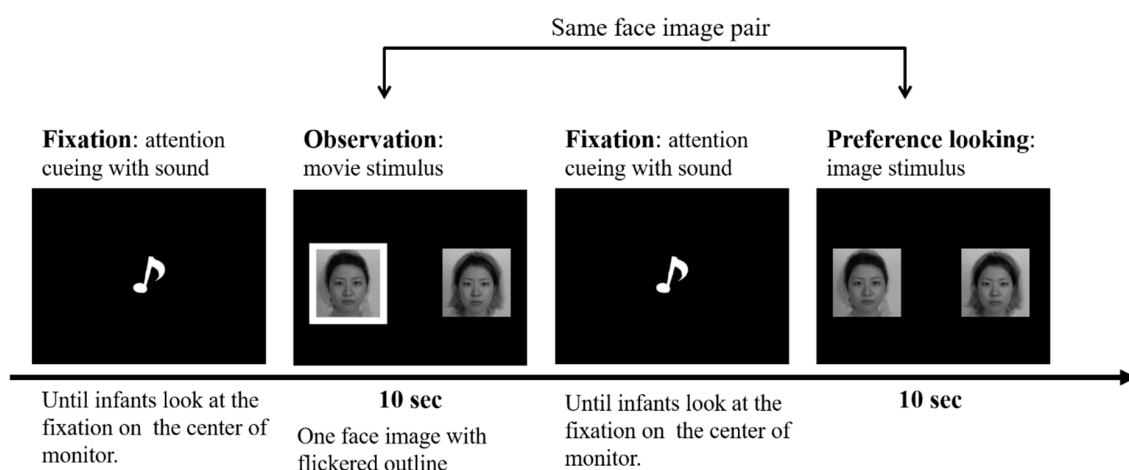


Figure 1. Procedure of a trial in this experiment. The face images in this figure are average faces to protect models' privacy, but original faces were used in the experiment.

2.1.4. Apparatus

The stimulus was presented on a 20-in LCD display (Dell 2001FP, 1600×1200 pixels) with a refresh rate of 60 Hz. We used an eye tracker (Tobii X3-120) to measure infants' gazes with a sampling rate of 120 Hz. We controlled the experiment and analyzed the fixation duration with Tobii Pro Studio.

2.1.5. Data Analysis

All fixation duration data used were provided by Tobii Pro Studio. In the observation phase using movies, we aimed to differentiate the observation time by using a flickered stimulus in order to perform an experimental manipulation of giving the observation experience to the face. Therefore, it is necessary to check whether the observation time of the paired-presented faces differs depending on the flickered stimulus during the observation phase. In addition, because the subsequent preference looking phase treats the experience formed by the flicker as a factor that does not intertwine with attractiveness, it is necessary to ensure that there is no interaction between the flickered and attractiveness in the observation phase. Furthermore, it is also necessary to check whether the effect of flickering depends on age. Therefore, a three-way ANOVA (month \times flickered \times attractiveness) was conducted in the observation phase involving movies.

In the preference looking phase using still images, a three-way ANOVA (month \times congruent/incongruent \times attractiveness) was conducted to examine the effects of experiences formed during the observation phase (congruent/incongruent) and the attractiveness of facial images, and to test whether these effects differed by age. A simple main effect test was used for the post-hoc test to analyze the interactions. In the preference looking phase, the presentation time was divided into the first half (first time bin) and the second half (second time bin) of the presentation, considering the possibility that infants' interest in faces may change with time.

2.2. Results and Discussion

The data of five participants (two 6-month-olds and three 9-month-olds) were excluded from the analyses because their data were not complete (i.e., crying or not watching the monitor).

2.2.1. Verification of the Validity of the Movie Stimuli

We used movie stimuli (10 s) where two faces were presented simultaneously and one of the faces was accompanied by the flickered outline of the image to generate the difference in observation experience. We then investigated whether the movie stimuli affected infants' fixation duration with three-way ANOVA (month \times flickered \times attractiveness) for each (un)attractive-(un)attractive (same attractiveness) and attractive-unattractive (different attractiveness) pair.

For the same-attractiveness pair, results revealed that both 6- and 9-month-olds looked longer at the face with flickered outline (flickered: $M = 2.54$ s ($SD = 1.15$) vs. non-flickered: $M = 1.71$ s ($SD = 0.68$); $F(1, 15) = 31.63$, $p < 0.001$, $\eta_p^2 = 0.68$; see Figure 2), which suggests that bottom-up attention through the flickered stimuli attracted infants' gaze and affected the fixation duration. We also found a significant main effect of month such that 9-month-olds looked longer at faces than 6-month-olds (6-month-olds: $M = 1.63$ s ($SD = 0.70$) vs. 9-month-olds: $M = 2.67$ s ($SD = 1.06$); $F(1, 15) = 14.34$, $p = 0.002$, $\eta_p^2 = 0.49$), but there were no significant interactions.

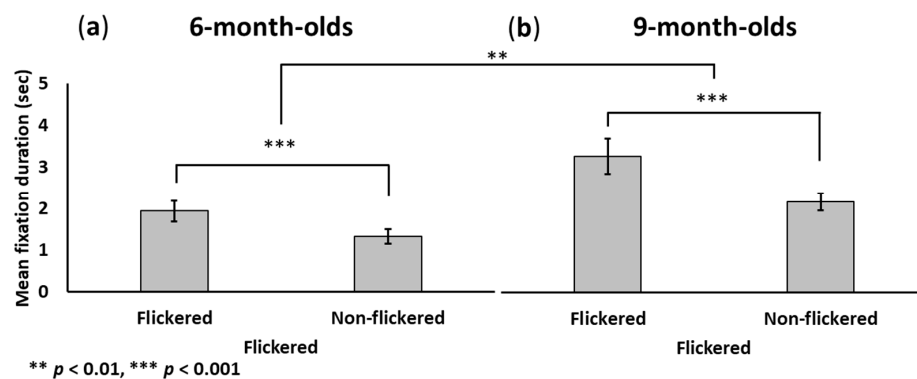


Figure 2. Mean fixation durations (s) for the movie stimuli of the same-attractiveness pairs in Experiment 1. Panel (a) shows the data for 6-month-olds and (b) for 9-month-olds. The error bars indicate standard errors.

For the different-attractiveness pairs, results revealed that both 6- and 9-month-olds looked longer at the face with flickered outline (flickered: $M = 2.64$ s ($SD = 1.47$) vs. non-flickered: $M = 1.65$ s ($SD = 0.95$); $F(1, 14) = 16.05$, $p = 0.001$, $\eta_p^2 = 0.53$; see Figure 3), suggesting that bottom-up attention by flickered stimuli attracted infants' gaze and affected the fixation duration even though the attractiveness differed between the presented faces. We also found a significant main effect of month such that 9-month-olds looked longer at faces than 6-month-olds (6-month-olds: $M = 1.62$ s ($SD = 0.86$) vs. 9-month-olds: $M = 1.51$ s ($SD = 1.51$); $F(1, 14) = 10.47$, $p = 0.006$, $\eta_p^2 = 0.47$), and marginally significant interactions between month and flicker ($F(1, 14) = 3.85$, $p = 0.070$, $\eta_p^2 = 0.22$). A simple main effect test revealed that both 6- and 9-month-olds looked longer at flickered stimuli than non-flickered stimuli (6-month: flickered $M = 1.87$ s ($SD = 0.92$) vs. non-flickered $M = 1.36$ s ($SD = 0.74$), $F(1, 7) = 5.79$, $p = 0.047$, $\eta_p^2 = 0.45$; 9-month: flickered $M = 3.42$ s ($SD = 1.54$) vs. non-flickered $M = 1.93$ s ($SD = 1.08$), $F(1, 7) = 8.34$, $p = 0.023$, $\eta_p^2 = 0.54$) but the fixation duration in 9-month-olds was longer than in 6-month-olds for flickered stimuli (6-month-olds: $M = 1.87$ s ($SD = 0.92$) vs. 9-month-olds: $M = 3.42$ s ($SD = 1.54$); $F(1, 14) = 11.27$, $p = 0.005$, $\eta_p^2 = 0.45$).

We therefore verified the validity of the movie stimuli, because the results mentioned above indicate that infants tended to look longer at the faces with flickered outlines. It was also confirmed that this observation experience did not depend on the attractiveness of the face and could be treated as a factor not confounded with attractiveness in the preferential gaze phase using still images.

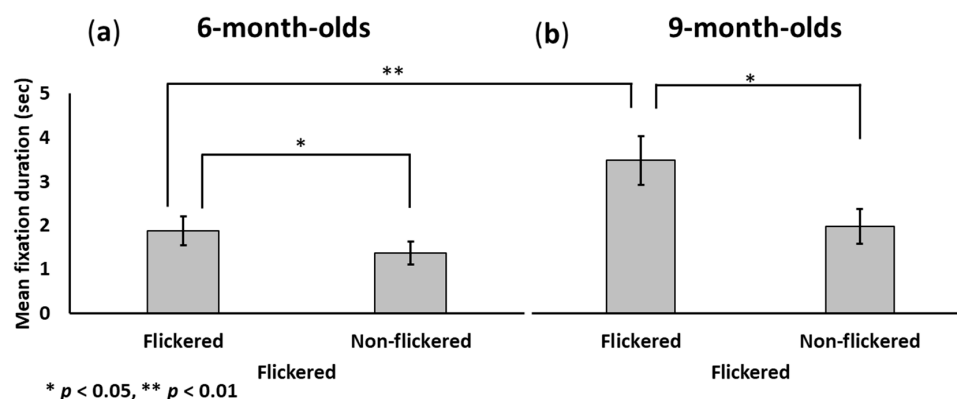


Figure 3. Mean fixation durations (s) for the movie stimuli of the different-attractiveness pairs in Experiment 1. Panel (a) presents the data for 6-month-olds and (b) for 9-month-olds. The error bars indicate standard errors.

2.2.2. Preference Looking

We investigated how the observation experience and facial attractiveness themselves affect the fixation duration of face images with a three-way ANOVA (month \times congruent/incongruent \times attractiveness) for each same- and different-attractiveness pairs. Congruent/incongruent is a measure of the impact of experience during the observation phase, and the congruent shows the same facial images at the same position that were flickered during the observation phase. We also investigated whether the looking behavior varied depending on the presentation time and divided the observation duration (i.e., 10 s) into two time bins. We then conducted the ANOVA mentioned above for each time bin. Figure 4 shows the data for the same-attractiveness pairs, and Figure 5 for different-attractiveness pairs.

For the same-attractiveness pairs, we found neither significant main effects nor interaction in the first time bin. In the second time bin, however, we found only a significant main effect of month ($F(1, 15) = 11.77, p = 0.004, \eta_p^2 = 0.44$), which means that 9-month-olds ($M = 1.31$ s, $SD = 0.53$) looked longer at faces than 6-month-olds did ($M = 0.90$ s, $SD = 0.59$).

The results were similar for the different-attractiveness pairs. In the first time bin, we found neither a significant main effect nor an interaction. In the second time bin, we found a significant main effect of month ($F(1, 14) = 14.91, p = 0.002, \eta_p^2 = 0.52$), which means that 9-month-olds ($M = 1.35$ s, $SD = 0.68$) looked longer at faces than 6-month-olds did ($M = 0.90$ s, $SD = 0.69$).

The results of Experiment 1 revealed that preference looking was not affected by observation experience or facial attractiveness, which might be due to the poor change of visual information because infants did not need further information.

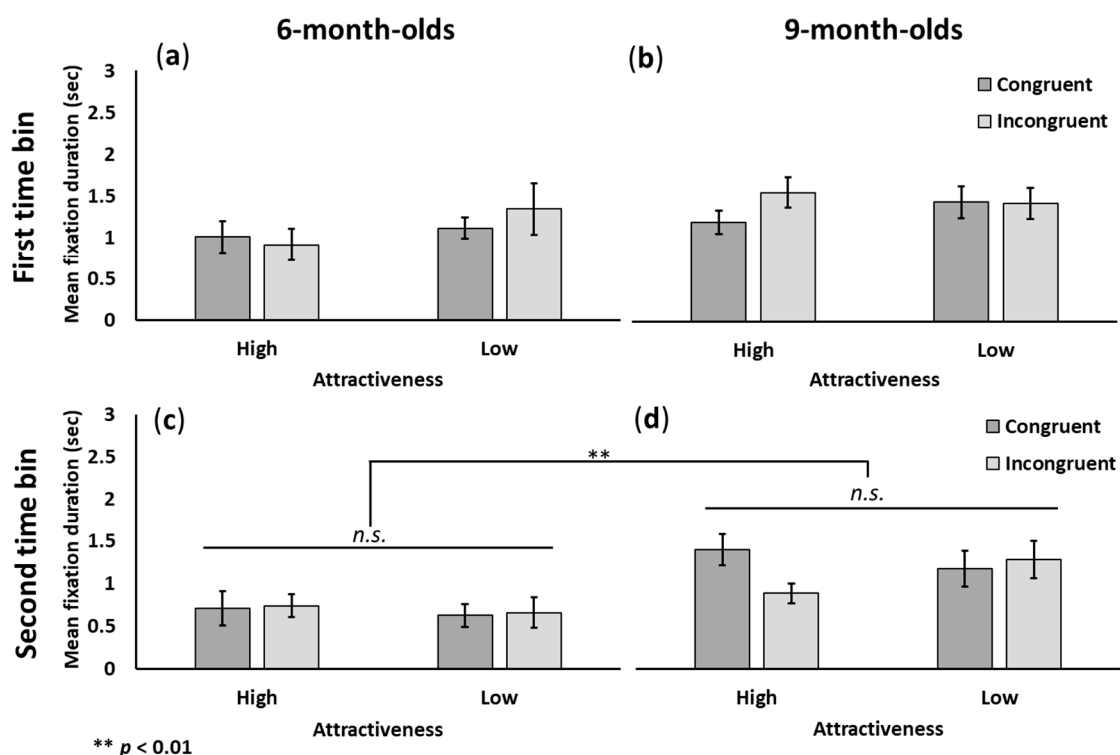


Figure 4. Mean fixation durations (s) for the preference looking to the same-attractiveness pairs in Experiment 1. Panels (a,c) show the data for 6-month-olds and (b,d) for 9-month-olds. The upper two panels show the fixation durations in the first time bin and the bottom two for the second time bin. Congruent means the fixation duration to the same face at the same position as the face with flickered outline in the movie stimuli. The error bars indicate standard errors.

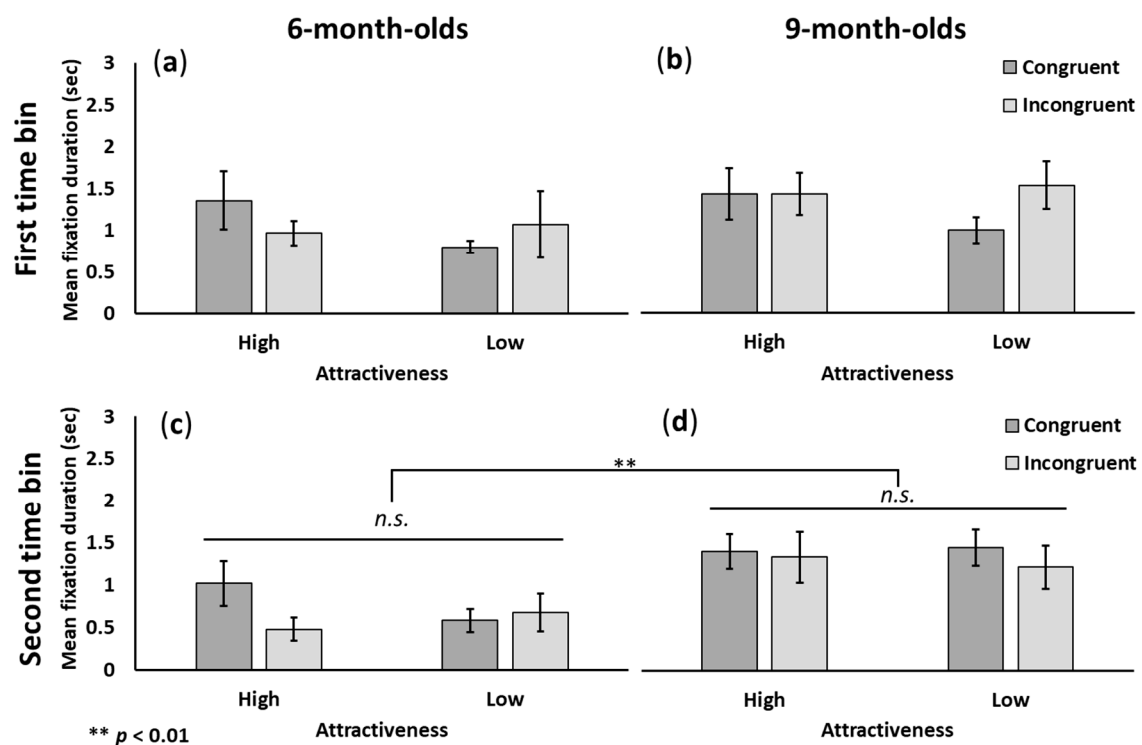


Figure 5. Mean fixation durations (s) for the preference looking at the different-attractiveness pairs in Experiment 1. Note that faces presented at the same time were either congruent attractive face and incongruent unattractive face or incongruent attractive face and congruent unattractive face. Panels (a,c) show the data for 6-month-olds and (b,d) for 9-month-olds. The upper two panels show the fixation durations in the first time bin and the bottom two in the second time bin. Congruent means the fixation duration to the same face at the same position as the face with the flickered outline in movie stimuli. The error bars indicate standard errors.

3. Experiment 2

3.1. Methods

3.1.1. Participants

The participants consisted of eight Japanese 6-month-olds (two boys and six girls: $M = 197.25$ days, $SD = 10.54$) and 12 Japanese 9-month-olds (seven boys and five girls: $M = 281.75$ days, $SD = 8.56$) who did not participate in Experiment 1. We recruited infants of relevant age from the list of participants at the Center for Baby Science, Doshisha University. Parents provided a verbal confirmation of the infants' good health condition. We obtained written informed consent from the parents of all participants before starting the experiment and paid a reward according to the standards of Doshisha University. This study was approved by the Ethics Committee of Doshisha University (approval number: 19038) and was conducted in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki).

3.1.2. Stimuli

We used the same face images as in Experiment 1.

3.1.3. Procedure

This experiment was conducted in a similar way to Experiment 1, except that we switched the left and right faces in the second (preference-looking) stage.

3.1.4. Apparatus

We used the same apparatus as in Experiment 1.

3.1.5. Data analysis

We analyzed the fixation duration data provided by Tobii Studio Pro. Furthermore, we conducted three-way ANOVA (month \times flickered \times attractiveness) for the fixation duration data in observation phase, and three-way ANOVA (month \times congruent/incongruent \times attractiveness) in preference looking phase. A simple main effect test was used for the post-hoc test to analyze the interactions. In the preference looking phase, the presentation time was divided into the first half (first time bin) and the second half (second time bin) of the presentation. All procedures of data analysis were the same as in Experiment 1.

3.2. Results and Discussion

The data of six participants (one 6-month-old and five 9-month-olds) were excluded from the analyses because they were incomplete (i.e., crying or not watching monitor).

3.2.1. Verification of the Validity of the Movie Stimuli

We investigated whether the movie stimuli affected infants' fixation duration with a three-way ANOVA in the same way as in Experiment 1.

We found similar results to those in Experiment 1 for the same-attractiveness pairs, showing that both 6- and 9-month-olds looked longer at the face with flickered outline (flickered: $M = 2.40$ s ($SD = 1.53$) vs. non-flickered: $M = 1.37$ s ($SD = 0.82$); $F(1, 15) = 33.40$, $p < 0.001$, $\eta_p^2 = 0.69$; see Figure 6), and that 9-month-olds looked longer at faces than 6-month-olds (6-month-olds: $M = 1.36$ s ($SD = 0.61$) vs. 9-month-olds: $M = 2.25$ s ($SD = 1.55$); $F(1, 15) = 5.30$, $p = 0.036$, $\eta_p^2 = 0.26$). We also found a significant interaction between month and flicker ($F(1, 15) = 11.46$, $p = 0.004$, $\eta_p^2 = 0.43$). A simple main effect test revealed that the 9-month-olds looked longer at flickered stimuli than the 6-month-olds did (6-month-olds: $M = 1.55$ s ($SD = 0.54$) vs. 9-month-olds: $M = 3.00$ s ($SD = 1.72$); $F(1, 15) = 6.63$, $p = 0.021$, $\eta_p^2 = 0.31$), and that flickered stimuli were looked at longer than non-flickered stimuli by both 6- and 9-month-olds (6-month-olds: flickered $M = 1.55$ s ($SD = 0.54$) vs. non-flickered $M = 1.16$ s ($SD = 0.63$); $F(1, 6) = 12.08$, $p = 0.013$, $\eta_p^2 = 0.67$, 9-month-olds: flickered $M = 3.00$ s ($SD = 1.72$) vs. non-flickered $M = 1.51$ s ($SD = 0.91$); $F(1, 9) = 17.67$, $p = 0.002$, $\eta_p^2 = 0.66$).

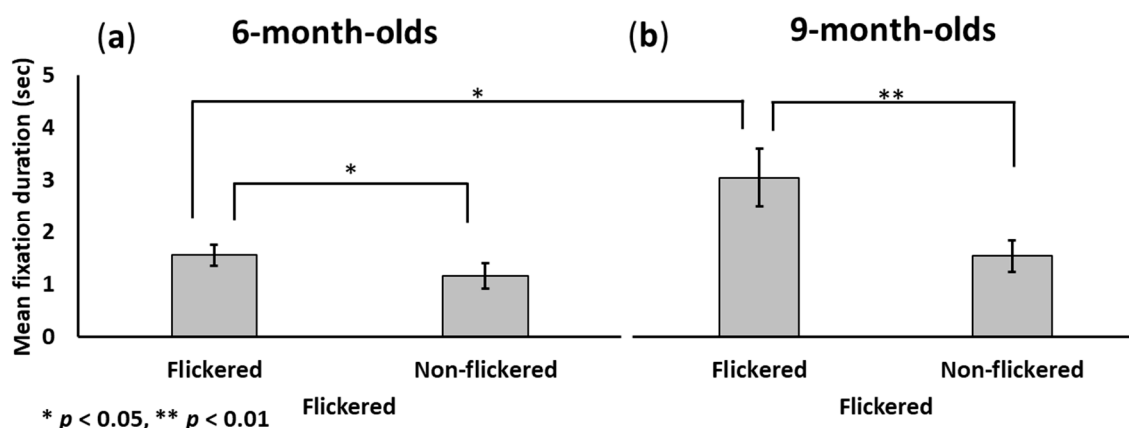


Figure 6. Mean fixation durations (s) for the movie stimuli of the same-attractiveness pairs in Experiment 2. Panel (a) shows the data for 6-month-olds and (b) for 9-month-olds. The error bars indicate standard errors.

We also found similar results to those in Experiment 1 for the different-attractiveness pairs in terms of the significant main effect of flicker, which means that infants looked longer at the flickered stimuli than non-flickered stimuli (flickered: $M = 1.89$ s ($SD = 1.10$) vs. non-flickered: $M = 1.45$ s ($SD = 0.94$); $F(1, 12) = 5.05$, $p = 0.044$, $\eta_p^2 = 0.30$; see Figure 7). Any other main effects or interactions were not significant.

The effect of the flickered stimuli was confirmed. It was also confirmed that this observation experience did not depend on the attractiveness of the face and could be treated as a factor not confounded with attractiveness in the preferential gaze phase using still images. We then verified the validity of the movie stimuli, as in Experiment 1.

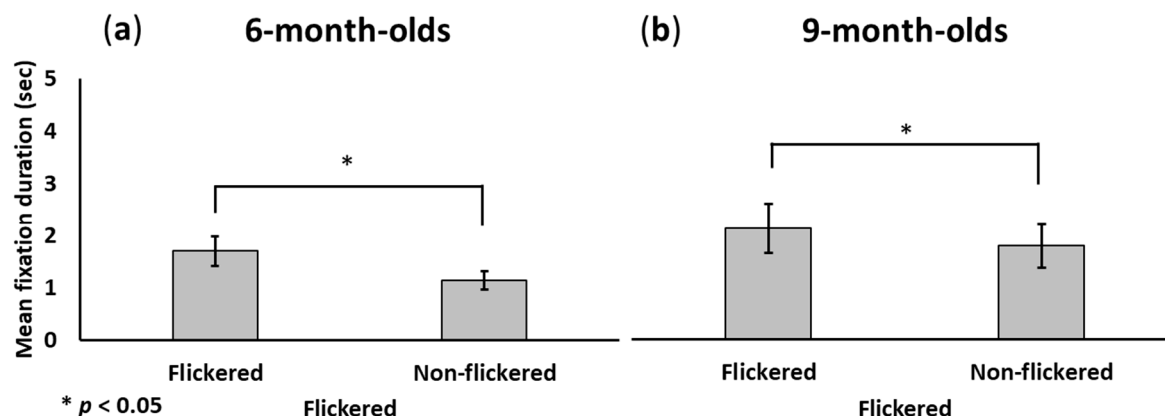


Figure 7. Mean fixation durations (s) for the movie stimuli of the different-attractiveness pairs in Experiment 2. Panel (a) shows the data for 6-month-olds and (b) for 9-month-olds. The error bars indicate standard errors.

3.2.2. Preference Looking

We conducted a three-way ANOVA (month \times congruent/incongruent \times attractiveness) in a similar way to Experiment 1. Congruent/incongruent is a measure of the impact of experience during the observation phase, as in Experiment 1, and the congruent shows the same facial images at a different position that were flickered during the observation phase.

For the first time bin of the same-attractiveness pairs, we found a significant main effect of congruent/incongruent, which means that infants looked longer at the flickered position (i.e., incongruent face) than the non-flickered position (i.e., congruent face) (congruent faces: $M = 0.94$ s ($SD = 0.53$) vs. incongruent faces: $M = 1.13$ s ($SD = 0.70$); $F(1, 15) = 6.44$, $p = 0.022$, $\eta_p^2 = 0.30$). We also found a marginally significant main effect of month ($F(1, 15) = 3.37$, $p = 0.086$, $\eta_p^2 = 0.18$). For the second time bin, we found only a significant main effect of month ($F(1, 15) = 5.48$, $p = 0.033$, $\eta_p^2 = 0.27$), such that 9-month-olds looked longer at faces than 6-month-olds did (6-month-olds: $M = 0.61$ s ($SD = 0.31$) vs. 9-month-olds: $M = 0.86$ s ($SD = 0.56$); Figure 8).

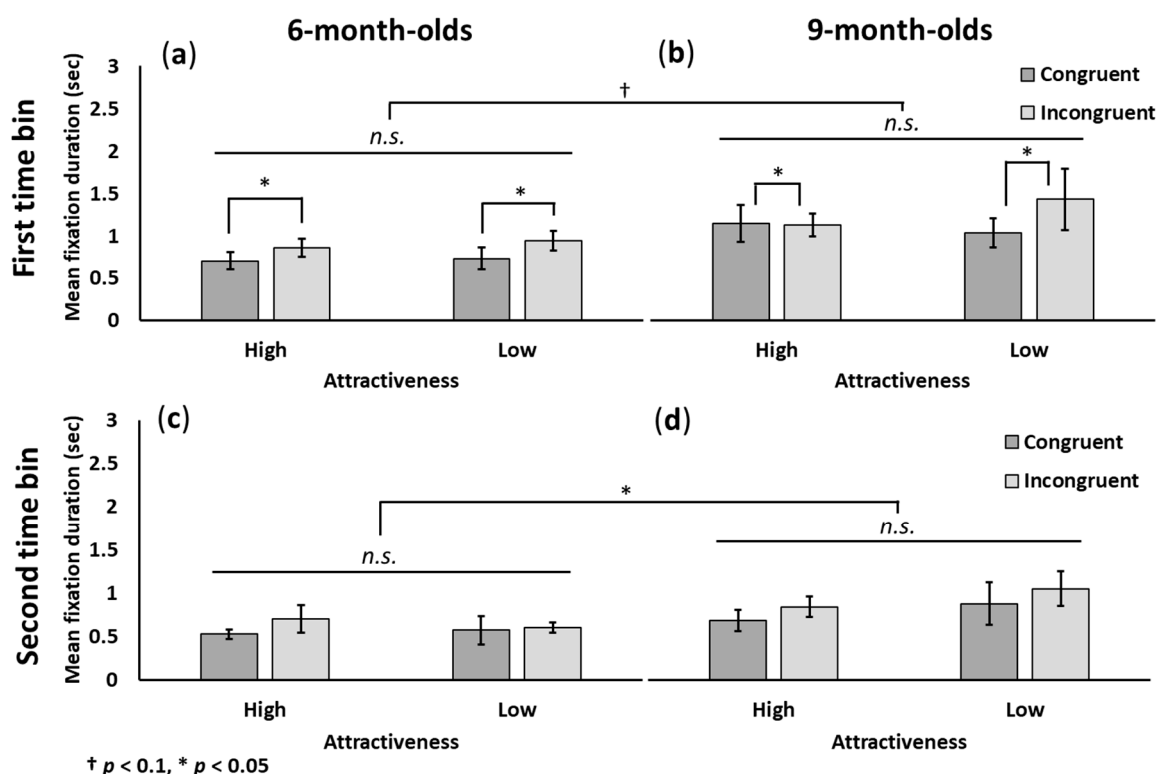


Figure 8. Mean fixation durations (s) for preference looking to the same-attractiveness pairs in Experiment 2. Panels (a,c) show the data for 6-month-olds and (b,d) for 9-month-olds. The upper two panels show the fixation durations in the first time bin, the bottom two in the second time bin. Congruent means the fixation duration to the same face, at the different position, as the face with the flickered outline in movie stimuli. The error bars indicate standard errors.

For first time bin of the different-attractiveness pairs, we found a significant main effect of month (6-month-olds: $M = 0.85$ s ($SD = 0.56$) vs. 9-month-olds: $M = 1.33$ s ($SD = 0.86$); $F(1, 12) = 5.46$, $p = 0.038$, $\eta_p^2 = 0.31$) and a marginally significant main effect of attractiveness ($F(1, 12) = 4.34$, $p = 0.059$, $\eta_p^2 = 0.27$), which means that attractive faces ($M = 1.26$ s, $SD = 0.93$) was looked longer than unattractive ones ($M = 0.90$ s, $SD = 0.48$). We also found a marginally significant interaction between attractiveness and congruent/incongruent ($F(1, 12) = 4.08$, $p = 0.066$, $\eta_p^2 = 0.25$). A simple main effect test revealed that infants looked longer at incongruent faces (i.e., flickered position) for unattractive faces (congruent faces: $M = 0.75$ s ($SD = 0.46$) vs. incongruent faces: $M = 1.07$ s ($SD = 0.47$); $F(1, 12) = 5.06$, $p = 0.044$, $\eta_p^2 = 0.30$) and that attractive faces were looked at for longer than unattractive ones for congruent faces (i.e., non-flickered position) (attractive faces: $M = 1.45$ s ($SD = 1.16$) vs. unattractive faces: $M = 0.74$ s ($SD = 0.46$); $F(1, 12) = 6.97$, $p = 0.022$, $\eta_p^2 = 0.37$). For the second time bin, we found a significant main effect of attractiveness, which means that infants preferred attractive faces to unattractive ones (attractive faces: $M = 0.87$ s ($SD = 0.67$) vs. unattractive faces: $M = 0.61$ s ($SD = 0.32$); $F(1, 12) = 6.34$, $p = 0.027$, $\eta_p^2 = 0.35$; Figure 9).

In Experiment 2, the effect of the observation experience and the effect of attractiveness were found in face preference. In particular, in the first time bin, for face pairs with the same attractiveness, the effect of the observation experience was seen for the presentation position, while for pairs with different attractiveness, the observation experience was seen for the attractive face. These trends were also observed in both 6-month-old and 9-month-old infants.

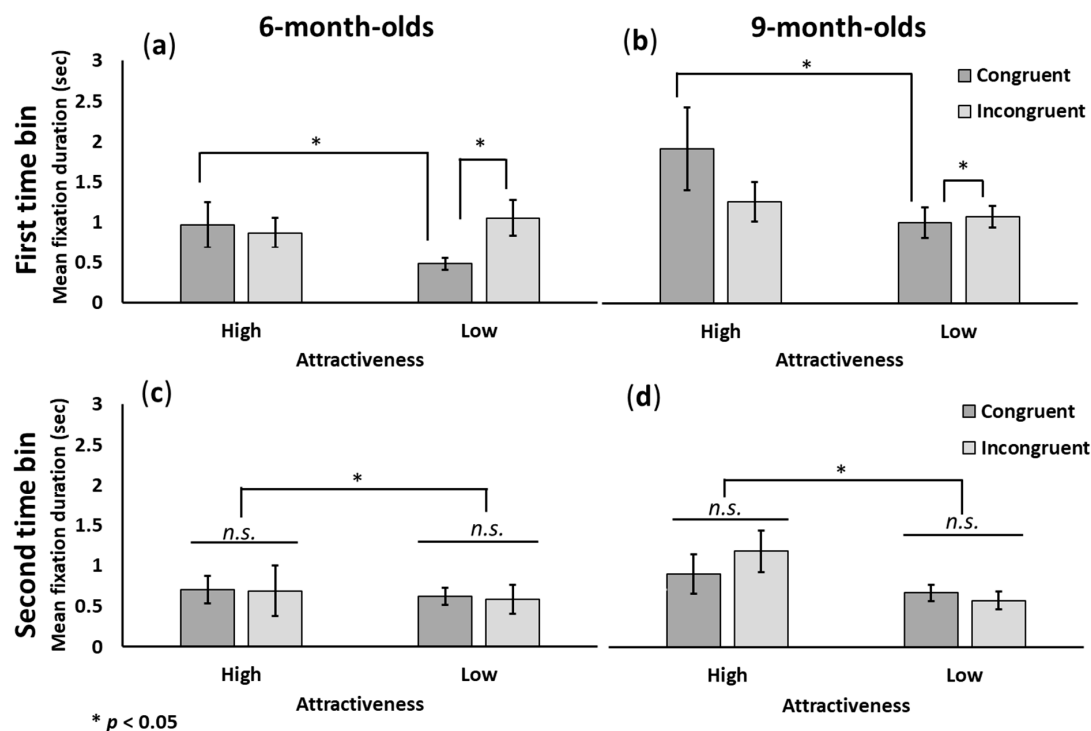


Figure 9. Mean fixation durations (s) for preference looking to the different-attractiveness pairs in Experiment 2. Note that presented faces at the same time were either congruent attractive face and incongruent unattractive face, or incongruent attractive face and congruent unattractive face. Panels (a,c) show the data for 6-month-olds and (b,d) for 9-month-olds. The upper two panels show the fixation durations in the first time bin, the bottom two in the second time bin. Congruent means the fixation duration to the same face, in a different position, as the face with the flickered outline in movie stimuli. The error bars indicate standard errors.

4. General Discussion

In this study, we targeted 6- and 9-month-olds and investigated whether the interaction between observation experience and attractiveness of face images appeared in preference looking. In Experiment 1, observation experience and attractiveness did not affect the preference looking in either 6- or 9-month-olds. However, in Experiment 2, observation experience and facial attractiveness affected preference looking: infants looked longer at the flickered position but different face in the first time bin of the same-attractiveness pairs and in the first time bins for the unattractive faces of the different-attractiveness pairs, but looked longer at the attractive face in the first time bin for the congruent faces (non-flickered position) of the different-attractiveness pairs. The difference in results between Experiments 1 and 2 show that infants recognized the faces they had observed before and remembered the flickered position they focused on, and that the change of face in the flickered position generally attracted infants' gaze except when attractive faces in the flickered position of movie stimuli changed to unattractive ones.

The results of Experiment 1 suggest that looking behavior was not affected by the observation experience or facial attractiveness. A possible reason is the poor change of visual information, because the faces were presented in the same position in the observation and preference-looking phases. Infants may understand the same faces in the same position, and did not need to seek further information on the face. Another possible reason is that our results might include both novelty preference and familiarity preference. According to the results for different time bins, time variation did not affect the fixation pattern. Therefore, both preferences might be suggested to appear throughout.

The results of Experiment 2 showed that infants looked longer at the face in the congruent position (i.e., flickered position in the movie stimulus) in the first time bin of the same-attractiveness pairs,

which suggests that infants noticed the change of the face images in the flickered position and observed the face in that position. The results for the different-attractiveness pairs also revealed a similar fixation behavior for unattractive faces. Therefore, observation experience has the advantage of presentation position generally. This result may relate to the tendency for infants to have a hard time habituating to unfamiliar places. On the other hand, attractive faces were looked at longer than unattractive faces presented simultaneously: When attractive faces were presented in the incongruent position (i.e., non-flickered position in the movie stimuli) in the first time bin and in all cases for the second time bin. Infants might tend to look for and stare at the attractive face, which did not appear in the results of Experiment 1 where the faces for preference looking were presented in the same position as the movie stimuli. Therefore, we suggest that facial attractiveness attracted their attention only when they noticed the change of faces. We also suggest that the change from attractive faces to unattractive ones alters their fixation pattern from position superiority to face superiority, which merits special note in that drawing an infant's attention depends on the direction of change but not on the difference itself in facial attractiveness. This asymmetry effect of attractiveness on preference looking suggests that facial attractiveness and observation experience together motivate infants to search for and look longer at the attractive face. That is, a familiarity preference for infants was found only when noticing the change from attractive to unattractive faces.

The reaction to change from attractive to unattractive faces in focused position might reflect sensitivity toward the change from symmetry to asymmetry. One of the attractive facial features is symmetry, and the change from attractive to unattractive faces might reflect a change from symmetry to asymmetry. Therefore, we suggest that infants may be more sensitive to change to asymmetry than to symmetry. In terms of evolutionary advantage, high facial symmetry in an individual reflects good health and potential heritable fitness, because symmetry in humans is an indicator of the ability to cope with developmental stress and of phenotypic and genotypic quality [13–15]. Therefore, symmetry is preferred as an honest indicator of mate selection. Preference for symmetry is also suggested to appear as a result of avoiding asymmetry, indicating something ill, rather than choosing symmetry [16]. Therefore, the sensitivity toward decreasing symmetry is adaptive for us, and this reaction to the change in symmetry might have been acquired by 6-month-olds, according to the results of Experiment 2. A previous study [31] involving 12- to 24-month-olds revealed preference for symmetrical faces, while another study [32] involving 5- to 8-month-olds revealed preference for asymmetrical faces rather than symmetrical faces. In the present study, when changes in symmetry occurred as a result of face image replacement, 6-month-old and 9-month-old infants may have disliked the reduction in symmetry and consequently showed a preference for faces with higher symmetry. However, the present study did not directly manipulate the symmetry, and this should be examined in detail in the future.

We also found that 9-month-olds tended to look longer at the faces than 6-month-olds did in most cases. This is consistent with the previous finding that infants looked at a face longer with greater age [33–35]. However, age did not accompany a change in the effect of facial attractiveness and observation experience on fixation duration. The fixation tendency mentioned above is suggested to arise in 6-month-olds, which means that sensitivity toward the change of the face in the particular area focused on beforehand is an important ability for infants, and that their looking for attractive faces when seeing a change from attractive to unattractive faces reflects their perceiving faces not only as object recognition but also as including an attractiveness judgment. That is, a change of face in a particular area spurs them to detect the change in the area in terms of an object, but the change from an attractive to an unattractive face drives them especially to look for the attractive face. For 6- and 9-month-olds, therefore, the level of facial attractiveness might have a more important meaning than the morphologic difference. According to Liao et al. [29], familiar faces are preferred by adults, but this tendency was limited in infants. The familiarity preference of faces may be shaped along with development, mainly centering on attractive people who have frequent contact with them.

This study has some limitations. In the present experiment, it can be said that the familiarity preference for faces arose when the gaze was directed to an attractive face in an observation situation,

where the attractiveness of the paired faces was different. However, no familiarity preference for high-attractive faces arose when the attractiveness of the paired faces was the same. This result could point to the possibility that infants may have used differences in attractiveness for their facial preferences, but it is also possible that the effect of attractiveness did not fully manifest itself in preference looking because the influence of flickering stimuli in the observation phase was too strong. This point should be considered in the future. Furthermore, the number of participants might be small. We calculated the sample size required to test the interaction in ANOVA using G*Power's prior test (a priori), with parameters of 0.25 (medium) for effect size, 0.05 for α (level of significance), and 0.80 for power (power of test), and found that the sample size required was 12 participants at each month of age ($24/2 = 12$ participants). However, we computed the compromise power analysis with total 14 participants assuming that both α and β error are equally costly (i.e., the ratio $q: \beta/\alpha = 1$) which is probably the default in basic research. We therefore found 0.80 for power. Since the number of participants in this study was about seven or eight in each age group, we cannot rule out the likelihood of both false positive and false negative outcomes, and need further verification with a larger sample size [36,37]. Further, we used a 2D face in this study, therefore, the results of this study may not be extended to real-life situations. The ecological validity of the findings should be further evaluated using 3D or virtual reality.

Observation experience affects spatial attention in most cases, but manifested in this study in the preference of looking to a particular face when two simultaneously presented faces differed in facial attractiveness. The decline of attractiveness in the focused area rather than an increase in attractiveness might trigger a search for a particular face, but not a check for changes in the area. The asymmetry effect of observation experience when both attractive and unattractive faces were presented simultaneously means that the level of attractiveness is important to infants. Note that our results might be qualitatively different from observation experience in daily life because we investigated the preferences for face images right after observation. For example, sensitivity toward the change in the focused area might differ depending on the time between observation and preference-looking. In this study, however, we used bottom-up attention through a flickering outline of the images, and found that the interaction between the preceding observation experience and the level of attractiveness informed infants' preference for faces, and that this preference did not differ between 6- and 9-month-olds. Our findings suggest that infants perceive faces not only as objects, but also as having attractiveness, and that the reaction to change of attractiveness differs depending on the direction of change. Therefore, we suggest that attractive faces are important to infants as well as adults.

Author Contributions: K.K. (Kana Kuraguchi) and K.T. designed this experiment, and K.K. (Kana Kuraguchi) and K.K. (Kei Kanari) prepared the stimuli. K.T. collected all the data. K.K. (Kana Kuraguchi) and K.T. analyzed the data. S.I. supervised this project. All authors discussed the results and commented on the manuscript. All authors have read and agreed to the published version of the manuscript.

Funding: The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was supported by JSPS KAKENHI Grant Number JP17K13901 to K. Kuraguchi and MEXT Promotion of Distinctive Joint Research Center Program Grant Number JPMXP0619217850.

Acknowledgments: The authors thank Yuri Akiyama, Chikako Hashizume, Mami Mitsuyasu, Miwa Nishi, and Miki Tsuguiwa from Center for Baby Science, Doshisha University for recruiting participants and all the volunteers for participating this project.

Conflicts of Interest: The authors declared no potential conflicts of interests with respect to the research, authorship, and/or publication of this article.

References

1. Grammer, K.; Thornhill, R. Human (*Homo sapiens*) facial attractiveness and sexual selection: The role of symmetry and averageness. *J. Comp. Psychol.* **1994**, *108*, 233–242. [\[CrossRef\]](#)
2. Rhodes, G.; Proffitt, F.; Grady, J.M.; Sumich, A. Facial symmetry and perception of beauty. *Psychonom. Bull. Rev.* **1998**, *5*, 659–669. [\[CrossRef\]](#)
3. Langlois, J.H.; Roggman, L.A. Attractive faces are only average. *Psychol. Sci.* **1990**, *1*, 115–121. [\[CrossRef\]](#)

4. Feinberg, D.R.; Jones, B.C.; DeBruine, L.M.; Moore, F.R.; Law-Smith, M.J.; Cornwell, R.E.; Tiddeman, B.P.; Boothroyd, L.G.; Perrett, D.I. The voice and face of women: One ornament that signals quality? *Evol. Hum. Behav.* **2005**, *26*, 398–408. [\[CrossRef\]](#)
5. Johnston, V.S.; Hagel, R.; Franklin, M.; Fink, B.; Grammer, K. Male facial attractiveness: Evidence for hormone-mediated adaptive design. *Evol. Hum. Behav.* **2001**, *22*, 251–267. [\[CrossRef\]](#)
6. Penton-Voak, I.S.; Jones, B.C.; Little, A.C.; Baker, S.; Tiddeman, B.; Burt, D.M.; Perrett, D.I. Symmetry, sexual dimorphism and facial proportions and male facial attractiveness. *Proc. R. Soc. B Biol. Sci.* **2001**, *268*, 1617–1623. [\[CrossRef\]](#)
7. Perrett, D.I.; Lee, K.J.; Penton-Voak, I.; Rowland, D.; Yoshikawa, S.; Burt, D.M.; Henzi, S.P.; Castles, D.L.; Akamatsu, S. Effects of sexual dimorphism on facial attractiveness. *Nature* **1998**, *394*, 884–887. [\[CrossRef\]](#)
8. Cunningham, M.R. Measuring the physical in physical attractiveness: Quasi-experiments on the sociobiology of female facial beauty. *J. Personal. Soc. Psychol.* **1986**, *50*, 925–935. [\[CrossRef\]](#)
9. Geldart, S.; Maurer, D.; Carney, K. Effects of eye size on adults' aesthetic ratings of the faces and 5-month-olds' looking times. *Perception* **1999**, *28*, 361–374. [\[CrossRef\]](#) [\[PubMed\]](#)
10. Kuraguchi, K.; Taniguchi, K.; Ashida, H. The impact of baby schema on perceived attractiveness, beauty, and cuteness in female adults. *SpringerPlus* **2015**, *4*, 164. [\[CrossRef\]](#)
11. Golle, J.; Mast, F.W.; Lobmaier, J.S. Something to smile about: The interrelationship between attractiveness and emotional expression. *Cogn. Emot.* **2014**, *28*, 298–310. [\[CrossRef\]](#) [\[PubMed\]](#)
12. Ueda, R.; Kuraguchi, K.; Ashida, H. Asymmetric effect of expression intensity on evaluations of facial attractiveness. *SAGE Open* **2016**, *6*, 1–6. [\[CrossRef\]](#)
13. Little, A.C. Domain specificity in human symmetry preferences: Symmetry is most pleasant when looking at human faces. *Symmetry* **2014**, *6*, 222–233. [\[CrossRef\]](#)
14. Møller, A.P. Developmental stability and fitness: A review. *Am. Nat.* **1997**, *149*, 916–932. [\[CrossRef\]](#)
15. Møller, A.P.; Thornhill, R. Bilateral symmetry and sexual selection: A meta-analysis. *Am. Nat.* **1998**, *151*, 174–192. [\[CrossRef\]](#)
16. Rhodes, G. The evolutionary psychology of facial beauty. *Annu. Rev. Psychol.* **2006**, *57*, 199–226. [\[CrossRef\]](#)
17. Zajonc, R.B. Attitudinal effects of mere exposure. *J. Personal. Soc. Psychol.* **1968**, *9*, 1–27. [\[CrossRef\]](#)
18. Moreland, R.L.; Beach, S.R. Exposure effects in the classroom: The development of affinity among students. *J. Exp. Soc. Psychol.* **1992**, *28*, 255–276. [\[CrossRef\]](#)
19. Peskin, M.; Newell, F.N. Familiarity breeds attraction: Effects of exposure on the attractiveness of typical and distinctive faces. *Perception* **2004**, *33*, 147–157. [\[CrossRef\]](#)
20. Cooper, P.A.; Maurer, D. The influence of recent experience on perceptions of attractiveness. *Perception* **2008**, *37*, 1216–1226. [\[CrossRef\]](#)
21. Saxton, T.K.; Little, A.C.; DeBruine, L.M.; Jones, B.C.; Roberts, S.C. Adolescents' preferences for sexual dimorphism are influenced by relative exposure to male and female faces. *Personal. Individ. Differ.* **2009**, *47*, 864–868. [\[CrossRef\]](#)
22. Langlois, J.H.; Ritter, J.M.; Roggman, L.A.; Vaughn, L.S. Facial diversity and infant preferences for attractive faces. *Dev. Psychol.* **1991**, *27*, 79–84. [\[CrossRef\]](#)
23. Langlois, J.H.; Roggman, L.A.; Casey, R.J.; Ritter, J.M.; Rieser-Danner, L.A.; Jenkins, V.Y. Infant preferences for attractive faces: Rudiments of a stereotype? *Dev. Psychol.* **1987**, *23*, 363–369. [\[CrossRef\]](#)
24. Bushnell, I.W.R.; Sai, F.; Mullin, J.T. Neonatal recognition of the mother's face. *Br. J. Dev. Psychol.* **1989**, *7*, 3–15. [\[CrossRef\]](#)
25. Pascalis, O.; de Schonen, S.; Morton, J.; Deruelle, C.; Febre-Grenet, M. Mother's face recognition by neonates: A replication and an extension. *Infant Behav. Dev.* **1995**, *18*, 79–85. [\[CrossRef\]](#)
26. Bushnell, I.W.R. Discrimination of faces by young infants. *J. Exp. Child Psychol.* **1982**, *33*, 298–308. [\[CrossRef\]](#)
27. Quinn, P.C.; Yahr, J.; Kuhn, A.; Slater, A.M.; Pascalis, O. Representation of the gender of human faces by infants: A preference for female. *Perception* **2002**, *31*, 1109–1121. [\[CrossRef\]](#)
28. Kelly, D.J.; Quinn, P.C.; Slater, A.M.; Lee, K.; Ge, L.; Pascalis, O. The other-race effect develops during infancy: Evidence of perceptual narrowing. *Psychol. Sci.* **2007**, *18*, 1084–1089. [\[CrossRef\]](#)
29. Liao, H.-I.; Yeh, S.-L.; Shimojo, S. Novelty vs. familiarity principles in preference decisions: Task-context of past experience matters. *Front. Psychol.* **2011**, *2*. [\[CrossRef\]](#)
30. Ramsey, J.L.; Langlois, J.H.; Hoss, R.A.; Rubenstein, A.J.; Griffin, A.M. Origins of a stereotype: Categorization of facial attractiveness by 6-month-old infants. *Dev. Sci.* **2004**, *7*, 201–211. [\[CrossRef\]](#)

31. Griffey, J.A.F.; Little, A.C. Infant's visual preferences for facial traits associated with adult attractiveness judgements: Data from eye-tracking. *Infant Behav. Dev.* **2014**, *37*, 268–275. [[CrossRef](#)] [[PubMed](#)]
32. Rhodes, G.; Geddes, K.; Jeffery, L.; Dziurawiec, S.; Clark, A. Are Average and Symmetric Faces Attractive to Infants? Discrimination and Looking Preferences. *Perception* **2002**, *31*, 315–321. [[CrossRef](#)] [[PubMed](#)]
33. Amso, D.; Johnson, S.P. Learning by selection: Visual search and object perception in young infants. *Dev. Psychol.* **2006**, *42*, 1236–1245. [[CrossRef](#)] [[PubMed](#)]
34. Frank, M.C.; Amso, D.; Johnson, S.P. Visual search and attention to faces during early infancy. *J. Exp. Child Psychol.* **2014**, *118*, 13–26. [[CrossRef](#)]
35. Frank, M.C.; Vul, E.; Johnson, S.P. Development of infants' attention to faces during the first year. *Cognition* **2009**, *110*, 160–170. [[CrossRef](#)]
36. Oakes, L.M. Sample size, statistical power, and false conclusions in infant looking-time research. *Infancy* **2017**, *22*, 436–469. [[CrossRef](#)]
37. Cruz-Khalili, A.; Bettencourt, K.; Kohn, C.S.; Normand, M.P.; Schlenger, H.D. Use of Repeated Within-Subject Measures to Assess Infants' Preference for Similar Others. *Front. Psychol* **2019**, *10*, 2239. [[CrossRef](#)]



© 2020 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).