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Infants recognize identity in a dynamic facial animation that simultaneously changes its identity and expression

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ABSTRACT

Recognition of facial identity and facial expression have been reported to be correlated. Previous studies using static facial photographs reported that identity recognition was not interfered by task-irrelevant change of facial expression but that expression recognition was interfered by task-irrelevant change of facial identity. In this study, we created dynamic morphing animations that simultaneously changes facial identity and expression to investigate the interaction between identity and expression recognition. We tested 7 –8-month-old infants who were around the age at which the recognition of facial expression develops. Using the familiarization–novelty preference procedure, we examined whether infants could learn identity and facial expression from morphing animation. We found that infants learned identity but not expression from the morphing animation. Our results demonstrate that the interaction between identity and expression occurs differently in infancy than in adults when both the dimension of facial identity and the expression vary simultaneously.

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Face recognition; facial identity; emotional expression; infants

The ability to recognize identity and facial expression from a face is an important part of our ability to communicate with other people. By remembering familiar people and discriminating them from strangers, we effectively share our resources preferentially with familiar people. Simultaneously, by recognizing others' emotional states, we choose to approach or avoid them in appropriate ways. The finding that even newborn infants discriminate between different identities (Pascalis, de Schonen, Morton, Deruelle, & Fabre-Grenet, 1995; Turati, Macchi Cassia, Simion, & Leo, 2006) and expressions (Farroni, Menon, Rigato, & Johnson, 2007) indicates that the ability to extract an identity and an expression from a face is fundamental to our survival in a social environment. The recognition of both identity and expression develops throughout childhood (Mondloch, Geldart, Maurer, & Le Grand, 2003).

The recognition of identity and expression are reported to be correlated in adults (Baudouin, Martin, Tiberghien, Verlut, & Franck, 2002; Dobel et al., 2008; Fox, Oruç, & Barton, 2008; Lander & Metcalfe, 2007; Pell & Richards, 2013; Schweinberger & Soukup, 1998; Schweinberger, Burton, & Kelly, 1999). Although Bruce and Young's (1986) well-known model of face perception proposed the independency of identification and expression recognition, more recent studies with adults have repeatedly and consistently demonstrated their interaction (Campbell & Burke, 2009; Fox, Moon, Iaria, & Barton, 2009; Leleu et al., 2012; Schweinberger et al., 1999; for review, Calder & Young, 2005). In the neuroscience domain, recent studies have provided evidence of interaction between identity processing and emotion processing (Biotti & Cook, 2016; for review, Calder, 2011). Calder (2011) argued that the neural bases for identity processing and emotion processing were dissociable and that the issue of the level at which the dissociation occurred should be questioned. Furthermore, dynamic facial movement is suggested to be processed by separate neural networks from the face processing of a static face (Gobbini & Haxby, 2007; Sato et al., 2004). Behavioural experiments also suggest that dynamic facial motion provides information not presented in a static facial image (Ambadar, Schooler, & Cohn, 2005; Ichikawa & Yamaguchi, 2014; Ichikawa, Kanazawa, & Yamaguchi, 2014). Examining the interaction between identity recognition and expression recognition using

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dynamic facial animation would enable us to examine the relation between identity and expression processing and processing of dynamic facial movement and give us insight to understand the face processing of identity, emotion, and dynamic facial movement.

To examine the interaction between the recognition of identity and expression, several previous studies (Baudouin, Durand, & Gallay, 2008; Ganel & Goshen-Gottstein, 2004; Schweinberger et al., 1999; Wang, Fu, Johnston, & Yan, 2013) used Garner's speeded classification paradigm (Garner, 1976). In the task, participants were presented with a sequence of facial photographs that varied in identity and expression and were required to classify each based on one of the two dimensions (identity or expression). If identity recognition and expression recognition were correlated, the classification performance based on one dimension (e.g., identity) suffered interference from the other dimension (e.g., expression). For example, if identity processing involved expression processing, then the reaction time increased and the accuracy decreased for the sequence of photographs in which expression varied compared with those in which the expression stayed the same in the identity classification task. If identity processing did not involve processing of expression, then reaction time and accuracy had no interference. Some neuroimaging studies also support the view that interaction exists between the processing of identity and expression (Fox et al., 2009; Ganel, Valyear, Goshen-Gottstein, & Goodale, 2005; Leleu et al., 2010; Wild-Wall, Dimigen, & Sommer, 2008).

There is little doubt that the recognition of identity and expression are involved with one another. However, asymmetrical interference from identity recognition to expression recognition has been observed. Using Garner's paradigm, Schweinberger et al. (1999) demonstrated that a change of identity interfered with the participants' performance on the classification of expression (anger or happiness) while a change of expression did not affect the classification of identity. More recently, Fox et al. (2008) used the visual adaptation paradigm, which examines whether the aftereffect is observed by seeing a series of facial images. If a participant adapted to the attributions of the facial images (i.e., identity or expression), he or she should show aftereffect, which is biased perception towards the opposite of the adapting attributions. Fox et al. demonstrated that adaptation to identity is observed regardless of changes in expression, while adaptation to expression depends on identity, and discussed that facial representation of identity is independent of variations in expression. Leleu et al. (2010, 2012) used the task-switching paradigm and an event-related potential (ERP) recording to demonstrate similar findings. The task-switching paradigm is a method for examining selective attention to identity and expression, which is reflected by the switch cost. The switch cost is assessed by comparing the response time between when the task was repeated and when the task was switched to another task. If asymmetrical interference from identity to expression occurs, the differential switch cost should be observed when the task was switched from the face-identification task to the expression-recognition task. To examine which task-switching elicited a greater switch cost in response time, either familiarity judgment or expression judgment, Leleu et al. (2012) required participants to judge the familiarity or expressions (disgust, fear, anger, sadness) of facial photographs. Their behavioural results showed greater switch cost in familiarity judgment than in expression judgment, suggesting the relative dominance of familiarity judgment over expression judgment. ERP recordings also revealed a neural correlate of the interference from identity processing on expression processing at the level of the frontal N2 component in the left hemisphere, which is interpreted as an index of modulations in endogenous executive control. These studies have consistently reported the dominance of identity processing over expression processing.

Even in studies with infants, interaction between identity and expression has been reported. Bornstein and Arterberry (2003) demonstrated that 5-month-old infants can learn expression across changes in identity and recognize expression in the novel identity. However, once infants learn a combination of expression and identity, it might be difficult to recognize the expression in novel identity. Nelson, Morse, and Leavitt (1979) revealed that 7.5-month-olds failed to discriminate between happy and fearful expressions posed by a model (model A) after they were habituated with a happy or fearful expression posed by a different model (model B). Schwarzer and Jovanovic (2010) demonstrated that 8-month-olds could not recognize the novel combination of identity and expression (model A's frowning and model B's smiling) after they had learned the two faces in varied expression and identity (model A's smiling and model B's frowning). These results indicate that infants learn an emotional expression in combination with a single model and do not recognize the expression when posed by another model. Infants' recognition of others' identity also depends on the expression. Turati, Montirosso, Brenna, Ferrara, and Borgatti (2011) demonstrated that infants could learn the identity of a female model when she was displaying a smile but not when she was displaying an emotionally neutral facial movement. Furthermore, their group found that both eye and mouth movement enhanced infants' identity recognition, in positive expressions but not in negative expressions (Brenna, Proietti, Montirosso, & Turati, 2013). These studies indicate that identity recognition is affected by expression recognition. In infancy, the interaction between identity recognition and expression recognition could be symmetrical while adults showed asymmetric interaction.

These previous studies controlled the face stimuli when one of two dimensions changed and the other remained consistent (e.g., when identity changed, expression was consistent) to assess if identity affects expression or expression affects identity recognition. However, in our daily lives, faces are always moving and accompanied by facial expression or speech production. Such dynamic presentation of faces has been reported to enhance identity recognition (for review see O'Toole, Roark, Abdi, & Toole, 2002) and expression recognition (Cunningham & Wallraven, 2009). Thus, when we use a static presentation of a face, the possibility of interference in emotional expression recognition from identity recognition might be underestimated. In contrast, Stoesz and Jakobson (2013) demonstrated that identity judgment was less affected by the change of emotion when expression was presented in motion rather than static. Although they clarified that dynamic expression might not interfere with identity recognition, it remains unclear whether the dynamic change of identity also interferes with expression recognition.

To investigate the interaction between identity and expression in a moving face, it is necessary to dynamically depict the identity change as well as the change of expression. Although a face can never change its identity in our daily lives, artificial dynamic morphing animation allows us to evaluate the ability to detect identity change from the dynamic non-rigid facial motion as well as expression change. Yet, as dynamic stimuli, morphing animations have been widely used to investigate adults' face processing (Kamachi et al., 2001; Yoshikawa & Sato, 2008). Artificial facial morphing animations, which do not exist in our typical visual experiences, have revealed important implications for face perception about identity and expression recognition in adults. Using computer animation techniques to combine an individual's idiosyncratic facial motion and another individuals' facial physical form, Knappmeyer, Thornton, and Bülthoff (2003) revealed that identity recognition was succeeded by integrating information of both facial movement and facial form. Using morphing techniques, Wallis and Bülthoff (2001) investigated identity recognition of novel faces in which the identity of the face changed as the head rotated. As far as we know, there have been no previous studies using dynamic stimuli that changed identity and expression simultaneously. Thus, we created artificial dynamic morphing animation that simultaneously changes its identity and expression.

In this study, we investigated the interaction between identity and expression in infants using dynamic facial animation. We created dynamic morphing animation that simultaneously changed in both identity and expression (see Figure 1, Figure A.1) and then examined infants' recognition of identity and expression.

We used a familiarization–novelty preference procedure to examine infants' ability to extract identity and/or expression from the dynamic morphing animation. First, we familiarized the infants by repeatedly presenting the dynamic morphing animation (familiarization phase). After the familiarization phase, if the infants recognized the identity depicted in the morphing animation, they would typically prefer to look at a novel identity rather than a familiar identity (that is, novelty preference) (Otsuka et al., 2009; Turati et al., 2011). We tested infants' preferential looking for identity both before (pre-familiarization phase) and after (post-familiarization phase) familiarization and compared their preferential looking to novel identity between the pre- and post-familiarization tests. Similarly, if infants recognized the happiness expression depicted in the morphing animation, after repeated presentation of happiness expression, they would typically prefer to look at a novel angry expression rather than the

Figure 1. Illustration of dynamic morphing animation used in this study. Dynamic version of morphing animation without sounds can be seen in Supplemental data.

familiar expression (Caron, Caron, & MacLean, 1988; Ludemann, 1991; Ludemann & Nelson, 1988; Nelson et al., 1979; Nelson & Dolgin, 1985). A significant novelty preference during the post-familiarization test indicated that infants had successfully recognized the identity (or expression) depicted in the morphing animation and discriminated it from the novel identity (or expression). Based on the previous studies reporting that infants learned identity and expression from static faces (Nelson et al., 1979; Schwarzer & Jovanovic, 2010), we hypothesized that infants might also learn identity and expression from dynamic images of faces. Examining the development of the interaction between identity and emotion recognition using dynamic morphing animation would contribute to understand the link between face processing of identity, emotion, and dynamic facial movement.

Method

Participants

The final sample consisted of 25 7–8-month-old infants (15 boys, 10 girls, mean age = 226 days, ranging from 196 to 254 days). An additional 10 infants were tested, but were excluded from the analysis due to a side bias of more than 90% (1) or longer looking times in the last three familiarization trials than in the first three (9). The participants were recruited using advertisements in newspapers. All participants were healthy at the time of testing. This study was approved by the Ethical Committee of Chuo University (2014-1). The experiments were conducted according to the principles laid down in the Helsinki Declaration. Written informed consent was obtained from each participant's parents prior to participation in the experiments.

Stimuli

We created dynamic stimuli from facial photographs of three Japanese women (models A, B, and C), each with a neutral and happy expression. We used female faces because most previous infant studies investigating identity/expression have used female faces only (Bornstein & Arterberry, 2003; Nelson et al., 1979; Turati et al., 2011). We excluded hair from the facial images so that only the internal features were visible. To exclude the possibility that infants might discriminate the novel face and the dynamic morphing image based on the low level of similarity, we controlled the RGB content of each pixel within the face image using SHINE Toolbox (Willenbockel et al., 2010).

From each of the facial images with a neutral expression, we produced a morphing animation that changed aspects of both identity (from model A to model B) and expression (from neutral and happy). This was accomplished by using computer morphing software (WinMorph, developed by Debugmode) and creating 24 intermediate images between model A's neutral expression and model B's happy expression. Each intermediate image was presented for 75 ms in sequence and the whole presentation of the animation clip lasted for 1800 ms (see Figure 2). Following the animation clip, we presented an oval mask coloured uniform grey for 600 ms to prevent infants from perceiving an afterimage of the sequence. We used only the happy expression because 7–8-month-old infants discriminate the happy expression from other emotional expressions while they have difficulty discriminating between other expressions such as fear and surprise (Ludemann & Nelson, 1988; Nelson et al., 1979).

Two identical animations were presented side-by-side on the monitor. Each facial image subtended about 20.2 deg × 24.5 deg, and the distance between the images was about 14.3 deg. In the

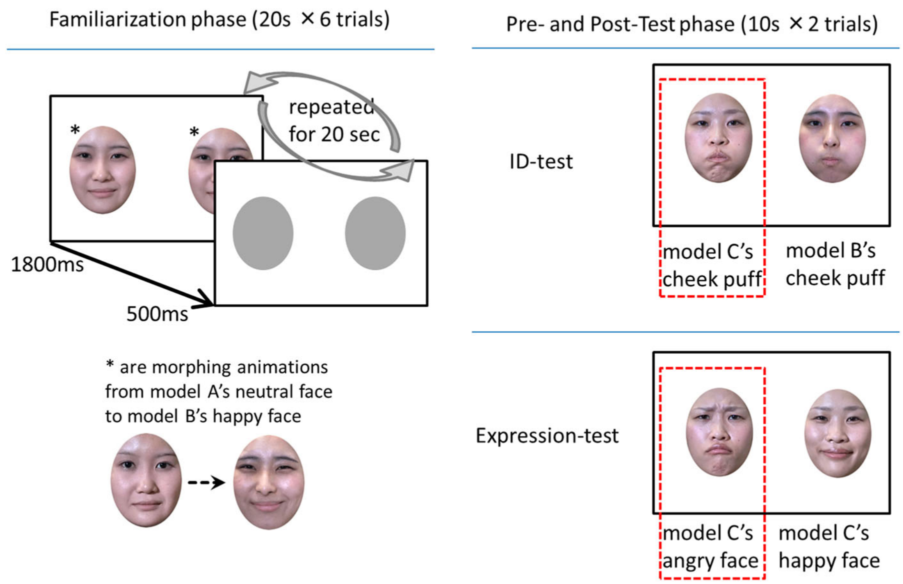

Figure 2. Stimuli used in the experiment. The left panel represents the stimuli presented in Familiarization phase. The right panel represents the stimuli presented in Pre- and Post-familiarization phases. Squares with broken lines indicate target stimuli in the test phase.

same manner, we also created animation clips in which the face morphed from model B's neutral expression to model A's happy expression.

Pilot study for stimuli validation

To choose the morphing animations used in the experiment, we conducted a pilot study with adults. Though we originally had created nine morphing animations from facial photographs of six Japanese women (models A–F), we had to exclude some of them because the duration and number of stimuli in the infant experiment was limited. Most infants could participate in the experiment calmly for only a few minutes, and it took a few minutes to be familiarized with a morphing animation. Simultaneously, we had to control for the possibility that the results from the experiment could vary depending on the animation, so we chose two variants of morphing animation.

Fifty-seven undergraduate students participated in the pilot study. Nine morphing animations, changing from a model's neutral face to another model's happy face, were presented on a 60-inch colour screen, one at a time. The participants were asked to determine whether the identity in the morphing animation had changed. To prevent participants from becoming aware that the correct answer was always "yes," another six morphing animations without identity change (that is, changing from a model's neutral face to the same model's happy expression) were also presented. Each of 15 animations were presented twice, and the order of presentation was randomized. Adult participants reported difficulty recognizing the identity change in some morphing animations. Based on this result and the subjective similarity of the models' faces, we finally chose two morphing animations that were moderately similar to each other and, thus, were the moderately difficult to discriminate.

Apparatus

All stimuli were displayed on a SONY GDM-F520, 21-inch CRT monitor controlled by a computer. The infant and the CRT monitor were located inside an enclosure, which was made of iron poles and covered with cloth. Each infant sat on his or her parent's lap in front of the CRT monitor. The infant's viewing distance from the monitor was approximately 40 cm. There were two loudspeakers, one on either side of the CRT monitor. There was a CCD camera just below the monitor screen. Throughout the experiment, the infant's behaviour was videotaped through this camera. The experimenter could observe the infant's behaviour via a TV monitor connected to the CCD camera.

Procedure

The experiment consisted of three phases: the pre-familiarization test, the familiarization trials, and the post-familiarization test. First, infants participated in two 15-s pre-familiarization test trials in which two different still facial photographs were presented simultaneously side by side on the monitor. They then participated in six 20-s familiarization trials in which two identical morphing animations were presented in the same position as in the pre-familiarization test. During each familiarization trial, infants saw the same video repeatedly. The familiarization trials were immediately followed by two 15-s post-familiarization test trials, which were identical to the pre-familiarization test. An identical test was repeated in the pre- and post-familiarization test phases for each infant to compare the infant's preferential looking time before and after the familiarization.

Prior to each trial, a picture of colourful marbles accompanied by a short beeping sound was presented at the centre of the monitor. The experimenter initiated each trial as soon as the infant was paying attention to the picture.

During the familiarization trials, two identical familiarization stimuli of morphing animation appeared on both sides of the monitor. Familiarization trials were terminated if the infant looked away from the monitor for at least 3 s or if the trials reached a maximum of 20 s. Half of the infants were familiarized with the morphing animation in which the face changed from model A's neutral expression to model B's happy expression, and the other half were familiarized with the morphing animation in which the face changed from model B's neutral expression to model A's happy expression. In this way, the identity of the target face was counterbalanced across infants.

We conducted the pre- and post-familiarization tests under two conditions: the ID-test condition and the Expression-test condition. Half of the infants were assigned to the ID-test condition, and the other half were assigned to the Expression-test condition.

In the ID-test condition, prior to the familiarization trials, we conducted a pre-familiarization test to check the infants' spontaneous preference for either identity. After the familiarization trials, we conducted a post-familiarization test to check infants' novelty preference. In these test trials, the still facial photographs of models B (or A) and C were presented side by side. Both of these faces in the test stimuli puffed out their cheeks to prevent infants from matching the photo only by a visual cue, such as the shape of the mouth, irrespective of the model's identity. We defined model C (novel identity) as a target and model B (or A) (familiarized identity) as a non-target. The identity of the novel face was the same for all infants.

In the Expression-test condition, prior to the familiarization trials, we conducted a pre-familiarization test to check the infants' spontaneous preference for either expression. After the familiarization trials, we conducted a post-familiarization test to check infants' novelty preference. In the test trials, the still photographs of the happy and angry expressions posed by model C were presented side by side. We defined the angry face (novel expression) as a target and the happy face (familiarized expression) as a non-target.

The positions of the target and non-target were reversed across the two trials for each infant. In addition, the positions of the two faces in the first trial were counterbalanced across infants. One observer, who was unaware of the stimulus identity, measured the infants' looking time for each stimulus based on the video recordings. Only the infants' looking behaviour was visible on the video. Although the observer could not see the stimulus, she could time the beginning and end of each trial by means of the beeping sound that was presented at those times. To calculate interobserver agreement, a second observer's measurement of the infants' looking time was obtained from 25% of the total data. Interobserver agreement was Pearson's $r = 0.97$, $p < .001$, across this experiment.

Results

Familiarization trials

The individual total looking times were summed over the two identical stimuli and then averaged across the first three and last three trials. Before analysis, we excluded nine infants who showed longer combined looking times in the last three familiarization trials than in the first three. The mean total looking time in the familiarization was 92.2 s for the infants included in the following analysis and 89.3 s for those excluded while the total amount of possible looking time during familiarization was 120 s.

A two-way analysis of variance (ANOVA) with trials (1–3 trials, 4–6 trials) as a within-participant factor and condition (ID-test condition, Expression-test condition) as a between-participant factor was performed on the individual fixation times. The average looking times for the first three familiarization trials were 50.4 s for ID-test condition and 54.5 s for Expression-test condition. The average looking times for the last three familiarization trials were 38.2 s for ID-test condition and 43.9 s for Expression-test condition. This analysis revealed only a significant effect of trials, $F(1,23) = 31.10$, $p < .001$, $\eta_p^2 = 0.58$, suggesting that the degree of familiarization and looking time were similar across the two conditions. For each condition, a two-tailed *t*-test revealed significant differences between the looking times in the first three and in the last three familiarization trials. The *t*-test for the ID-test condition revealed significant differences, $t(11) = 3.61$, $p = .004$, $r = 0.74$. The *t*-test for the Expression-test condition also revealed significant differences, $t(12) = 4.43$, $p = .001$, $r = 0.79$. The results showed that infants in each condition were significantly familiarized with the morphing animation and that there were no significant differences in the decrease in looking time between the experimental conditions.

Test trials

A two-tailed two-sample *t*-test revealed no significant difference between the total looking time in the post-familiarization test of the ID-test condition and that of the Expression-test condition, $t(23) = 0.34$, $p = .73$, $r = 0.07$.

In each condition, as an index to test whether infants looked longer at the target (that is, novel identity in the ID-test condition and novel expression in the Expression-test condition), a novelty preference score was calculated for each infant in the pre- and post-familiarization tests, respectively. This was done by dividing the infant's looking time at the target by the total looking time over the two trials. The ratios for the two test trials were averaged. Figure 3A shows the mean novelty preference scores in the ID-test condition, and Figure 3B shows the scores in the Expression-test condition.

In the ID-test condition, to first determine whether infants had a spontaneous preference for either model B (or A) or model C, we conducted a two-tailed one-sample *t*-test (vs. chance level at 50%) on the novelty preference score in the pre-familiarization test. This analysis revealed that the infants showed a marginally significant spontaneous preference for familiarized identity, $M = 0.46$, $SE = 0.02$, $t(11) = 1.98$,

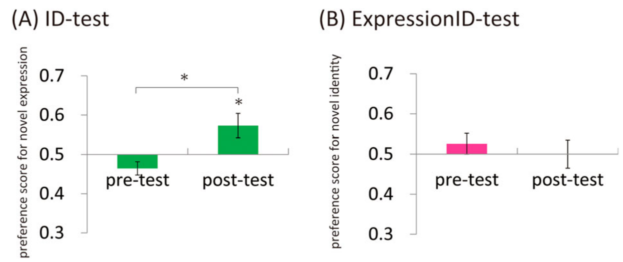

Figure 3. Mean novelty preference score. Each bar shows the mean novelty preference score. The vertical axis depicts the preference score, and the horizontal axis depicts the experimental conditions. The error bars show 1 standard error.

$p = .074$, $r = 0.51$. Next, we conducted a two-tailed one-sample *t*-test (vs. chance level at 50%) on the novelty preference score in the post-familiarization test. This analysis revealed that the infants showed a significant preference for the novel identity, $M = 0.57$, $SE = 0.03$, $t(11) = 2.43$, $p = .033$, $r = 0.59$. As infants showed slight spontaneous preference for familiarized faces in the pre-familiarization test (Sakuta, Sato, Kanazawa, & Yamaguchi, 2014; Tsuruhara, Sawada, Kanazawa, Yamaguchi, & Yonas, 2009; Yamashita, Kanazawa, Yamaguchi, & Initiative, 2011), to determine whether there were differences of novelty preference between the pre- and post-familiarization tests, we conducted a two-tailed *t*-test. The analysis revealed that the novelty preference was greater in the post-familiarization test than in the pre-familiarization test, $t(11) = 3.28$, $p = .007$, $r = 0.70$.

In the Expression-test condition, to first determine whether infants had a spontaneous preference for either the happy or the angry expression, we conducted a two-tailed one-sample *t*-test (vs. chance level at 50%) on the novelty preference score in the pre-familiarization test. This analysis revealed that the infants showed no spontaneous preference for expression, $M = 0.53$, $SE = 0.26$, $t(12) = 0.99$, $p = .34$, $r = 0.27$. Next, to determine whether infants preferred the novel expression after they were familiarized with the morphing animation, we conducted a two-tailed one-sample *t*-test (vs. chance level at 50%) on the novelty preference score in the post-familiarization test. This analysis revealed that the infants did not show a significant preference for the novel expression, $M = 0.50$, $SE = 0.03$, $t(12) = 0.00$, $p = .99$, $r = 0.00$. To determine whether there were differences of novelty preference between the pre- and post-familiarization tests, we conducted a two-tailed *t*-test. The analysis revealed no significant difference between pre- and post-familiarization tests, $t(12) = 0.58$, $p = .57$, $r = 0.16$.

Discussion

We investigated whether infants recognize identity and expression in a morphing animation that changes its identity and expression simultaneously. Using the familiarization–novelty preference procedure, we examined whether infants could learn identity and expression from a dynamic morphing animation. The 7–8-month-old infants learned the identity but not the expression when a face simultaneously changed its identity and expression.

Infants recognized only identity when both identity and expression changed simultaneously. They showed greater novelty preference than spontaneous preference only in the ID-test condition and not in the Expression-test condition. The finding that the dynamic facial movement of a happy expression enabled infants to learn a post-morphed identity is consistent with results shown by Turati et al. (2011). Using dynamic animation of expression, previous studies have shown that 3-month-old infants successfully recognized identity (Brenna et al., 2013; Otsuka et al., 2009; Turati et al., 2011). Turati et al. (2011) and Brenna et al. (2013) used a familiarity–novelty preference procedure and a happy expression, as did the present study. Turati et al. (2011) demonstrated that the facial movement of a happy expression enhanced infants' identity recognition. Furthermore, Brenna et al. (2013) revealed that the advantage of a dynamic happy expression over a negative expression was caused solely by either smiling eyes or a smiling mouth. Although the age of their participants (3-month-olds) differed from ours (7–8-month-olds), the present study provides the new but related finding that a dynamic happy expression led the infants to learn identity from a peak happy expression. On the other hand, the dynamic movement depicting identity change interfered with the infants' recognition of expression. The dominance of identity recognition over expression recognition suggests two possibilities. One possibility is that infants' recognition of facial expression depends on who is making the expression. Since a happy expression conveys that an infant's environment is "safe and easy" only when the expression is conveyed by a trusted person, such as a caregiver, information about identity might be more vital for infants than information about expression. The other possibility is that the "unusual" facial movement of identity change was novel and salient and thus attracted the infants' attention. Moreover, while naturally recorded dynamic facial animation contains characteristic patterns for each expression (Kamachi et al., 2001), the artificial facial morphing animations used in this study linearly morphed and might be hardly recognized as a facial expression change. Then, our infants could not ignore the identity change and might have attributed the semi-rigid motion of the morphing animation only to identity change.

The possible interpretation remains that infants could recognize identity and expression of both the face shown at the beginning of the movie and the face shown at the end of the movie. We conducted the present study to test the effect of dynamic simultaneous change of identity and expression on recognition of the facial image shown at the end of the movie, because the facial image shown at the beginning of the movie can be recognized at the start of the movie as the static image and not be affected by following dynamic change of the facial image. The previous study conducted by Turati et al. (2011) also examined if the dynamic presentation affected the recognition of the facial identity shown at the end of the video. However, dynamic presentation might backwardly affect identity or expression recognition of the facial image shown at the beginning of the movie under the certain condition, like a masking effect in face processing (Esteves & Ohman, 1993). In future study, we would be able to test this possibility.

The present study examined the interaction between identity and expression recognition in infants and children. We created a morphing animation that simultaneously changed identity and expression and dynamically changed both the identity and expression of the faces. Previous studies (Brenna et al., 2013; Turati et al., 2011) have shown that infants' identity recognition was enhanced by dynamic movement derived from emotional expression; our study further revealed that infants recognize facial identity even from a dynamic morphing animation depicting non-rigid change other than facial expression. We first demonstrated that the expression recognition was interrupted by dynamic change of facial identity using dynamic morphing animation. This would be the evidence of separate systems for static vs. dynamic face processing early in development.

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