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Enhanced Experience of Emotional Arousal in Response to Dynamic Facial Expressions

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Abstract In this study, we investigated the emotional effect of dynamic presentation of facial expressions. Dynamic and static facial expressions of negative and positive emotions were presented using computer-morphing (Experiment 1) and videos of natural changes (Experiment 2), as well as other dynamic and static mosaic images. Participants rated the valence and arousal of their emotional response to the stimuli. The participants consistently reported higher arousal responses to dynamic than to static presentation of facial expressions and mosaic images for both valences. Dynamic presentation had no effect on the valence ratings. These results suggest that dynamic presentation of emotional facial expressions enhances the overall emotional experience without a corresponding qualitative change in the experience, although this effect is not specific to facial images.

Keywords Dynamic presentation · Emotional facial expressions · Emotional arousal

The term ‘‘emotion’’ derives from the Latin word that means, ‘‘to move out’’ (Planalp, 1999). This etymology suggests that powerful emotional messages may be communicated to us through the dynamic actions of others. A common way of communicating emotions is through facial expressions. For example, observing the

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sudden change in another person's facial expression as it moves from a neutral state to one of fear may provoke a fearful state in the perceiver.

The importance of the dynamic properties of facial expressions has been emphasized in the psychological literature. Ekman and colleagues (e.g., Ekman & Friesen, 1975) have described various facial expressions from a dynamic perspective, and Tomkins (1982) has proposed that the temporal changes of physical responses, including facial expressions, constitute useful cues for distinguishing emotions.

Experimental studies that have tested the effect of dynamic presentation of facial stimuli report a facilitative effect on facial processing. For example, studies have shown that dynamic presentation of facial expressions improves the emotional recognition of the expressions (Frijda, 1953; Harwood, Hall, & Shinkfield, 1999; Kozel & Gitter, 1968; Wehrle, Kaiser, Schmidt, & Scherer, 2000). Neuropsychological studies have revealed that dynamic, relative to static, presentation improved emotional recognition in prosopagnosic patients (Humphreys, Donnelly, & Riddoch, 1993) and a blind patient (De Gelder, Vroomen, Pourtois, & Weiskrantz, 1999). Other researchers reported that dynamic presentation of facial stimuli facilitated age (Berry, 1990) and identity recognition (Bruce, & Valentine, 1988; Lander, Christie, & Bruce, 1999; Schiff, Banka, & de Bordes Galdi, 1986), as compared to static presentation. These data suggest that compared to static presentation, dynamic presentation of facial expressions facilitates the ways in which the expressions are processed.

Whether dynamic presentation of emotional facial expressions affects emotional elicitation in response to the expressions is not known. Emotion elicitation is an elemental component of facial expression processing, which plays an important role in guiding social behaviors (Frijda, 1986, 1996; Keltner, & Kring, 1998). For example, the elicitation of the emotion of being scared in response to others' fearful expressions could facilitate coordinated actions between individuals facing a dangerous event.

Previous experimental studies have consistently found that static presentation of facial expressions of emotion elicits a subjective emotional experience (Dimberg, 1988; Hess & Blairy, 2001; Johnsen, Thayer & Hugdahl, 1995; Lundqvist & Dimberg, 1995; Wild, Erb & Bartels, 2001). For example, Lundqvist and Dimberg reported that presenting photographs of facial expressions of basic emotions elicited a subjective experience of the same emotion. The evidence for the facilitative effect of dynamic presentation on other types of facial processing suggests that dynamic presentation of emotional expressions may facilitate a subjective emotional response to the expressions. If so, experiments using static images as stimuli may have underestimated the real-world significance of this component. Furthermore, a comparison of the effect of dynamic and static presentation of emotional facial expressions on emotional elicitation could provide useful information for psychological researchers who present facial expressions as a means of eliciting emotion.

It is widely accepted that subjective emotional experience can be well represented by the dimensions of valence and arousal (Greenwald, Cook & Lang, 1989). The most prevalent interpretation of these dimensions is that the valence, which ranges from positive to negative, represents the qualitative component, whereas the arousal, which ranges from high to low, reflects the intensity of either positive or negative emotions (Lang, Bradley & Cuthbert, 1998; Reisenzein, 1994).

Based on this dimensional view of emotion, Simons and his colleagues (Detenber & Simons, 1998; Simons, Detenber, Reiss, & Shults, 2000; Simons, Detenber, Roedema & Reiss, 1999) investigated the effect of dynamic scenes (e.g., a funeral scene) on participants' emotional experiences. Although some of their stimuli included human faces, the specific effect of facial expression was not investigated. They presented dynamic and static scenes, and asked participants to rate the emotional valence and arousal of their response. The results consistently demonstrate that dynamically presented emotional scenes induce greater emotional arousal than do static images (Detenber & Simons; Simons et al. 1999, 2000), but the impact of dynamic presentation on valence was reported to be non-significant (Simons et al., 2000) or considerably smaller than the effect of dynamic presentation on arousal (Detenber & Simons; Simons et al., 1999). These data indicate that dynamic presentation of stimuli can induce a more intense emotional experience than can static presentation, with no or small qualitative changes.

The primary purpose of the present study was to investigate the effect of dynamic presentation on emotional experience while viewing facial expressions of emotion. To present the dynamic facial expressions, we used computer-morphing techniques in Experiment 1 and videos of natural facial expressions in Experiment 2. Both methods have advantages and disadvantages and the two complement each other (Sato & Yoshikawa, 2004). We prepared facial expressions of positive (happy) and negative (fearful and angry) emotional valences in Experiments 1 and 2, respectively. For the static condition, we used the apex image of the dynamic facial expression. To measure subjective emotional experience, we asked the participants to rate emotional valence and arousal, following the method of Simons et al. (e.g., Simons et al., 2000). Based on the aforementioned data indicating the facilitative effect of dynamic presentation on various types of facial processing and higher emotional arousal in response to dynamic rather than static emotional scenes, we hypothesized that dynamic presentation of facial expressions of emotion would induce higher emotional arousal than the corresponding static presentation.

The secondary purpose of the present study was to investigate whether dynamic faces could have a specific effect on emotional elicitation as compared with other dynamic visual stimuli. There is some evidence suggesting that humans have specific psychological and neural mechanisms for processing faces. For example, infant studies have reported that newborn infants preferentially pay attention to faces relative to other images (Johnson, Dziurawiec, Ellis, & Morton, 1991). Neuroimaging studies have reported that some brain areas are more active in response to visually presented faces than to other stimuli (Kanwisher, McDermott, & Chun, 1997). As a first step in investigating this issue, we prepared dynamic and static mosaic images of faces as stimuli and compared the results. The dynamic mosaic images that we used provided equivalent information in terms of low-level visual features, such as brightness and velocity, to the dynamic facial expressions, but without facial properties. Although previous studies have indicated that dynamic presentation of various types of stimuli can induce higher emotional arousal than static presentation (e.g., Detenber & Simons, 1998), based on the data suggesting the special significance of faces, we hypothesized that the effect of presentation condition (dynamic vs. static) on emotional arousal would be larger for faces than for mosaic images

Experiment 1

In this experiment, we used a computer-morphing technique to create dynamic emotional facial expressions (Figure 1). The stimuli consisted of facial images that transformed seamlessly from neutral to emotional expressions. This method allowed us to compare dynamic and static presentation of facial expressions. In addition, this method enabled us to incorporate movement into static images chosen from a

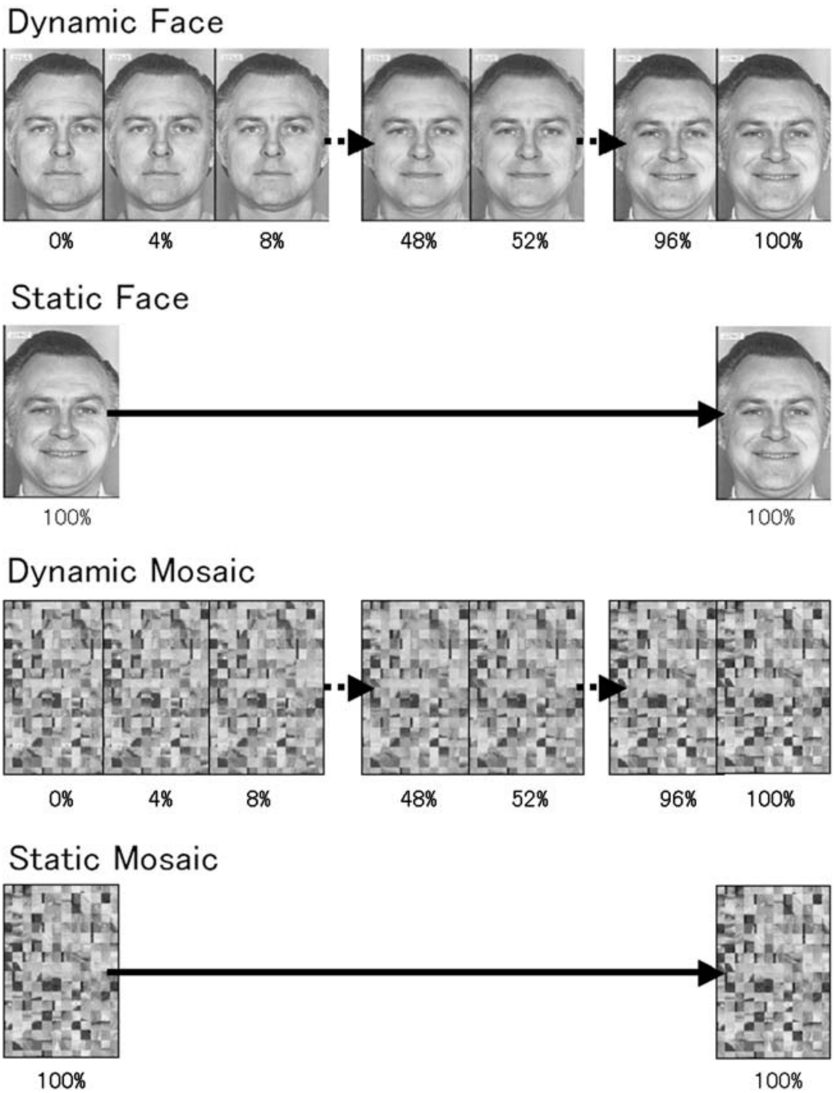

Fig. 1 Stimulus presentation in the dynamic facial expression condition (upper), static facial expression condition (upper middle), dynamic mosaic condition (lower middle), and static mosaic condition (lower) in Experiment 1

well-researched stimulus set (Ekman & Friesen, 1976) and to compare our results with previous findings using the static images (e.g., Johnsen et al., 1995). In this experiment, we presented facial expressions of fear and happiness to represent negative and positive emotional valences, respectively.

Method

Participants

Seventeen volunteers (eight female and nine male; mean age, 20.5 years) participated in this experiment. All of the participants were right-handed, and had normal or corrected-to-normal visual acuity.

Experimental design

The experiment was constructed as a within-participants three-factor design, with presentation condition (dynamic or static), emotion (fear or happiness), and stimulus type (face or mosaic) as factors. Valence and arousal ratings were the two dependent variables measured.

Stimuli

The raw materials were grayscale photographs of ten individuals' faces, chosen from a standard set (Ekman & Friesen, 1976), depicting fearful, happy, and neutral expressions. None of these faces was familiar to any of the participants.

Computer animation clips constructed from these photos of emotional facial expressions served as dynamic expression stimuli. First, 24 intermediate images were created in 4% steps between the neutral (0%) and emotional (100%) expressions using computer-morphing techniques (Mukaida et al., 2000), implemented on a computer running Linux. Figure 1 displays an example of the stimulus sequence. Next, a total of 26 images (i.e., one neutral image, 24 intermediate images, and the final emotion image) were presented in succession to create a moving clip. Each image was presented for 40 ms, except the first and last images, which were presented for 280 ms; thus, each animation clip was presented for 1520 ms. This velocity was shown to sufficiently represent natural changes in the dynamic facial expressions of fear and happiness (Sato & Yoshikawa, 2004).

The emotional expressions that corresponded to the final images in the dynamic face condition were chosen as the static expression stimuli and were presented for 1520 ms.

For the dynamic mosaic image stimuli, all of the dynamic facial expression images were divided into 18 vertical × 12 horizontal squares and reordered using a fixed randomization algorithm. This rearrangement made each face unrecognizable as a face. A set of these 26 images, corresponding to the original dynamic face images, was serially presented as a moving clip at the same velocity as that of the dynamic expression stimuli.

For the static mosaic image stimuli, the mosaic images created from the final images in the dynamic mosaic image condition were presented for 1520 ms.

Apparatus

The experimental events were controlled by a program written in Visual C++5.0 and implemented on a laptop computer (Inspiron 8000, Dell) running the Windows operating system. The stimuli were presented on the 15-inch TFT display of the laptop computer (480 vertical × 640 horizontal pixels resolution, 16-bit color) from a viewing distance of about 0.6 m. The stimuli were presented at 300 pixels in height × 200 pixels in width, subtending a visual angle of about 13.5° in height × 9° in width.

Procedure

The participants were tested individually. They were asked to rate ‘‘How did you feel emotionally when you viewed the stimuli?’’ in terms of emotional valence –4 (*negative*) to +4 (*positive*) and arousal –4 (*low arousal*) to +4 (*high arousal*) in response to each stimulus. The mid-point of each scale was coded as 0 without wording. The participants were allowed to view the stimuli repeatedly by clicking a button until they were confident of their ratings. The participants performed a few practice trials to familiarize themselves with the procedure.

A total of 80 trials (10 each for dynamic and static fearful and happy faces, plus mosaics of fearful and happy faces) were performed. The order of stimulus presentation was randomized.

Data analysis

Each rating (valence, arousal) was analyzed separately. The following two analyses were conducted.

First, to confirm that the stimuli elicited emotion as compared to the neutral state, each rating of each condition was tested for difference from zero using one-sample t tests (two-tailed) with Bonferroni's correction; the alpha level was divided by the number of statistical tests performed (i.e., 8 per dependent variable).

Then, each rating was analyzed in a three-way analysis of variance (ANOVA) with presentation condition, emotion, and stimulus type as within-participant factors. For significant interactions, follow-up simple effect analyses were conducted. When higher-order interactions were significant, the main effects were not subjected to interpretation because of their problematic properties (c.f., Tabachnick & Fidell, 2001).

The results of all tests were considered statistically significant at $p < .05$.

Results

For the valence ratings, the means, *SE*s, and t values obtained from one-sample t tests were shown in Table 1 (upper). The t tests revealed that dynamic fearful faces and static fearful faces both induced negative valence ratings that differed

Table 1 Mean Ratings (with *SE* and *t* values) for Valence (upper) and Arousal (lower) in Experiment 1

Measure		Face				Mosaic			
		Fear		Happiness		Fear		Happiness	
		Dynamic	Static	Dynamic	Static	Dynamic	Static	Dynamic	Static
Valence	M	–2.16	–2.12	2.57	2.40	–0.13	–0.38	0.07	–0.14
	SE	0.18	0.19	0.22	0.19	0.22	0.19	0.26	0.17
	t value	11.99*	10.93*	11.76*	12.91*	0.59	1.97	0.25	0.85
Arousal	M	1.21	0.08	2.32	1.24	0.57	–0.84	0.82	–0.86
	SE	0.30	0.28	0.19	0.26	0.21	0.26	0.26	0.30
	t value	4.11*	0.27	12.18*	4.73*	2.68	3.22*	3.20*	2.86+

Note. *t* values were obtained from one-sample *t* tests for difference from zero

* $p < .05$; + $p < .1$

significantly from the neutral state. Dynamic happy faces and static happy faces both induced positive valence ratings that differed significantly from the neutral state.

The ANOVA for the valence ratings revealed no significant main effects or interactions regarding the presentation condition factor, *F*s < 2, *p*s > .1, partial η^2s < .2. Among the other factors, emotion had a significant main effect, indicating higher valence ratings for happy than for fearful stimuli, $F(1, 16) = 164.85$, $p < .001$, partial $\eta^2 = .910$. The main effect of stimulus type was not significant, $F < 3$, $p > .1$, partial $\eta^2 < .2$. The interaction of emotion × stimulus type was significant, $F(1, 16) = 230.35$, $p < .001$, partial $\eta^2 = .935$. Follow-up analyses of this interaction revealed that the simple main effect of emotion, indicating higher valence ratings for happy than for fearful stimuli, was significant only for faces, $F(1, 32) = 373.39$, $p < .001$, partial $\eta^2 = .927$. It is not surprising that a difference in valence ratings was found for faces but not for mosaics.

For the arousal ratings, the means, *SE*s, and *t* values obtained from one-sample *t* tests were shown in Table 1 (lower). The *t* tests revealed that dynamic fearful faces, dynamic happy faces, static happy faces, and dynamic happy mosaics induced significantly high arousal ratings as compared to the neutral state. Static fearful mosaics induced low arousal ratings that differed significantly from the neutral state, and static happy mosaics showed the same pattern, although it was statistically nonsignificant, p < .10.

The ANOVA for the arousal ratings showed that the main effect of presentation condition was significant, indicating higher arousal ratings for dynamic than for static presentation, $F(1, 16) = 24.87$, $p < .001$, partial $\eta^2 = .608$. There were no significant interactions related to presentation condition, *F*s < 2, *p*s > .1, partial η^2s < .1. For other factors, the main effects of emotion and stimulus type were significant, *F*s(1, 16) = 32.24 and 28.31, *p*s < .001 and .001, partial η^2s = .668 and .639, respectively. The interaction of emotion × stimulus type was also significant, $F(1, 16) = 17.36$, $p < .001$, partial $\eta^2 = .930$. Follow-up analyses of the interaction revealed that the simple main effect of emotion, indicating higher arousal ratings for happy than for fearful stimuli, was significant only for faces, $F(1, 32) = 47.57$, $p < .001$, partial $\eta^2 = .723$.

Discussion

For facial stimuli, the results of the one-sample *t* tests showed that both dynamic and static presentation of facial expressions of fear and happiness induced emotional experiences, in terms of both emotional valence and arousal. The results of the valence ratings indicated that participants experienced a negative emotion in response to fearful faces and a positive emotion in response to happy faces, with both dynamic and static presentation. The arousal ratings indicated that both dynamic and static presentation of facial expressions induced high arousal states, although no effect was evident for static fearful faces. These results are in line with previous studies using static facial photos, which reported that presenting emotional facial expressions induced a subjective experience of the emotional state expressed in the stimulus (e.g., Johnsen et al., 1995).

The results of the ANOVA indicated that dynamic presentation had no effect on valence ratings. In contrast, dynamically presented facial expressions conveying the emotions of fear and happiness were rated as highly arousing relative to static expressions of those same emotions. These results are consistent with previous studies (e.g., Detenber & Simons, 1998) reporting that dynamically presented scenes induced higher emotional arousal than static images, as well as that the impact of dynamic presentation on valence was non-significant or considerably smaller than its effect on arousal. Taken together, these findings support our first hypothesis that dynamic presentation of facial expressions facilitates emotional arousal.

The results of the one-sample *t* tests for the mosaic images indicated that dynamic and static presentation of mosaics induced high and low arousal states, respectively. The presentation of mosaic images had no effect on valence ratings. Although the significance of these results differed with the emotions of original faces, a similar pattern was evident.

The results of the ANOVA indicated higher emotional arousal for dynamic than static presentation, not only for facial images but also for mosaic images. There was no significant interaction between presentation condition and stimulus type. These results are inconsistent with our second hypothesis and indicate that there was no specific effect of faces in the emotional elicitation of dynamic presentation. Although there are some data indicating specific psychological/neural mechanisms for faces (e.g., Johnson et al., 1991), the effect of dynamic presentation on the elicitation of emotion appears not to be specific to facial expression processing. This result could be considered in line with previous studies using various types of dynamic stimuli (e.g., Detenber & Simons, 1998), and extends previous findings showing that the facilitative effect of dynamic presentation on emotion elicitation applies even to nonsense objects.

Experiment 2

We conducted Experiment 2 to investigate unresolved issues from Experiment 1. First, in Experiment 1, we used computer-morphing to present dynamic facial expressions. Although this method allowed for significant stimulus control, it was artificial and might not have modeled real dynamic facial expressions. To clarify this issue, we conducted a second experiment using video clips of real facial expressions. Second, to examine whether the results of Experiment 1 could be generalized to different negative expressions, we presented angry instead of fearful expressions as the negative emotional valence stimuli.

Method

Participants

Fifteen volunteers (nine females and six males; mean age, 26.9 years) participated in this experiment. All of the participants were right-handed, and had normal or corrected-to-normal visual acuity.

Experimental design

The design and dependent measures were identical to those used in Experiment 1 with one exception. The negative emotional factor was changed from fear to anger.

Stimuli

The materials were videotapes of angry and happy facial expressions of eight women and eight men. These stimuli were selected from a video database of emotional facial expressions that were posed by more than 50 Japanese models. None of the faces was familiar to the participants. Preliminary ratings from participants who did not take part in this experiment confirmed that the stimuli clearly displayed the target emotions relative to other basic emotions. The expressions contained temporal parameters that were similar to the dynamic stimuli in Experiment 1, as well as a few artifacts irrelevant to emotional expressions.

For the dynamic faces, a total of 38 frames ranging from neutral to full emotional expression were presented. Each frame was shown for 40 ms, and each clip was presented for 1520 ms.

The final frame of the emotional expression was taken from the dynamic video clip and presented as the static face for 1520 ms.

For the dynamic mosaics, all of the dynamic faces were divided into 25 vertical $\times$ 20 horizontal squares and reordered using a fixed randomization algorithm. A set of these 38 images corresponding to the original dynamic faces was serially presented as a moving clip at the same velocity as that of the dynamic faces.

Apparatus

The experimental events were controlled by the same program as that was used in Experiment 1 and implemented on a desktop computer (FSA600, Teknos) running the Windows operating system. The stimuli were presented on a 19-inch CRT monitor (HM903D, Iiyama; 480 vertical $\times$ 640 horizontal pixels resolution, 16-bit color) from a viewing distance of about 0.6 m. The stimuli were presented at 300 pixels in height $\times$ 200 pixels in width, subtending a visual angle of about 16.5° in height $\times$ 11° in width.

Procedure

The procedure was identical to that in Experiment 1, with one alteration. Since the number of presentations of each condition was lowered from ten to eight, the participants participated in a total of 64 rather than 80 trials.

Data analysis

The method of data analysis was identical to that used in Experiment 1.

Results

For the valence ratings, the means, *SE*s, and *t* values obtained from one-sample *t* tests were shown in Table 2 (upper). The *t* tests revealed that dynamic angry faces, static angry faces, dynamic angry mosaics, static angry mosaics, and static happy mosaics induced negative valence ratings that differed significantly from the neutral state. Dynamic happy faces and static happy faces induced positive valence ratings that differed significantly from the neutral state.

Table 2 Mean Ratings (with *SE* and *t* values) for Valence (upper) and Arousal (lower) in Experiment 2

Measure		Face				Mosaic			
		Anger		Happiness		Anger		Happiness	
		Dynamic	Static	Dynamic	Static	Dynamic	Static	Dynamic	Static
Valence	M	−1.93	−1.88	1.78	1.45	−0.98	−1.23	−0.85	−1.23
	SE	0.37	0.31	0.23	0.24	0.29	0.29	0.36	0.29
	t value	5.27*	5.97*	7.72*	5.96*	3.39*	4.28*	2.37	4.18*
Arousal	M	1.63	0.73	1.77	0.70	0.41	−0.91	0.38	−0.63
	SE	0.36	0.38	0.28	0.34	0.36	0.49	0.40	0.51
	t value	4.50*	1.92	6.33*	2.06	1.86	1.86	0.94	1.24

Note. *t* values were obtained from one-sample *t* tests for difference from zero

* $p < .05$

The ANOVA for the valence ratings revealed only a marginally significant main effect for presentation condition, $F(1, 14) = 3.61, p < .1$, partial $\eta^2 = .205$. This factor had no significant interactions, Fs < 1, ps $> .1$, partial η^2s $< .1$. For the other factors, emotion and stimulus type both showed significant main effects, indicating higher valence ratings for happy than for angry stimuli, and for mosaics than for faces, Fs(1, 14) = 62.85 and 6.69, ps < .001 and .05, partial η^2s = .818 and .323, respectively. The interaction of Emotion × Stimulus type was significant, $F(1, 14) = 68.05$, $p < .001$, partial $\eta^2 = .829$. Follow-up analyses of the interaction revealed that the simple main effect of emotion, which indicated higher valence ratings for happy than angry stimuli, was significant only for faces, $F(1, 28) = 130.46$, $p < .001$, partial $\eta^2 = .830$. It simply means that a difference in valence ratings was found for faces but not for mosaics.

For the arousal ratings, the means, *SE*s, and *t* values obtained from one-sample *t* tests were shown in Table 2 (lower). The *t* tests revealed that dynamic angry faces and dynamic happy faces induced high arousal ratings that differed significantly from the neutral state.

The ANOVA for the arousal ratings revealed that the main effect of presentation condition was significant, indicating higher arousal for dynamic than for static presentation, $F(1, 14) = 9.94$, $p < .01$, partial $\eta^2 = .415$. No significant interactions were related to the presentation condition, Fs < 3, ps $> .1$, partial η^2s $< .2$. For the other factors, the main effect of stimulus type was significant, indicating higher arousal ratings for faces than for mosaics, $F(1, 14) = 7.55$, $p < .05$, partial $\eta^2 = .350$. There were no other significant main effects or interactions, Fs < 1, ps $> .1$, partial η^2s $< .1$.

Discussion

For facial stimuli, the results of the one-sample *t* tests were similar to those of Experiment 1, although there was no evidence of an effect on arousal of static presentation of facial expressions. The results of the valence ratings indicated that participants experienced a negative emotion in response to angry faces and a positive emotion in response to happy faces, with both dynamic and static presentation. The results of the arousal ratings indicated that dynamic presentation of facial expressions of both anger and happiness induced high arousal.

The results of the ANOVA were also almost identical to those of Experiment 1. The presentation condition had no effect on the valence ratings. Dynamic facial expressions of both anger and happiness induced higher arousal ratings than did static expressions of the same emotions. Because the stimuli were of natural changes in facial expression under dynamic conditions, these results cannot be attributed to artifacts related to artificial dynamic stimuli. These results provide further support for our first hypothesis that dynamic presentation of facial expressions facilitates emotional arousal.

For mosaic images, the results of the one-sample *t* tests indicated that both dynamic and static presentation of mosaics induced negative valence ratings. The presentation of mosaics had no effect on arousal ratings. Although the reliability of these results differed with the emotions of original faces, their patterns were the same.

The results of the ANOVA replicated those of Experiment 1 with regard to our second hypothesis. Emotional arousal was higher for dynamic vs static presentation of both faces and mosaics, and there was no significant interaction between presentation condition and stimulus type. These results are inconsistent with our second hypothesis, indicating that there is no specific effect of faces in emotion elicitation by dynamic presentation.

General Discussion

In the present study, we investigated the effect of dynamic presentation on emotional experience while viewing facial expressions of emotion. We presented dynamic and static facial expressions of negative and positive emotions, as well as dynamic and static mosaics, to the participants, and asked them to rate the valence and arousal of their emotional experience. Our first hypothesis was that dynamic presentation of facial expressions of emotion would induce higher emotional arousal than the corresponding static presentation. Our second hypothesis was that dynamic vs static presentation of faces would induce more intense subjective emotional arousal than dynamic vs static presentation of mosaic images.

Our first hypothesis was supported by our results indicating that for both negative and positive valences, arousal ratings were higher in response to dynamic presentation using computer-morphing and video clips of natural expressions than in response to static facial expressions. Dynamic presentation had no effect on valence ratings. The majority of researchers propose that valence represents the qualitative component, whereas arousal reflects the intensity of either positive or negative emotions (Reisenzein, 1994).[1] Our results indicate that dynamic presentation of facial expressions induces more intense subjective emotions, and that it is qualitatively consistent with the subjective emotional experience of viewing static facial expressions.

Although previous studies in the literature of face processing have reported that dynamic presentation facilitates various types of face processing (e.g., Wehrle et al., 2000), its effect on the elicitation of emotions has not been researched. Previous studies utilizing emotional scenes and objects (e.g., Detenber & Simons, 1998) have indicated that dynamic presentation of stimuli enhanced emotional arousal, but the specific effect of faces has not been tested. Our study is the first to demonstrate that dynamic presentation of facial expressions facilitates emotional arousal. The elicitation of emotion in response to others' facial expressions could lead to socially consequential behaviors, and this is particularly the case when the emotion being elicited is intense (Frijda, Ortony, Sonnemans, & Clore, 1992). Daily communication

[1] In contrast to this view, some researchers have proposed that arousal indicates the quality of emotional experience, which is different from that of valence (e.g., Russell, 1989). To clarify this issue, we replicated Experiment 1 and measured intensity, instead of arousal, with 15 participants. The results were almost identical to those of Experiment 1: The valence ratings indicated that participants experienced a negative subjective emotion in response to fearful faces and a positive emotion in response to happy faces, and that dynamic presentation had no effect on the valence ratings; The results of the intensity ratings indicated that dynamically presented stimuli were rated as highly intense relative to static stimuli. These results suggest that, at least for emotional experience in response to dynamic faces and their mosaics, arousal and intensity can be used interchangeably.

via dynamic facial expressions may be more emotionally toned, and subsequently more socially interactive, than researchers have previously proposed.

Our findings indicated that dynamic presentation of emotional facial expressions enhanced the overall emotional experience without changing its quality. Some of our results indicated that even when static presentation of facial expressions did not induce evident emotional arousal as compared with the neutral state, dynamic presentation of the same stimuli induced clear emotional arousal. These results have practical, as well as theoretical, significance for experimental psychological studies. Several studies have used static presentation of emotional facial expressions to elicit emotion (e.g., Schneider, Gur, Gur, & Muenz, 1994). Based on our results, we propose that dynamic presentation of emotional facial expressions is more appropriate than static presentation for evoking a subjective emotional experience.

The results of neuroimaging studies may provide clues regarding the neural substrate involved in emotional enhancement in response to dynamic facial expressions. In a recent functional magnetic resonance imaging (fMRI) study (Sato, Kochiyama, Yoshikawa, Naito, & Matsumura, 2004), fearful or happy facial expressions were dynamically presented using the same morphing technique as that used in Experiment 1. Static facial expressions and dynamic mosaic images were presented as controls. The activity of the broad cortical and subcortical brain regions while viewing dynamic facial expressions was enhanced over that of presentation of either control stimulus. Thus, enhanced neural activation may account for the heightened emotional elicitation in response to dynamic facial expressions that we found in this study.

The underlying mechanism for the enhanced elicitation of emotion in response to dynamic facial expressions may be an intriguing issue for further studies. A recent psychological study (Sato & Yoshikawa, in press) found that dynamic facial expressions induce facial mimicry more clearly than do static facial expressions. Thus, enhanced elicitation of emotion may be the effect of facial mimicry in response to dynamic, as opposed to static, facial expressions, via the afferent feedback of facial muscle activities (c.f., Hess, Kappas, McHugo, Lanzetta, & Kleck, 1992). However, enhanced elicitation of emotion could alternatively be the cause of the evident facial mimicry (c.f., Ekman & Friesen, 1975).

In contrast to our first hypothesis, our second hypothesis was not supported by the results. Arousal ratings were higher in response to dynamic mosaic as well as facial images, and there was no significant interaction between presentation condition and stimulus type in either computer-morphed or natural facial expressions. These results indicate that the facilitative effect of dynamic presentation is not specific for faces but domain-general in eliciting subjective emotion.

It must be noted that the interpretation for the emotional ratings in response to dynamic mosaics is problematic in some respects. Dynamic presentation of mosaics did not induce strong emotional valence as compared to the neutral state, particularly in Experiment 1. Similarly, dynamic presentation of mosaics did not induce intense emotional arousal as compared to the neutral state, particularly in Experiment 2. Based on these results, it may not be appropriate to suggest that dynamic presentation of mosaic images elicited emotion. Further studies are necessary to investigate the domain-general property of the elicitation of emotion by dynamic presentation.

For future research, it may be interesting to clarify the face specificity of the effect of dynamic presentation for other cognitive processing. Some studies have reported that dynamic information contributes to the recognition of face-specific information, such as the identification of individuals and gender classification (e.g., Hill & Johnston, 2001; Knappmeyer, Thornton, & Bulthoff, 2003; for a review, see O'Toole, Roark, & Abdi, 2002). Studies have also reported that dynamic information serves in the recognition of non-facial objects (e.g., Stone, 1998). Direct comparison between the performance for faces and for non-facial images could determine whether dynamic faces have specific characteristics.

In summary, we found that

(1) Subjectively experienced emotional arousal was higher in response to dynamic than to static presentation of the stimuli; this was the case for facial expressions of both negative and positive valences. The valence ratings did not differ for dynamic and static presentation of the expressions.
(2) Reported emotional arousal/intensity was higher not only for faces but also for mosaic images.

Our finding that dynamic presentation of facial expressions induces a more intense emotional experience relative to static presentation of the same facial expressions could have important implications for future investigations into the processing of facial expressions, and for studies that use facial expressions as emotion-elicitation stimuli.

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