Evaluation of the affective values of neutral faces in the context of expression attenuation

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This study aimed to quantify the affective values of neutral faces in the context of attenuation of the six basic facial expressions (i.e., anger, disgust, sadness, happiness, fear, and surprise) via the affect grid method and verify whether overshoot perceptual bias was visible. In Experiment 1, still images of faces displaying six facial expressions and of an expressionless neutral face were evaluated on a two-dimensional affect grid scale consisting of hedonic valence (i.e., pleasure-displeasure) and arousal (i.e., high arousal-low arousal), and their affective values were confirmed. In Experiment 2, the final neutral faces shown at the end of the moving images—in which one of six expressions gradually disappeared—were evaluated using the same methods as those described for Experiment 1. As a result, the evaluation of a neutral face with expression attenuation differed from evaluations without context in many cases and shifted depending on the initial context expression on any one of or both the hedonic valence and arousal dimension. Given the affective values of context expression confirmed in Experiment 1, this shift can be considered a forward shift in line with the expression attenuation context in the specific dimension defining emotion.

Key words: attenuation of facial expressions, affective value shift, perception of neutral face

Facial expressions change dynamically, with a variety of information being communicated to onlookers. There is considerable research on the recognition of facial expressions of emotions focusing on the effects of dynamic changes in expressing facial expressions, including a facial change from neutral to emotional expression. Studies using morphing images have reported that for each facial expression, there is a pace of change most suited to its perception (Kamachi et al., 2001), and the naturalness of an expression varies depending on its speed (Sato & Yoshikawa, 2004). However, when an expression is ambiguous or faint, showing it as a moving image improves the accuracy of emotional identification (Ambadar, Schooler, & Cohn, 2005), and when an expression is shown as a moving image, the emotion expressed is perceived as more intense (Biele & Grabowska, 2006; Yoshikawa & Sato, 2008). Moreover, researchers using non-invasive brain function measurement methods have found that showing a facial expression dynamically leads to a higher level of brain activity at the time of perception (Yoshikawa & Sato, 2006). As a result of these findings, it is generally considered that displaying facial expressions of emotions as moving images has the effect of promoting the perception of facial expressions and the emotions being expressed (Alves, 2013; Krumhuber, Kappas, & Manstead, 2013).

In addition to the expression of facial expressions as described above, in recent years,

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facial expression attenuation has also been noted, and the effects of dynamic facial changes from an emotional expression to a neutral expression have also been discussed. Some studies have described a phenomenon in which the expression attenuation process is shown as a temporal context; a change occurs in the perception of the final neutral face, depending on the specific expression attenuation context (Ishi & Gyoba, 2006, 2007; Jellema, Pecchinenda, Palumbo, & Tan, 2011; Marian & Shimamura, 2013; Palumbo & Jellema, 2013). For example, a neutral face in the context of expression attenuation of anger is evaluated as more affable than a neutral face without context (Ishi & Gyoba, 2006, 2007), and happiness or positive emotions are perceived in the neutral face (Jellema et al., 2011; Marian & Shimamura, 2013; Palumbo & Jellema, 2013). However, a neutral face in the context of expression attenuation of happiness is evaluated as sterner than a neutral face without context (Ishi & Gyoba, 2006, 2007), and anger or negative emotions are perceived (Jellema et al., 2011; Marian & Shimamura, 2013; Palumbo & Jellema, 2013) in the neutral face. These perceptual distortions of neutral faces seem to oppose the facial expression at the beginning of the change, maintaining the direction of their expression attenuation context. It can, therefore, be seen as a perceptual forward shift (i.e., an overshoot bias; Jellema et al., 2011; Palumbo & Jellema, 2013) to which there is a contribution from a mechanism that causes the subject to anticipate a change in the emotional state, although some researchers believe that caution should be exercised when generalizing these results (Thornton, 2014).

The abovementioned studies (Ishi & Gyoba, 2006, 2007; Jellema et al., 2011; Marian & Shimamura, 2013; Palumbo & Jellema, 2013) involved attenuation of two facial expressions, namely anger and happiness. Marian and Shimamura's (2013) investigation added attenuation of sadness, and the same phenomenon of neutral face perception was reported. Thus, a distortion in the perception of a neutral face following the expression attenuation process is mainly confirmed for anger and sadness as negative emotions and for happiness as a positive emotion. Are these reported perceptual bias seen in the facial attenuation process in general? To answer this question, it is considered important to increase the type of expression attenuation contexts and include the six basic expressions (Ekman & Friesen, 1971). Facial expressions of anger, disgust, sadness, happiness, fear, and surprise are universally understood as basic expressions, regardless ethnicity or language (Ekman & Friesen, 1971); many studies on the recognition of facial expression of emotions use these six basic expressions. Therefore, this study also used the six basic expressions of emotion as contexts of attenuation expression.

Having increased the type of expression attenuation contexts, it is necessary to use an evaluation method that differs from those used in the abovementioned studies. When evaluating emotions as they relate to neutral faces in the context of expression attenuation of anger or happiness, a one-dimensional scale was used in these studies, with emotion labels of anger and happiness at either end (Jellema et al., 2011; Palumbo & Jellema, 2013). Marian and Shimamura (2013) also evaluated emotions with regard to neutral faces shown at the end of a moving image using a scale with positive and negative extremes. However, when the types of facial expressions are broadened, and the nature of the emotions involved becomes

more varied, it would be difficult to establish opposing emotion labels for each expression attenuation context or use a simple positive-negative scale for a detailed investigation of differences in the impact of the context of expression attenuation.

Thus, in this study, the focus was on the affect grid method (Russel, Weiss, & Mendelsohn, 1989), which allows the evaluation of various emotions without using emotion labels. The affect grid method is a rating scale in which the evaluation target is positioned on a continuous emotion space with hedonic valence (i.e., pleasure-displeasure) on the x-axis and arousal (i.e., high arousal-low arousal) on the y-axis, and its underlying concept is based on the emotion recognition dimensional viewpoint (Russell, 1980). With the dimensional viewpoint, there is no assumption of distinct emotional categories; instead, all the emotional stimuli are positioned in a psychological space constructed by a small number of dimensions that specify emotions; according to its coordinates on the grid, each stimulus is assigned an emotional label, such as 'happy' or 'sad.' The affect grid method is often used in research to evaluate the perception of the nature of emotions in expression stimuli without using the name of the emotion (e.g., Fujimura & Suzuki, 2010; Takehara & Suzuki, 1997). The use of the affect grid method allows the positioning of neutral faces (that have changed from an expressive face) in a two-dimensional (hedonic valence and arousal) space with respective polarity guaranteed without using an emotion label. It also allows the quantitative comparison of relevant affective values.

Accordingly, this study used the affect grid method to evaluate the affective values of final neutral faces shown at the end of moving images in which the six basic expressions (i.e., anger, disgust, sadness, happiness, fear, and surprise) gradually disappeared. In Experiment 1, still images of faces displaying the six expressions and a neutral face were positioned in the emotion space, and their distribution was used to confirm the affective values of the stimuli. Then, in Experiment 2, the final neutral faces shown at the end of the moving images—in which the expression gradually disappeared—were positioned in the same emotion space, and their affective values were measured. The aim of these two experiments was to quantify the affective value of neutral faces that changed dynamically from the six basic expressions and verify whether overshoot perceptual bias was detected. Incidentally, since there are significant individual differences in the form taken by neutral and expressive faces and in the impression given, the facial images shown in these experiments were the averaged faces of four men and four women.

Experiment 1

The aim of this experiment was to determine the distribution of facial stimuli in the psychological emotion space. Emotion evaluation was carried out using the affect grid method and still picture stimuli (averaged male and female faces expressing the six emotions and neutral faces). Each stimulus was plotted in a pleasure-arousal space, and its position was confirmed. The results of Experiment 1 informed the methods used in Experiment 2.

Method

Participants.

Thirty-six undergraduate and postgraduate students (18 males, 18 females, average age 20.53 years) participated in this study.

Stimuli.

From the ATR database (ATR-Promotions), colored images of the six facial expressions (i.e., anger, disgust, sadness, happiness, fear, and surprise) and a neutral face were selected for eight people in their twenties and thirties (four men and four women). The image size was normalized by the distance between the pupils. An averaged face was created for each expression and for men and women separately, providing a total of 14 facial images as stimuli. The composite faces were produced using the FUTON system (ATR-Promotions). To exclude impact from factors other than facial expression, the images were cropped by an oval frame, and the background remained black. Next, using Adobe Premiere 6.5 and Adobe Premiere CS5.5 software, moving image files showing the same facial stimulus (still image) three times were produced for all the facial stimuli and shown on a screen with a frame rate of 30 fps. These moving image files comprised three repetitions of the same 31-frame facial stimulus (1/30ms per frame) sandwiched between nine black frames (Fig. 1a). The size of the facial image stimuli on the screen was 14.2 cm by 13.5 cm, while the viewing distance was maintained at 80 cm, and the viewing angle was approximately 10.1° x 9.6°.

Procedure

Prior to conducting the experiment, the affect grid judgment method was explained to the participants in detail based on Russell et al. (1989). In this experiment, each moving image file was shown four times on a monitor in a randomized order, rendering a total of 56 trials. In each trial, a point of gaze was first shown in the middle of the screen, and then the moving image file showing the same facial stimulus was played three times, with the facial stimulus disappearing as soon as it had been played. Approximately 1200 ms after the facial stimulus disappeared, an affect grid evaluation screen was shown with two dimensions— a horizontal axis showing the hedonic valence dimension (nine stages, from 'pleasure' on the extreme right to 'displeasure' on the extreme left) and a vertical axis showing the arousal dimension (from 'high arousal' at the top, to 'low arousal' at the bottom). Participants selected a cell on the affect grid corresponding to their evaluation of the facial stimuli. They had previously been instructed to make their evaluation quickly without thinking too deeply. A CRT monitor (resolution: 1280×1024 pixels) and a personal computer, as well as an evaluation program produced via E-prime 2.0, were used to show the facial stimuli and collect data. The experiment was conducted in a darkened room while the participants rested their chins on a chin rest and viewed the facial stimuli at a distance of approximately 80 cm. Additionally, in each trial, the time between the appearance of the evaluation screen and each evaluation was measured.
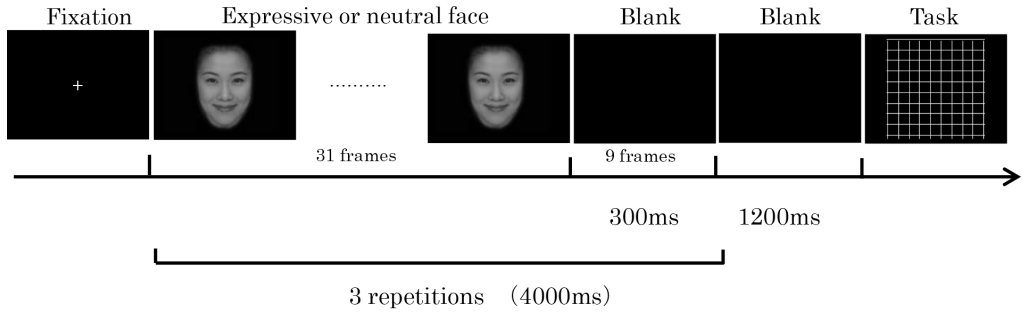
(a) Timeline in Experiment 1
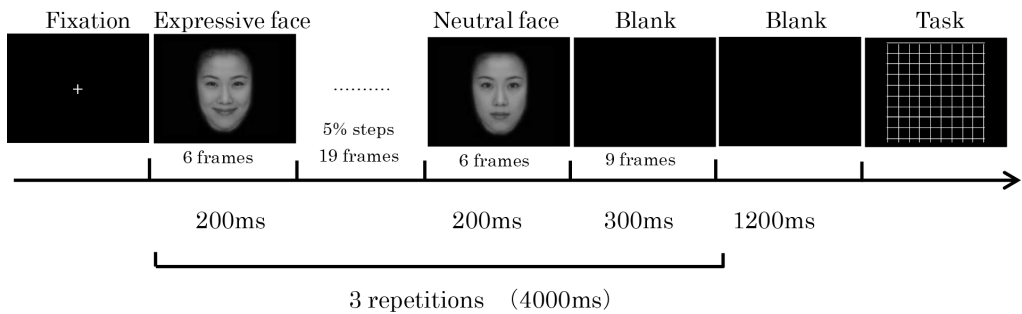
(b) Timeline in Experiment 2

Figure 1. Overview of the timeline of one trial in Experiment 1 and Experiment 2.

Results and Discussion

Trials with extremely long evaluation times (average +3 SD or more, 1.687% of the total) were excluded from the analysis as unreliable responses since it was possible that the judgment may have been revised. Each rating on the hedonic valence and arousal dimensions was assigned a score from one to nine, and the value of the average rating for each dimension for each facial stimulus was used as the hedonic valence score and the arousal score; each was plotted on the horizontal and vertical axes in the two-dimensional space (Fig. 2). The figure shows that expressions of 'surprise' and 'happiness' were in the first quadrant, 'fear,' while 'anger,' and 'disgust' were in the second quadrant, and 'sadness' was in the third quadrant. Several researchers have shown that the various facial expression stimuli are distributed in a broad circular shape within the emotion space constructed by the hedonic valence and arousal dimensions (Russell & Bullock, 1985; Takehara & Suzuki, 1997, 2001). The results of this experiment are thought to largely comply with the circular models' locational relationships except for the location of the 'surprise' facial stimuli in the hedonic valence dimension and the location of the neutral face).

High arousal
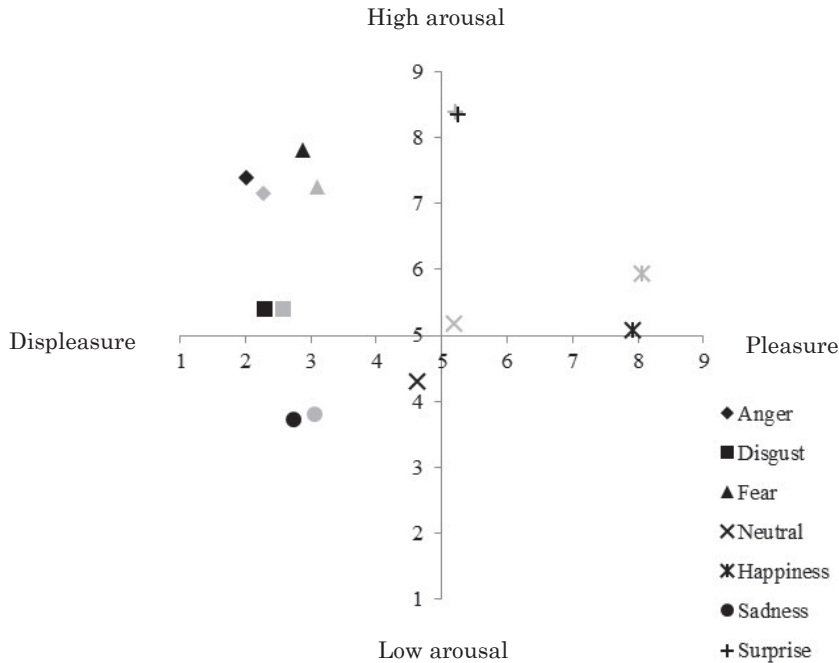
Figure 2. Distribution of the neutral face and expressive face stimuli in the emotion space.
The six basic expressions used as context expressions in Experiment 2 and the relevant neutral faces
were plotted in the space determined by the horizontal pleasure-displeasure axis and the vertical
arousal level axis, based on their affect grid evaluation value. The black symbols indicate male faces
and the grey symbols female faces.

Next, to investigate whether there were any differences between the location of neutral stimuli and the center where the dimensions bisected (signifying neutrality in both the hedonic valence and arousal dimensions), a one-sample t-test was conducted using a test value of 5. The results showed that the male neutral face was slightly negative for both the hedonic valence and arousal dimensions (two-sided test: $t(35) = -2.983$, $p<.01$, $t(35) = -4.920$, $p<.01$), which was slightly distant from the central coordinates. Meanwhile, the female neutral face was slightly positive in the arousal dimension (two-sided test: $t(35) = 2.143$, $p<.05$) with no significant differences in the hedonic dimension (two-sided test: $t(35) =1.465$, *n.s.*). More specifically, the averaged male neutral face used in the stimulus set in this study was judged as showing slightly more displeasure and lower arousal than neutral, while the averaged female neutral face was judged as showing slightly higher arousal than neutral. Previous studies on the psychological dimension of facial expression recognition have indicated that the point where the dimensions bisect is neutral (Schlosberg, 1952) and that a neutral face will be located at the central point. However, in recent years, experimental investigations related to the significance of neutral faces have shown that they are not located at the central coordinates (Carrera-Levillain & Fernandez-Dols, 1994; Shah & Lewis, 2003), and from the emotional dimension viewpoint, they are not 'neutral.' The results of this study are in line with these

findings.

To then confirm whether there were discrepancies in the scores for neutral faces and for each facial expression, a two-way analysis of variance was conducted for different expressions (seven levels: anger, disgust, fear, happiness, sadness, surprise, and neutral face) and the gender of the faces (two levels: male, female) using the rating average value for each evaluation dimension. This showed that in both dimensions, there was a significant interaction between the different expressions and the gender of the face (hedonic valence dimension $F(6, 210)=2.477$, $p<.05$; arousal dimension $F(6, 210)=12.163$, $p<.01$). When a difference-in-expression simple main effect test was carried out for facial stimuli of each gender, there was a significant result in both dimensions for both genders, and a Ryan test using multiple comparisons (5% level) confirmed the significant discrepancy between all expressions and neutral faces, except for the expression of 'surprise' in a female face in the hedonic dimension and the expression of 'disgust' by both male and female faces in the arousal dimension. These results confirm that for the facial stimuli set used in this experiment, all facial expression stimuli have a significant score discrepancy with the neutral facial stimuli in at least one dimension of hedonic valence and arousal.

Experiment 2

The aim of Experiment 2 was to quantitatively evaluate the affective value of neutral faces dynamically changing from an expressive face using the same affect grid method (Russell et al, 1989) utilized in Experiment 1.

Method
Participants.
The participants in Experiment 1 also participated in Experiment 2.

Stimuli.
Using the facial stimulus images produced in Experiment 1, 19 intermediate images were produced by changing the composition ratio in 5% steps between the averaged neutral face (0%) and the averaged face for each expression (100%). These images were combined into a continuous display via Adobe Premiere 6.5 and Adobe Premiere CS5.5 software, and a video clip of the change from the facial expression to a neutral face (i.e., the video clip of the development of the facial expression played backward) was produced. In the expression attenuation video clips, after the facial expression was shown for 200 ms, the expression gradually weakened, and finally, a neutral face was displayed for 200 ms. A total of 12 video clips were created showing a male and a female face displaying the six expressions, which then changed to a neutral face in each case. Moreover, as done in Experiment 1, for all the video clips, a moving image file was created showing the video clip three times between the black frames and displayed on the screen at a frame rate of 30 fps. This moving image file comprised

a 31-frame video clip shown three times between nine black frames (see Fig. 1b). The size of the facial stimulus image and the viewing distance were the same as in Experiment 1.

Procedure

In this experiment, each moving image file was shown on a monitor four times in randomized order for a total of 56 trials. In each trial, after a point of gaze was presented in the middle of the screen, the moving image file in which the same video clip was repeated three times was played, with the facial stimuli disappearing from the screen after being played. About 1200 ms later, the same affect grid evaluation screen used in Experiment 1 appeared. The participants selected a cell on the affect grid corresponding to their evaluation of the neutral face shown in the final frame of the video clip. Other steps of the procedure were the same as those used in Experiment 1.

Results and Discussion

Similar to Experiment 1, trials for which the evaluation time was extremely long (average +3 SD or more) were excluded from the analysis (1.505% of the total), and hedonic valence and arousal were each scored on a scale from one to nine. For each expression context, the neutral face rating's average value was used as the respective hedonic valence score and arousal score and, for each case, they were plotted on the two-dimensional space (Fig. 3).

Fig. 3 reveals that even when a rating is for the same neutral face (the final frame of video clips that began from difference context expressions) for both male and female faces, the distribution is scattered according to the context facial expression. Moreover, while the neutral male faces tended to follow the low arousal displeasure direction (third quadrant), for the neutral female faces, there was a tendency for the distribution to be centered in the high arousal pleasure direction (the first quadrant). As neutral faces presented without context were somewhat far from the coordinate origin for both male and female faces, this could be because the difference in the distribution of the neutral faces themselves is reflected, even in the context of expression attenuation.

An adjusted score for each dimension was calculated using the rating value for the neutral faces obtained in Experiments 1 and 2. To calculate an adjusted score, for each participant in the experiment, the rating value of the neutral face shown without context (Experiment 1) was deducted from the rating value of the neutral face that changed from each context expression (Experiment 2), and there is alignment so that the neutral stimuli in Experiment 1 is 0.. Fig. 4 presents the adjusted scores with each dimension as a vertical scale. The positive value means there was a tendency to judge it as 'pleasure' (Fig. 4a) or 'high arousal' (Fig. 4b) compared to the original still neutral face, and the negative value means there was a tendency to judge it as 'displeasure' (Fig. 4a) or 'low arousal' (Fig. 4b). The figure shows that the hedonic valence dimension scores are more scattered than the arousal dimension scores. A one-sample t-test was conducted using a test value of 0 and the results showed that in the hedonic dimension, male and female neutral faces that changed from anger and female neutral
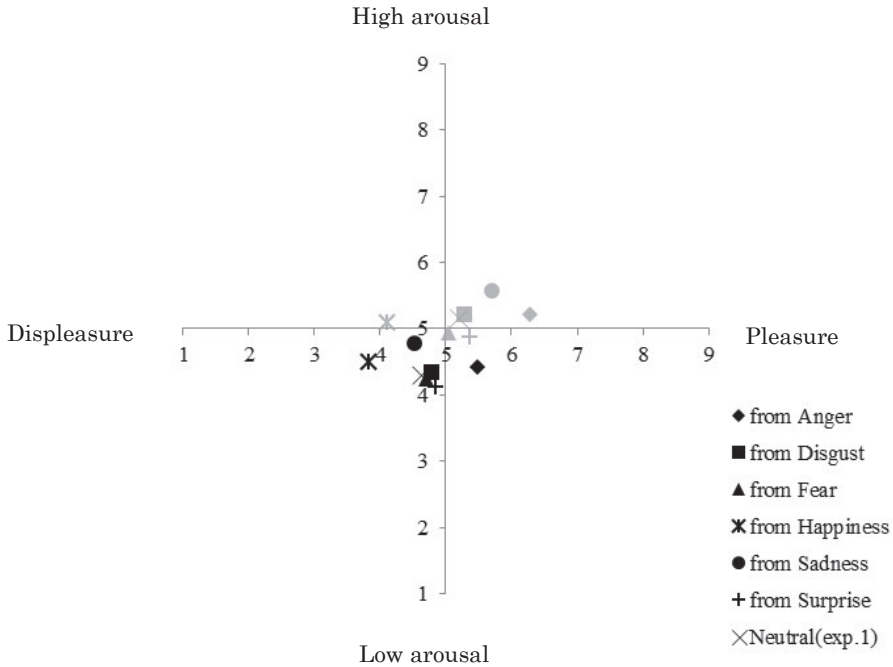
Figure 3. Distribution of the emotion space of the neutral face stimuli with an expression attenuation context. The neutral face was seen in the expression attenuation process when the expression gradually weakened and disappeared; plot based on affect grid evaluation value in the space represented by the horizontal pleasure–displeasure axis and the vertical arousal axis. The black symbols indicate male faces and the grey symbols female faces. The figure shows that even though the same neutral face was being evaluated for both male and female faces, evaluations are scattered depending on the initial context expression.

faces that changed from sadness had significantly higher scores (two-sided test: respectively, $t(35) = 4.598$, $p<.01$, $t(35) = 5.618$, $p<.01$, $t(35) = 2.614$, $p<.05$), and male and female neutral faces that changed from happiness had significantly lower scores (two-sided test: respectively, $t(35) = -4.464$, $p<.01$, female neutral faces that changed from happiness $t(35) = -6.244$, $p<.01$). Meanwhile, in the arousal dimension, male and female neutral faces that changed from sadness had significantly higher scores (two-sided test: respectively, $t(35) = 3.025$, $p<.01$, $t(35) = 3.265$, $p<.01$), and the scores for female neutral faces that changed from fear and surprise were significantly lower (two-sided test, respectively $t(35) = -2.129$, $p<.05$, $t(35) = -2.266$, $p<.05$). There were cases in both the hedonic valence and arousal dimensions in which subjects' evaluations of the affective value of neutral faces in the process of expression attenuation presented in the final frame of the video clip leaned in a positive or negative direction in response to the context expression. The details of these changes are discussed in the next section.
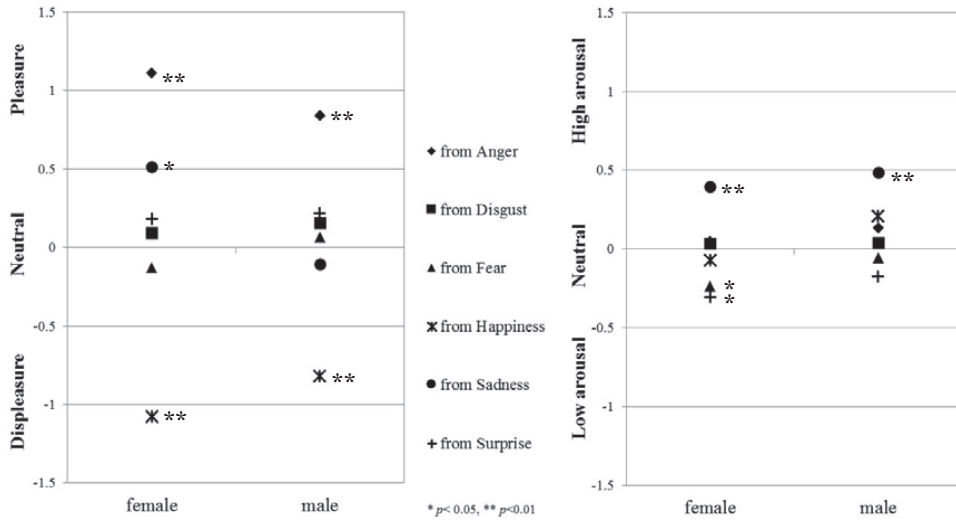
(a) Hedonic valence dimension adjusted score   (b) Arousal dimension adjusted score

Figure 4. Affective value shift in neutral faces in the context of the facial expression attenuation process. Values are adjusted scores (for each participant in the experiment, the rating value of the neutral face shown without context [Experiment 1] subtracted from the rating value for the neutral face changed from each context expression [Experiment 2]) and averaged with the neutral face stimuli in Experiment 1 aligned as 0. For both male and female faces, an overshoot-like effect was confirmed for neutral faces that changed from anger and happiness in the hedonic valence dimension and for neutral faces that changed from the expression of sadness in the arousal dimension.

General Discussion

Some cases were observed in which the affective values of neutral faces in the context of attenuating facial expression significantly differed from that of neutral faces without context. This difference in affective value is thought to have arisen due to the impact of the expression attenuation context. First, we focus on the context of expression attenuation of anger and happiness covered in previous studies (Ishi & Gyoba, 2006, 2007; Jellema et al., 2011; Marian & Shimamura, 2013; Palumbo & Jellema, 2013). In Experiment 2, a shift in the affective value of neutral faces in the context of expression attenuation was observed on the hedonic valence dimension but not on the arousal dimension. The evaluation of neutral faces was biased toward 'pleasure' in the context of anger attenuation and 'displeasure' in the context of happiness attenuation for both male and female faces when compared to those without context. Given that in Experiment 1, the expression of anger was negative and happiness was positive in the hedonic dimension, this shift in the affective value of neutral faces was characterized in the opposite direction from the affective value of expression at the beginning of the change. This finding is consistent with previous research (Ishi & Gyoba, 2006, 2007; Jellema et al., 2011;

Marian & Shimamura, 2013; Palumbo & Jellema, 2013). However, no change was seen in the evaluation of neutral faces on the arousal dimension. Thus, a perceptual distortion for neutral faces changed from an expression of anger or happiness is specific to the hedonic valence dimension.

Second, with regard to the expression of sadness covered by Marian and Shimamura (2013), a shift in the affective value of a neutral face was observed for the dimensions of hedonic valence and arousal in this study. Evaluations of a neutral face in the context of sadness attenuation were biased toward 'pleasure' for female faces and toward high arousal for both male and female faces compared to those without context. Some of these results concur with the results of Marian and Shimamura (2013). The face displaying a sad expression was evaluated as having more 'displeasure' and higher arousal than the neutral face in Experiment 1. Thus, it was shown that the neutral face that changed from sadness was judged in contrast to the affective value for the arousal dimension and to the hedonic valence dimension affective value for female faces of the initial expression of sadness at the beginning of the change.

Looking at the context of expression attenuation of other emotions, it was found that for fear and surprise, a shift in the affective value of a neutral face was observed only for on the arousal dimension. The evaluation of a neutral face in the context of fear or surprise attenuation was biased toward low arousal for female faces. Given that in Experiment 1, the faces expressing fear and surprise were rated higher in arousal than the neutral face (Fig. 2); the affective value of arousal dimension of the neutral faces was shifted in the opposite direction of the expression at the beginning of the change. For disgust, no affective value shift was observed for either male or female neutral faces. In Experiment 1, disgust was the only expression for which there were no significant differences between the neutral stimulus in the arousal score. Thus, although the 'displeasure' level of the expression of disgust was higher than the neutral face, it is possible that the undifferentiated neutral face in the arousal dimension would suppress the affective shift in the hedonic valence dimension for the neutral face in the context of disgust attenuation.

Takehara and Suzuki (1997, 2001), and Fujimura, Matsuda, Katahira, Okada, and Okanoya (2012) reported that faces synthesized between different emotions or between expressions and neutral faces are distributed in the emotional space in line with their morphing ratio. Furthermore, when -50% 'anti-faces'" synthesized as line drawing expression stimuli on continua between the six basic expressions and a neutral face were positioned in the emotion space using an affect grid, there was a tendency for 'anti-faces' of basic expressions of anger, happiness, sadness, and surprise to be counter-posed on opposite sides of the basic expressions in the space, across the neutral face (Shibui & Shigemasu, 2005). When we consider these findings, it is possible that in the process noted in this study of a face gradually changing from expressiveness to expressionless, its affective values of hedonic valence and arousal transitioned along a trajectory that matches the morphing ratio to reach the neutral face. Moreover, it is possible that even when the neutral face has disappeared, the transition of its affective value 'does not stop' but overshoots into the specific emotional dimension, and the

affective value is perceived as though the visual change had continued. In an investigation conducted by Shibui and Shigemasu (2005), 'anti-faces' with regard to the expression of fear and disgust were positioned near neutral faces, and the same tendency as with the other four expressions—being counter-posed continuously toward the opposite side—was not seen. This study also observed no affective value shift for the neutral face changed from an expression of disgust, and it is thought to be related to this finding.

The transformation mentioned above in the affective value of a neutral face shown at the end of the expression attenuation process can be interpreted as the overshoot perceptual bias shown in previous studies. However, it is possible that this perceptual distortion is not an affective value shift encouraging the transfer of an expression category but a phenomenon arising separately in each dimension that stipulates emotion. Using the expression of happiness on a male face as an example, if a neutral face that changed from a happy expression with a strong pleasure affective value was perceived as an expression of 'anger,' it would be positioned close to the anger expression located in the emotion space and evaluated as exhibiting more 'displeasure' and higher arousal than the neutral face shown without context. However, in the results of Experiment 2, the neutral male face that changed from the expression of happiness did move further in the direction of displeasure than the neutral face without context, while the arousal level declined, falling more than the neutral face without context. Therefore, the neutral male face that changed from an expression of happiness was not perceived as 'angry,' and a hedonic valence dimension shift in affective value was perceived. Yamada (2000) proposed a three-stage model for the process of the perceptual judgment of facial expressions: (a) the extraction of visual information related to the expression of the emotion (i.e., the extraction of expression information), (b) the evaluation of the emotional significance of the expression information (i.e., the evaluation of emotional significance based on psychological dimensions such as the pleasure-displeasure hedonic valence dimension and the arousal dimension related to activation), and (c) the categorization of the expression based on an evaluation of emotional significance. Based on the results of this study and the model mentioned by Yamada (2000) in previous research, perceptual distortion (Jellema et al., 2011; Palumbo & Jellema, 2013)—wherein, due to the usage of emotion labels for evaluation, the affective value of a neutral face that changed from the expression of anger/happiness is judged as a different emotion (i.e., a certain degree of happiness / a certain degree of anger) from that at the beginning of the change—can be considered to be characterized by a shift in the hedonic valence dimension in the second stage of the process of perceptual judgment of facial expressions in the model.

Palumbo and Jellema (2013) reported that in their series of experiments, (a) the bias disappeared if the face is switched to that of other person at the end of the expression disappearance process; (b) the opposite response bias, an undershoot response bias, arose with stimuli in which the face changed from neutral to expressing an emotion and then back to neutral; and (c) an overshoot response bias arose even when a 400 ms mask was inserted immediately before the neutral face was shown. These results refute the possibility

that overshoot perceptual bias in a neutral face that changed from an expression of anger or happiness involves the low-order visual mechanisms that, for example, explain the facial expression after-effect adaptation (Webster & Hoyos, 2004), physical facial representational momentum (Freyd, 1987), or sequential contrast effects (Suzuki & Cavanagh, 1998). The results instead support the theory that the mechanism that predicts emotional state changes relates to the perceptual distortion of the neutral face (Palumbo & Jellema, 2013). If the mechanism that predicts a change in emotional states is involved, by adopting appropriate stimuli, such as those with the speed of change or movement that allows the expression attenuation to feel more natural, the anticipation of the change in the emotional state will become more accurate and efficient. This may maximize the affective value shift, as is the occurrence of the phenomenon even with context expressions that did not see an affective value shift in the present study.

Investigations into the recognition of the facial expression attenuation process are not as common as those into the process of the onset of an expression, and the findings have not yet been sufficiently verified. Reinl and Bartels (2014) conducted fMRI experiments to examine the sensitivity of neural face-processing regions to emotional directionality (increasing or decreasing fear expressions) and timeline directionality (natural frame order or reversed frame order). They showed that FFA was sensitive to emotional directionality (increasing or decreasing fear expressions), for natural timeline. Further investigations are required to investigate the recognition of attenuation of facial expressions as a process distinct from expression of facial expressions.

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