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Your attention makes me smile: Direct gaze elicits affiliative facial expressions

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Abstract

Facial electromyographic responses and skin conductance responses were measured to investigate whether, in a neutral laboratory environment, another individual's direct gaze elicits a positive or negative affective reaction in the observer. The results showed that greater zygomatic responses associated with positive affect were elicited by seeing another person with direct as compared to averted gaze. The zygomatic responses were greater in response to another person's direct gaze both when the participant's own gaze was directed towards the other and when the participant was not looking directly towards the other. Compatible with the zygomatic responses, the corrugator activity (associated with negative affect) was decreased below baseline more in response to another person's direct than averted gaze. Replicating previous research, the skin conductance responses were greater to another person's direct than averted gaze. The results provide evidence that, in a neutral context, another individual's direct gaze is an affiliative, positive signal.

Key words: affect; facial EMG; eye contact; facial expression; SCR

Introduction

In both humans and non-human primates, eye contact can communicate messages with opposite meanings, such as friendliness or threat (Argyle & Cook, 1976; Gomez, 1996; Kleinke, 1986; Skuse, 2003; Yamagiwa, 1992). One's interpretation of the meaning of another's direct gaze depends on a great number of antecedent, concurrent, and anticipated contextual factors, and the outcome of this interpretation is likely to have a great influence on a perceiver's behavioral responses. In some circumstances, direct gaze is likely to become interpreted as a positive, affiliative signal, and it is responded to, for example, with a smile and by moving closer to the gazing person, whereas in other circumstances direct gaze may evoke negative feelings leading to indifferent or even hostile behavior. An interesting question is, however, what kind of a response is elicited by another's direct gaze in a situation which could be regarded as socially relatively neutral. Is another's direct gaze (eye contact) inherently positive or negative? Although real-life social encounters between two persons may never be completely devoid of social contextual factors, investigation of this issue is possible in a neutral laboratory environment where many of the real-life factors influencing these responses can be controlled and eliminated.

Considering that another individual's direct gaze is often an affiliative cue signaling the sender's motivational tendency of approach (Adams & Kleck, 2003, 2005), it seems likely that another's direct gaze would elicit compatible reactions in the observer. Moreover, as humans have a fundamental need for belonging (Baumeister & Leary, 1995) and as direct gaze indicates social inclusion (Wirth, Sacco, Hugenberg, & Williams, 2010), one would expect that direct gaze would be perceived as a positive social signal evoking positive affective reactions. Compatible with these considerations, previous research has shown, for example, that seeing another person with direct as compared to averted gaze elicits increased electroencephalographic, relative left-sided frontal alpha activity associated with positive affect and motivational approach tendency (Hietanen, Leppänen, Peltola, Linna-aho, & Ruuhiala, 2008; Pönkänen, Peltola, & Hietanen, 2011). Two recent studies employing the affective priming paradigm indicated that more positive affective reactions were automatically activated by perception of direct gaze compared to perception of closed eyes (Chen, Helminen, & Hietanen, 2017; Chen, Peltola, Ranta, & Hietanen, 2016), and a study relying on the implicit association paradigm showed a robust preference for faces looking towards as compared to faces looking away (Lawson, 2015). Most recently, a study employing the startle reflex methodology reported that the magnitudes of participants' eyeblink startle and cardiac reflexes elicited by high-intensity noise stimuli were modulated by simultaneously presented gaze direction stimuli (Chen, Peltola, Dunn, Pajunen, & Hietanen, 2017). Direct gaze attenuated the eyeblink startle and cardiac reflexes compared to those elicited in the context of a downward gaze. Thus, the defense reflexes were weaker when presented in the context of direct versus downward gaze suggesting that another's direct gaze, compared to downward gaze, automatically elicits more positive affective responses in the viewer. In addition, studies relying on self-evaluative rating measures have shown more positive ratings to direct than averted gaze when the measurements have been conducted in "neutral" laboratory-environments (Kuzmanovic et al., 2009; Mason, Tatkow, & Macrae, 2005), although in some studies the ratings of direct gaze, even though being positive, have been less positive than those of averted gaze (Hall et al., 2005; Hietanen et al., 2008; Pönkänen, Alhoniemi, Leppänen, & Hietanen, 2011).

In the present study, our main aim was to investigate the nature of affective reactions to another person's direct gaze by measuring one's facial electromyographic (EMG) responses. Measuring of facial EMG responses has been a widely used method to investigate the valence of affective reactions (Cacioppo, Petty, Losch, & Kim, 1986; Tassinary & Cacioppo, 1992). As the facial EMG responses seem to be relatively automatic, evidenced by their short latency (i.e., 300–400 ms after stimulus onset; Dimberg & Thunberg, 1998) and by their occurrence even when the stimuli are rendered invisible by backward masking (Dimberg, Thunberg, & Elmehed, 2000), this method can be seen suitable to provide more direct and objective information about one's affective reactions than any of the methods used in the studies described above. Numerous studies have shown that affectively positive stimuli elicit increased EMG activity of the *Zygomaticus major* (the muscle that elevates the corners of the mouth) and decreased activity of the *Corrugator supercilii* (the muscle that knits the eyebrows), whereas affectively negative stimuli elicit increased activity of the *Corrugator supercilii* muscle (Cacioppo et al., 1986; Larsen, Norris, & Cacioppo, 2003). These EMG responses have been observed in reaction to other people's facial (Dimberg, 1990), vocal (Hietanen, Surakka, & Linnankoski, 1998) and bodily (Magnée, Stekelenburg, Kemner, & de Gelder, 2007) expressions of emotions as well as in reaction to affective pictures of complex scenes, clips of environmental sounds, and words (Larsen et al., 2003).

There are a few previous studies measuring participants' facial EMG responses to pictures of human faces or animated virtual characters looking towards the observer or not and expressing a facial emotion or a neutral face (Mojzisch et al., 2006; Rychlowska, Zinner, Musca, & Niedenthal, 2012; Schrammel, Pannasch, Graupner, Mojzisch, & Velichkovsky, 2009; Soussignan et al., 2013). While the results of most of these studies provided evidence that the facial reactions in response to the facial expressions were modulated by the expressor's gaze direction (Rychlowska et al., 2012; Schrammel et al., 2009; Soussignan et al., 2013), the studies showed no effect of gaze direction on the EMG responses when there was a neutral expression on the face. However, it is possible that this was due to the fact the stimuli were images presented on a computer monitor. Images of avatars or images of real people do not *look* back at the viewer, not even when the gaze is directed towards the viewer. In many previous experiments from our laboratory, gaze direction has been observed to influence psychophysiological responses (electroencephalographic and autonomic responses) when participants are seeing a live person, but not when they are seeing a picture of the same person on a computer monitor (Hietanen et al., 2008; Pönkänen, Alhoniemi, et al., 2011; Pönkänen, Peltola, & Hietanen, 2011). Therefore, in the present study too, we investigated the effect of another's gaze direction on facial EMG responses when the participants were facing a live person.

In everyday dyadic interactions, both interactors shift their gaze towards and away from each other. There are periods of time when neither of the partners looks towards the other partner's eyes, periods while one of them looks at another's eyes while the other is looking elsewhere, and periods when both look into each other's eyes, thus, making eye contact. In the present experiment, a secondary aim was to investigate the effects of another's gaze direction on a participant's reactions when the participant him-/ herself is looking either at the other person or slightly away. Moreover, to simulate the everyday interaction, the participants could voluntarily choose whether to look at the other individual or not. Third, this feature of the experiment allowed us also to investigate if the facial EMG responses to direct gaze could depend on whether the eye contact was voluntary or forced. It has been suggested that processing of social information is influenced by the possibility for interaction (De Jaegher, Di Paolo, & Gallagher, 2010; Schilbach et al., 2006). Supposedly, an interaction resulting from an external (experimenter's) demand is not as rewarding as a voluntary interaction. To investigate the effect of free-choice vs. forced choice eye contact on facial EMG responses we also included in our experimental design a condition in which the participant and the model person were required to look at each other. We also measured sympathetic skin conductance responses (SCR) in order to measure, not only physiological responses related to affective valence, but also responses indexing physiological arousal (Critchley, 2002), another central component of the affective response (Plutchik, 1980). Previous studies have shown that SCRs are larger in response to seeing another's direct gaze than averted gaze or closed eyes (Helminen, Kaasinen, & Hietanen, 2011; Hietanen et al., 2008; Myllyneva & Hietanen, 2015; Nichols & Champness, 1971).

In sum, in the present study, we measured facial EMG activity from the *Zygomaticus major* muscle region (cheek) and from the *Corrugator supercilii* muscle region (brow) and autonomic arousal (skin conductance responses, SCR) from participants when they were presented with another live person through an electronic shutter. On a majority of trials, the participants were allowed to decide whether they looked at the other person or looked sideways (at a pre-determined fixation spot). The model persons also independently varied their gaze direction between direct and averted. In addition to these free-choice trials, there were a number of trials on which the participant and the model were instructed to look at each other (i.e., forced choice trials). We expected that eye contact with another person would result in greater zygomatic EMG activity and SCRs compared to looking at another person with averted gaze. Secondly, we hypothesized that another person's direct gaze would result in greater zygomatic EMG responses and SCRs compared to averted gaze also when the observer himself/herself is not looking directly towards the other person, but sees from the "corner of the eye" that the other is looking at him/her. This assumption was based on results from a previous study suggesting that increased psychophysiological responses to eye contact critically depend on the understanding of being watched by another (Myllyneva & Hietanen, 2015). Third, we expected that the zygomatic EMG responses and SCRs in response to eye contact would be greater if the eye contact results from participants' free choice compared to when it is externally controlled. We also measured participants' explicit affective feelings (affective valence and arousal) in response to different gazing conditions to compare the psychophysiological responses to these explicit evaluations.

Methods

Participants

The participants (N = 27) were 15 females and 12 males (age range = 22 – 27 years; mean age = 22.2, SD = 2.1) recruited from undergraduate psychology courses. Apart from one male, all participants were right-handed. All participants had normal or corrected-to-normal vision and they did not report of any neurological or psychiatric problems. All participants gave a written, informed consent, and received either course credits or a movie ticket for their participation. Ethical statement for the experiment was obtained from the Ethics Committee of the Tampere region. The study conformed to the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Stimuli and Procedure

A young male and a young female, previously unknown to the participants, served as models (stimulus persons). The model's and the participant's sex was matched. The models bore a neutral expression and kept their faces as motionless as possible throughout the experiment. However, when necessary, eye blinks were allowed to occur. The models were instructed to maintain a slight muscle tonus in the lower part of the face in order not to look sullen or fatigued. The models' faces were presented through a 38×22 cm custom-built electronic shutter with a voltage sensitive liquid crystal (LC) window (NSG UMU Products Co., Ltd.) attached to a black frame between the model and the participant. The participant was seated at a distance of 90 cm from the LC-shutter and the model was sitting at a distance of 40 cm from the shutter. The model's seat was adjusted in such a way that vertically his/her eyes were at the same level with the participant's own eyes. The state of the LC-shutter (transparent or opaque) was operated by E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA) running on a desktop computer and the LC-shutter switched between opaque and transparent states within an overall speed of 3 milliseconds.

The participants were informed that the purpose of the study was to measure physiological responses during a simple interaction situation. To disguise the purpose of the facial EMG electrodes, the participants were told that skin temperature would be measured during the task with sensors attached to the face. The participants were told that they would be seeing another person on the other side of the LC-shutter, and that, on most of the trials, they were free to choose whether to look directly to the other person or whether to avert their gaze side-ways and look to a pre-determined fixation point. Importantly, these instructions were given both to the participant and the model person, and the participants were led to believe that the model also had a possibility to voluntarily choose where to look at. For the participant, the fixation marks were located on the frame of the LC-shutter. Looking at these marks resulted in a gaze deviation of 7 degrees (from the line of straight gaze). For the model, the fixation marks were laterally further away resulting in a gaze deviation of 50 degrees. This arrangement made it possible for the participants to see whether the model was looking at him/her or not, even if his/her own gaze was averted. The instructions emphasized that the participant and the model keep their heads straight ahead and move just their eyes.

The participants (and the model) were told that before the shutter becoming transparent there would be two different types of sound signals. One signal indicated that the participant (and the model) were free to choose whether to look directly at the other person or whether to avert their gaze side-ways, to the left or right. They were asked to make their choice immediately after the sound signal, turn their gaze to the chosen direction, and to keep the gaze direction throughout the rest of the trial until the shutter, after becoming transparent, turned opaque again. The participants were also asked to indicate the chosen gaze direction, immediately after choosing it, with a button press on a keyboard in front of them. The other sound signal indicated that the participant and the model had to look at each other. Otherwise they were instructed to behave exactly like on the free-choice trials (including the button press).

The sound signals were easily distinguishable, computer-generated sounds played with a relatively low level of intensity. The shutter turned transparent 5-7 seconds after the sound signal, stayed transparent for 3 seconds, and turned opaque again. The experimenter monitored the skin conductance level on-line and initiated the next trial when the skin conductance level had returned to the baseline level, however, not before at least 15 seconds had passed from the shutter tuning opaque.

The trials were presented in blocks of 10 trials. In these blocks, there were 8 free-choice trials and 2 forced-choice eye contact trials, presented in a random order. On the free-choice trials, E-Prime software controlling presentation of the sound signals and the state of the LC-shutter also delivered instructions to the model where to look at. The instructions appeared on a monitor located on the model's side of the panel. On four trials, the model (M) was to look directly (d) to the participant (P) (eye contact) and, on four trials, the model was to avert his or her gaze (a) and look either to the left or right (1:1). After three 10-trial blocks, there was a short pause. The experimenter sitting 2 m behind the participant on the other side of a partition followed on-line the model's and the participant's gaze directions based on their button presses, and the data collection was continued until there were at least 6 trials in each five condition (free choice PdMd, PdMa, PaMd, and PaMa; forced choice PdMd). Thus, in minimum, there were 30 trials.

Immediately after the presentation of the experimental trials, the participants were asked to fill brief questionnaires to evaluate their explicit affective responses to the different gaze conditions. The experimenter asked the participants to recall how they felt during the previous experimental blocks during different gaze conditions. In order to help the participants in this task, the shutter window was opened five times for 3000 ms to show the different gaze conditions to the participant. Before each trial, the experimenter asked the participant and the model to adopt one of the five different gaze conditions, in random order. After each stimulus displays, the participants evaluated their own feelings of affective *valence* and *arousal* during each condition on a 9-point Self-Assessment Manikin (SAM, see Bradley & Lang, 1994) scales (1 = unpleasant/calm, 9 = pleasant/arousing).

Physiological Measures

Facial muscle activity. EMG was used to measure facial muscle activity over *Zygomaticus major* and *Corrugator supercilii* muscle regions. First, the skin over the recording sites was rubbed with alcohol. Electrode paste (Signa gel) was then injected to bipolar 4-mm Ag-AgCl electrodes (BioMed Electrodes) which were attached 1 cm apart with a tape over the recorded muscle sites according to the placement guidelines by Fridlund and Cacioppo (1986). A ground electrode was attached to middle forehead, directly below the hairline. The signal was amplified by a QuickAmp amplifier and continuously recorded with the BrainVision Recorder software (Brain Products GmbH, Munich, Germany) with a sampling rate of 500 Hz. Offline, the signal was filtered with a 28-249 Hz bandpass filter and a 50-Hz notch filter using BrainVision Analyzer 2.1 software. Offline, the EMG signal around each experimental trial was visually inspected for artifacts due to excessive muscle movements and blinks. An average of 6.9% of the trials were excluded following this procedure. For the analyses, the signal was rectified, smoothed, and averaged from a 500 ms baseline (prior stimulus onset) to 3000 ms post-stimulus in 500-ms bins. These values were then standardized within participant to reduce the influence of extreme values. The muscle activity related to the experimental trials was calculated as change scores by subtracting the baseline muscle activity from each 500-ms average value and averaged across all accepted trials (mean number of accepted trials/condition; free choice PdMd: M = 7.0; PdMa: M = 6.7; PaMd: M = 9.5; PaMa: M = 10.0; forced choice PdMd: M =8.0) within each experimental condition. Note that the slight differences in the number of accepted trials between conditions do not stem from differences in the number of rejected trials/condition, but from differences in the total number of collected trials/condition (to reach the criterion of a minimum of 6 trials/condition).

Skin conductance. Two electrodes (Ag/AgCl) were filled with isotonic paste and attached to the palmar surface of the distal phalanxes of the index and middle fingers of the participant's left hand. The data were re-sampled offline to 100 Hz and filtered with a 10 Hz high cutoff filter. The maximum amplitude was detected during 1-6 s after stimulus onset and subtracted from the preceding minimum during 1-3 s after stimulus onset, to calculate the maximum amplitude change. In a case, that a response had two peaks, only the first one was taken into account. The trial was coded as a zero response if the maximum amplitude change was less than 0.01 µS. If there was an amplitude rise of 0.01 µS or more during the first second after stimulus onset, the trial was rejected. Of all trials, 16.9% was eliminated due to this criterion or because of a technical error. The data from accepted trials (mean number of accepted trials/condition; free choice PdMd: M = 6.1; PdMa: M = 5.7; PaMd: M = 8.6; PaMa: M = 9.4; forced choice PdMd: M = 6.9) were averaged in each condition for each participant, including trials with zero responses; this calculation results in the *magnitude* of the skin conductance responses; a measure that combines response size and response frequency (cf., Dawson, Schell, & Filion, 2000)[1]. To normalize the distributions, a two-step procedure involving first transforming the values into a percentile rank and then applying the inverse-normal transformation to the results of the first step was applied to the data (Templeton, 2011).

Data analysis

All statistical analyses were conducted using repeated measures ANOVA. Planned comparisons were performed for the analysis of simple main effects when interactions were observed. A Greenhouse-Geisser correction procedure was applied when appropriate.

For the analyses of the EMG responses and SCRs, the model's sex/identity was originally included into the analyses. However, as the results showed this factor had no main effects nor was it interacting with any of the other effects, this factor was not included into the final analyses reported in the results section below.

Results

EMG responses

Zygomatic region EMG responses for the free-choice trials were analysed with a 2(Model's gaze) × 2(Participant's gaze) × 6(Time) ANOVA (see Figure 1). The main effects of Model's gaze, $F(1,26) = 16.894$, $p = .0001$, $\eta_p^2 = 0.394$, and Participants' gaze, $F(1,26) = 6.846$, $p = .015$, $\eta_p^2 = 0.208$, were statistically significant. The zygomatic muscle region responses were greater in response to model's direct gaze ($M = 0.518$, $SEM = 0.114$) than averted gaze ($M = 0.016$, $SEM = 0.097$), and also when the participant had direct gaze ($M = 0.380$, $SEM = 0.099$) as compared to averted gaze ($M = 0.153$, $SEM = 0.094$). The main effect of Time was marginally significant, $F(5,130) = 3.061$, $p = .054$, $\eta_p^2 = 0.105$, indicating increasing zygomatic activity as a function of time. The two-way interactions between Model's and Participant's gaze direction, $F(1,26) = 4.809$, $p = .037$, $\eta_p^2 = 0.156$, and between the Model's gaze direction and Time, $F(5,130) = 4.966$, $p = .007$, $\eta_p^2 = 0.160$, were significant.

The interaction between Model's gaze and Participant's gaze reflected the fact that the model's gaze direction had a larger effect on the zygomatic responses when the participant was looking at the model than when the participant's gaze was averted.

Importantly, however, the zygomatic responses were greater to model's direct gaze than averted gaze both when the participant's gaze was direct (M_{PdMd} = 0.740, *SEM* = 0.153 vs. M_{PdMa} = 0.020, *SEM* = 0.109, *t*(26) = 4.040, *p* = .0001, Cohen's *d* = 0.791) as well when the participant's gaze direction was averted (M_{PaMd} = 0.296, *SEM* = 0.124 vs. M_{PaMa} = 0.011, *SEM* = 0.106, *t*(26) = 2.132, *p* = .043, *d* = 0.413). Model's direct gaze resulted in greater zygomatic responses when the participant's gaze was direct compared to when the participant's gaze was averted (*t*(26) = 2,761, *p* = .010, *d* = 0.537). The interaction between Model's gaze and Time reflected the fact that, for model's direct gaze, the zygomatic activity increased as a function of time, whereas this was not the case for responses to averted gaze.

The effect of free-choice vs. forced choice eye contact was analyzed with a 2 x 6 ANOVA. The main effect of time was significant, *F*(5,130) = 7.577, *p* = .0001, η_p^2 = 0.226, but the main effect of Choice (M_{free} = 0.740, *SEM* = 0.153 vs. M_{forced} = 0.651, *SEM* = 0.125, *p* > .400) or the interaction between Choice and Time (*p* > .400) were not significant.

Corrugator region EMG responses for the free-choice trials were analysed with a 2(Model's gaze) × 2(Participant's gaze) × 6(Time) ANOVA (see Figure 1). The main effects of Model's gaze, *F*(1,26) = 5.518, *p* = .027, η_p^2 = 0.175, and Time, *F*(5,130) = 3.799, *p* = .025, η_p^2 = 0.127, were statistically significant. The corrugator muscle region activity decreased more in response to the model's direct gaze (*M* = -0.584, *SEM* = 0.117) than averted gaze (*M* = -0.203, *SEM* = 0.094). The main effect of Time reflected decreasing corrugator activity from the beginning of the 3-s stimulus presentation period. The other effects were not significant.

The effect of free-choice vs. forced choice eye contact was analyzed with a 2 x 6 ANOVA. The main effects of Choice $F(1,26) = 13.347$, $p = .001$, $\eta_p^2 = 0.339$, and Time, $F(5,130) = 5.000$, $p = .012$, $\eta_p^2 = 0.161$, were statistically significant. The decrease in corrugator activity in response to eye contact was greater on the free-choice than force choice trials ($M_{free} = -0.806$, $SEM = 0.174$ vs. $M_{forced} = -0.144$, $SEM = 0.191$). The main effect of time reflected the decrease of the corrugator activity as a function of time.

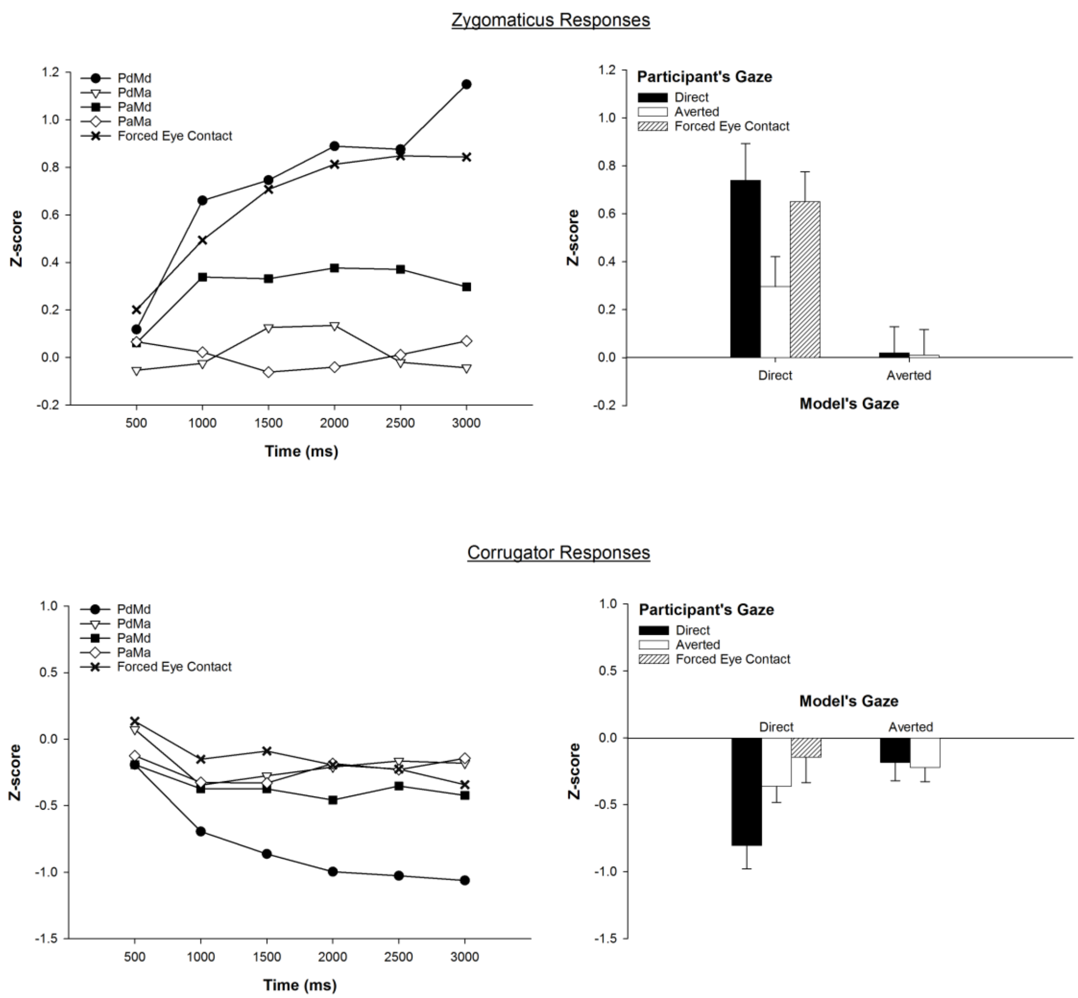

Figure 1. Standardized mean zygomatic and corrugator electromyographic (EMG) responses as a function of model's and participant's gaze direction. The left panels show the EMG

activity during the 3-s time window of analysis. The right panels show the responses averaged across time (and SEM).

Skin conductance responses

SCRs for the free-choice trials were analysed with a 2(Model's gaze) × 2(Participant's gaze) ANOVA (see Figure 2). The analysis indicated significant main effects for both the model's gaze, $F(1, 26) = 12{,}527$, $p = .002$, $\eta_p^2 = 0.325$, and participant's own gaze, $F(1, 26) = 23.919$, $p = .0001$, $\eta_p^2 = 0.479$. For both variables, direct gaze resulted in greater SCRs than averted gaze. The interaction between the main effects was also significant, $F(1, 26) = 10.700$, $p = .003$, $\eta_p^2 = 0.292$. Pairwise comparisons indicated that the SCR was greater for the model's direct ($M_{PdMd} = 0.032$, $SEM = 0.007$) vs. averted ($M_{PdMa} = 0.015$, $SEM = 0.003$) gaze when the participant had direct gaze, $t(26) = 3.572$, $p = .001$, $d = 0.979$), but the model's gaze direction had no effect when the participant was looking away, ($M_{PaMd} = 0.012$, $SEM = 0.003$ vs. $M_{PaMa} = 0.011$, $SEM = 0.002$, $p > .050$, $d = 0.122$). The analysis on the effect of free-choice vs. forced choice indicated that the SCRs during eye contact were greater on the free-choice ($M = 0.032$, $SEM = 0.007$) than forced choice ($M = 0.016$, $SEM = 0.004$) trials, $t(26) = 4.054$, $p = .0001$, $d = 1.076$.

Figure 2. Standardized mean skin conductance responses (and SEM) as a function of model's and participant's gaze direction.

Self-ratings of affective valence and arousal

For the valence ratings (scale range: 1–9) of the free-choice trials, a 2(Model's gaze) × 2(Participant's gaze) ANOVA showed a main effect of participants gaze, $F(1, 26) = 22.122$, $p = .0001$, $\eta_p^2 = 0.460$, indicating that the participants felt more positive when looking at the model person ($M = 6.463$, $SEM = 0.210$) compared to when looking away ($M = 5.278$, $SEM = 0.224$). The model's gaze direction had no effect on the valence ratings ($p > .900$). The interaction between the main effects was marginal ($p < .070$) reflecting the effect that the participant's gaze direction had a larger effect on the valence rating when the model's gaze was direct ($M_{PdMd} = 6.704$, $SEM = 0.296$ vs. $M_{PaMd} = 5.000$, $SEM = 0.292$) than when the model's gaze was averted ($M_{PdMa} = 6.222$, $SEM = 0.313$ vs. $M_{PaMa} = 5.556$, $SEM = 0.279$). Free-choice ($M = 6.701$, $SEM = 0.300$) vs. forced choice ($M = 6.259$, $SEM = 0.290$) eye contact did not have an effect on the valence ratings ($p >.100$).

For the arousal ratings (scale range: 1–9) of the free-choice trials, an ANOVA showed a main effect of a model's gaze, $F(1, 26) = 17.549$, $p = .0001$, $\eta_p^2 = 0.403$, indicating that the participants felt more aroused when the model was looking directly ($M = 4.426$, $SEM = 0.365$) as compared to when looking away ($M = 3.037$, $SEM = 0.228$). The participant's gaze direction had no effect on the arousal ratings ($p > .400$), nor was there an interaction between the main effects ($p > .500$). Free-choice ($M = 4.441$, $SEM = 0.441$) vs.

forced choice (M = 4.673, SEM = 0.392) eye contact did not have an effect on the arousal ratings (p >.600).

Discussion

In the present study, we used measurements of facial electromyography to investigate whether another individual's direct gaze is perceived as an affiliative, positive signal when observed in a neutral context. In this case, direct gaze was expected to result in greater zygomatic responses compared to seeing another with averted gaze. In addition to facial EMG, we also measured skin conductance responses indexing sympathetic arousal as well as self-evaluations of the affective valence and arousal of the feelings elicited by gaze stimuli. A special feature of the present experiment was that the participants' responses were measured in a situation where the participant had a possibility to freely choose whether he or she would look towards the other person or not. The participants also believed that, on each trial, the model person was similarly choosing freely whether to look at the participant or not. The experimental design also included a condition in which the participant and the model were required to look at each other.

The results of the present study supported the hypothesis that another individual's direct gaze is perceived as an affiliative, positive signal. Seeing another person with direct gaze elicited greater zygomatic responses than seeing another with averted gaze. The zygomatic responses were greater in response to another person's direct gaze both when the participant had his or her gaze directed towards the other as well as when the participant was looking to the side. The zygomatic activity increased within the first 500 ms after stimulus onset, which is in line with previous findings showing that the latency of the automatic facial reactions is very short (300–400 ms; Dimberg &Thunberg, 1998).

Compatible with the pattern of zygomatic responses, the corrugator activity decreased (below baseline) more in response to another person's direct than averted gaze. This finding further accentuates the interpretation that seeing another's direct gaze elicits more positive reactions than seeing another's averted gaze. Previous studies have also reported corrugator EMG activity below baseline in response to happy faces (for example, Dimberg & Lundqvist, 1990, Dimberg & Thunberg, 1998; Dimberg et al., 2000).

To the best of our knowledge, this is the first study to show specifically the effect of another person's gaze direction on a perceiver's facial EMG responses. Considering that zygomatic responses have been associated with the occurrence of positive emotional reactions (Dimberg, 1990; Larsen et al., 2003; Tassinary & Cacioppo, 1992), the results can be interpreted to be compatible with previous studies employing implicit and explicit behavioral measures and reporting that direct gaze stimuli elicit more positive reactions than averted gaze or closed eyes stimuli (Chen et al., 2016; Chen, Helminen, et al., 2017; Chen, Peltola et al., 2017; Kuzmanovic et al., 2009; Lawson, 2015; Mason et al., 2005). As noted above, the zygomatic responses to another's direct vs. averted gaze were greater both when the participant was looking at the model and when the participant's own gaze was slightly turned away from the model. Interestingly, however, the zygomatic responses to another's direct gaze were greater when the participant was also looking towards the model, i.e., during eye contact, compared to when the participant's own gaze was averted. This result suggests that participants' understanding of mutual, reciprocal reception of each other's attention triggered the greatest zygomatic responses.

The zygomatic EMG responses to eye contact were not influenced by whether the eye contact was forced by task instructions or whether it resulted from both parties' free choice. However, the corrugator activity in response to eye contact decreased more on the free-choice than force choice trials. Thus, the results from the corrugator responses could be interpreted to provide weak evidence that the voluntary eye contact was associated with more positive affect compared to that evoked by forced eye contact. However, considering that the zygomatic response did not differentiate between these two conditions, and that corrugator activity has been associated with mental effort during cognitive tasks (Van Boxtel & Jessurun, 1993), it is possible that the observed differences in the corrugator activity reflected differences in the effort during maintaining the externally instructed eye contact vs. voluntary eye contact.

Replicating previous research, the present results showed that autonomic arousal responses (SCRs) were greater to another person's direct than averted gaze when the participant was directing his or her gaze towards the other person (e.g., Helminen et al., 2011; Hietanen et al., 2008; Myllyneva & Hietanen, 2015; Nichols & Champness, 1971). A novel finding was, however, that the autonomic arousal response was greater to another's direct vs. averted gaze only when the participant also was looking towards the model person, i.e., when there was eye contact. Our previous research has indicated that enhanced arousal to another's direct gaze is dependent on the perceiver's understanding of being seen (attended) by the other person (Myllyneva & Hietanen, 2015). The present results extend these findings by showing that the increased arousal to another's direct gaze is conditional to the perceiver's own gaze directed to the other person. In other words, enhanced arousal to another's direct gaze seems to be conditional to two factors: 1) an observer must see and understand that there is another individual whose attention is directed to him or her and 2) an observer must simultaneously direct his or her gaze towards the other and understand that the other individual perceives to be the target of the observer's attention. Another novel finding related to autonomic arousal responses was that the arousal response was significantly greater during voluntary eye contact than during forced eye contact. This result suggests that the arousal response to eye contact reflects not only the reciprocated mutual understanding of being attended by the other, but is also sensitive to whether the eye contact results from both parties' free choice or not. Knowing that eye contact results from both parties' deliberate decisions to look at each other is more arousing than an eye contact which the parties know not to be based on their free will. This finding is also compatible with the results from our previous experiment in which the participants did not have the possibility to choose whether to look or not towards the other person (they were asked to always look at the other person), but in one condition they had the possibility to control the opening and closing of the electronic shutter themselves (Helminen et al., 2011). The results showed that the autonomic responses were overall greater in this self-controlled stimulus block compared to a computer-controlled stimulus block. This result was also interpreted to reflect the participants' active role in the interaction. One could argue that the lack of arousal enhancement by another's direct gaze when the perceiver had averted gaze resulted from the fact that, in this case, the visual stimulus, another's gaze, was projected to the parafoveal area of the retina and, therefore, the visual acuity was not high enough. This is unlikely for two reasons. First, as mentioned in the Methods section, even when an observer's gaze was averted to the side, a pre-testing showed that it was still possible to see whether the model was looking towards or away. Second, and more importantly, the zygomatic responses differentiated between the model's direct and averted gaze also when the participant's gaze was averted, indicating that visual information about another's gaze direction was accurate enough, in the present conditions, to specifically modulate the zygomatic EMG responses.

It should be noted that although zygomatic activity has been associated with the experience of positive affect (Dimberg, 1990; Larsen et al., 2003; Tassinary & Cacioppo, 1992), there has also been an extensive debate regarding the role of communicative motives behind facial expressions, i.e., to which extent facial expressions, especially during social interaction, reflect emotional reactions or whether they are used as tools for communicating social motives to other individuals (e.g., Buck, 1994; Fridlund, 1991; Parkinson, 2005). Thus, it is possible that the enhanced zygomatic activity to direct gaze, instead of reflecting an automatic positive affective reaction, could reflect a highly automatized affiliative response (Hess, Blairy, & Kleck, 2000; Knutson, 1996; Niedenthal, Mermillod, Maringer, & Hess, 2012) in response to another individual’s affiliative signal. In the present study, we do not want to adopt a strong stance towards whether enhanced zygomatic activity to direct gaze would reflect an automatic positive affective reaction or a highly automatized affiliative response.

As mentioned in Introduction, there are a few previous studies measuring participants’ facial reactions in response to expressive faces and neutral faces looking towards the observer (eye contact) or not. These studies, however, showed no effect of gaze direction on the EMG responses when the faces bore a neutral expression (Schrammel et al., 2009; Soussignan et al., 2013), although they showed greater zygomaticus responses to happy faces with direct gaze as compared to happy faces with averted gaze (Rychlowska et al., 2012; Schrammel et al., 2009; Soussignan et al., 2013). Schrammel et al. (2009) suggested that because the zygomatic responses were modulated by eye contact, they were not reflex-like reactions to smiles, but served as communicative acts to signal affiliation. To complement this view, Soussignan et al. (2013) postulated that the stimulus face's gaze direction modulated the zygomatic responses because of its influence on self-relevance; a smile directed to the self is more self-relevant than a smile directed elsewhere. As discussed above, the present results are in line with these views.

The subjective evaluations of affective valence showed that the participants felt more positive when looking at the model person compared to when looking away. The model's gaze direction had no effect on the valence ratings. Regarding the arousal evaluations, the participants felt more aroused when the model was looking directly as compared to when looking away. For arousal ratings, the participant's own gaze direction had no effect on the ratings. Furthermore, there was no effect of the free-choice vs. forced choice on either of these evaluations. Thus, the subjective evaluations of affective experiences match, to some degree, with the results from the physiological measurements. However, considering that the self-evaluations were based on ratings collected after the physiological measurements while the participants were asked to recall how they felt during the previous experimental blocks during different gaze conditions, it is not surprising, perhaps, that there was not a perfect match in the pattern of results between self-evaluations and physiological measures. Also, the fact that the experimenter had asked the participant and the model to adopt the different gaze conditions once more, after the physiological measurements, in order to help the participants in the rating task, might have influenced the ratings. Namely, on these trials (one in each condition), the participants were not free to choose their gaze direction, and although the task was to base the ratings on the feelings they had felt during the original gaze conditions, the feelings they felt during these additional trials might have influenced their ratings. Moreover, it is well-known that explicit responses reflect controlled and analytic processing and are often affected by motivational biases or other top-down influences (Evans, 2008; Hofmann, Gawronski, Gschwendner, Le, & Schmitt, 2005). In fact, like in the present study, in many of our own previous studies in which we have measured both implicit (e.g., frontal EEG asymmetry, automatic affective priming, and startle reflex modulation) and explicit affect-related responses it has a been a typical finding that implicit measures indicate more positive responses to direct gaze versus averted gaze or closed eyes, whereas explicit measures have indicated either no difference in valence ratings between direct and averted gaze (Chen, Peltola, et al., 2017) or even less positive responses to direct than averted gaze (Hietanen et al., 2008; Pönkänen et al., 2011). As we have suggested elsewhere, these seemingly discrepant findings may be explained by assuming that people's initial and automatic responses may be attenuated and suppressed when they start to evaluate their feelings to other people's gaze. People respond to the gaze stimuli in a reflective and analytic way and they may start to analyse the reason for the eye contact. This uncertainty may evoke negative feelings (Chen, Helminen, et al., 2017). Importantly, this may be particularly likely to happen when one is looking at another, live person, like the participants were doing in the present study.

A limitation of the present study was that we did not record the model's facial expressions. In principle, it is possible that the participants' greater zygomatic responses could be responses to smiles expressed by the models during eye contact. Seeing an emotional expression on another's face elicits rapid facial reactions on one's own face which are congruent with the muscular activity producing the other individual's facial expression (Dimberg, 1982; Dimberg & Thunberg, 1998). However, we do not find this possibility likely. We took great care in training our models to keep their faces neutral during the experiments. The model persons did not report seeing any overt facial expressions on the participants' faces, and there is no reason to presume that the models would have reacted with visible facial expressions either. Another limitation is that we did not measure the participants' eye movements during the experiment. When the participants were looking away from the model, they were asked to fixate on lateral fixation points, and it is likely that they maintained their gaze on these points. However, when the participants were looking towards the models, they were likely to gaze at the models' eyes (and this was also the model's experience when the models themselves had a direct gaze), but it is impossible to know if there were differences in the gazing patterns depending on whether the model had a direct or averted gaze. These differences could have contributed to the observed findings regarding the EMG and SCR results. In future studies, simultaneous eye tracking would be helpful in investigating this issue. In future studies, it would also be useful to measure EMG activity from the muscle region of *Orbicularis oculi* in addition to zygomatic EMG activity. As orbicular activity is associated with genuine feelings of enjoyment (Ekman, Davidson, & Friesen, 1990), measurements from this muscle area could help in differentiating between whether eye contact elicits an affiliative response or a positive affective reaction. Moreover, as embarrassment has been shown to evoke smiling (without orbicular activity) (e.g., Keltner & Buswell, 1997), these measurements could also help in excluding the possibility that the zygomatic activity could be related to feelings of embarrassment during eye contact, for example, due to concerns regarding the self. It should be noted, however, that the self-ratings, in the present study, indicated more positive affective feelings when the participants were looking directly towards the other person compared to when they averted their gaze. This finding speaks against the possibility that the observed zygomatic activity reflected feelings of embarrassment.

In conclusion, measurements of facial electromyographic responses showed that seeing another person with direct gaze elicited greater zygomatic responses than seeing another with averted gaze. The measurements were carried out in a neutral laboratory environment while the participants were looking at a neutral face of a live model person. This result was interpreted to suggest that another individual's direct gaze is inherently a positive, affiliative signal when observed in a neutral context. The zygomatic responses were greater in response to another person's direct than averted gaze both when the participant was not looking directly towards the other as well as when the participant's own gaze was directed towards the other. Thus, mutual gaze, eye contact, was not necessary for the enhanced zygomatic responses. It should be noted that the present study was conducted in a neutral laboratory environment. In real-world, however, social interaction does not happen in a vacuum. Therefore, an interesting challenge for future studies is to investigate how factors related affective context, power status, ingroup versus outgroup membership etc. influence the affiliative responses to another's attention. Considering that previous research employing facial images as stimuli has not reported the effects of gaze direction on facial EMG responses when the faces have been expressionless, i.e. affectively neutral, the present study also suggests that there are interaction processes which may not be captured in experiment using pictorial representations of social stimuli.

References

Adams, R. B., Jr., & Kleck, R. E. (2003). Perceived gaze direction and the processing of facial displays of emotion. *Psychological Science, 14,* 644–647. doi:10.1046/j.0956-7976.2003.psci_1479.x

Adams, R. B., Jr., & Kleck, R. E. (2005). Effects of direct and averted gaze on the perception of facially communicated emotion. *Emotion, 5*, 3–11. doi:10.1037/1528-3542.5.1.3

Argyle, M., & Cook, M. (1976). *Gaze and mutual gaze*. Cambridge, England: Cambridge University Press.

Argyle, M., Lefebvre, L., & Cook, M. (1974). The meaning of five patterns of gaze. *European Journal of Social Psychology, 4*, 125–136. doi:10.1002/ejsp.2420040202

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human-motivation. *Psychological Bulletin, 117,* 497–529. doi:10.1037/0033-2909.117.3.497

Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The self-assessment mannequin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry, 25,* 49–59. doi: 10.1016/0005-7916(94)90063-9

Buck, R. (1994). Social and emotional functions in facial expression and communication: The readout hypothesis. *Biological Psychology, 38*, 95–115.

Cacioppo, J. T., Petty, R. E., Losch, M. E., & Kim, H. S. (1986). Electromyographic activity over facial muscle regions can differentiate the valence and intensity of affective reactions. *Journal of Personality and Social Psychology*, *50*, 260–268.

Chen, T., Helminen, T. M., & Hietanen, J. K. (2017). Affect in the eyes: Explicit and implicit evaluations. *Cognition and Emotion*, *31,* 1070-1082. doi: 10.1080/02699931.2016.1188059

Chen, T., Peltola, M. J., Dunn, R., Pajunen, S. M., & Hietanen, J. K. (2017). Modulation of the eyeblink and cardiac startle reflexes by genuine eye contact. *Psychophysiology*. doi:10.1111/psyp.12975

Chen, T., Peltola, M. J., Ranta, L. J., & Hietanen, J. K. (2016). Affective priming by eye gaze stimuli: Behavioral and electrophysiological evidence. *Frontiers in Human Neuroscience*, *10*:619. doi:10.3389/fnhum.2016.00619

Critchley, H. D. (2002). Electrodermal responses: What happens in the brain. *Neuroscientist*, *8*, 132–142.

Dawson, M. E., Schell, A. M., & Filion, D. L. (2000) The electrodermal system. In J. T. Cacioppo, L. G. Tassinary, & G. G. Berntson (Eds.), *Handbook of Psychophysiology* (2nd edition, pp. 200–223). New York, NY: Cambridge University Press.

De Jaegher, H., Di Paolo, E., & Gallagher, S. (2010). Can social interaction constitute social cognition? *Trends in Cognitive Sciences*, *14,* 441–447.

Dimberg, U. (1982). Facial reactions to facial expressions. *Psychophysiology*, *19*, 643–647.

Dimberg, U. (1990). Facial electromyography and emotional reactions. *Psychophysiology*, *27*, 481–494.

Dimberg, U., & Lundqvist, L. O. (1990). Gender differences in facial reactions to facial expressions. *Biological Psychology*, *30*, 151–159.

Dimberg, U., & Thunberg, M. (1998). Rapid facial reactions to emotional facial expressions. *Scandinavian Journal of Psychology*, *39*, 39–46.

Dimberg, U., Thunberg, M., & Elmehed, K. (2000). Unconscious facial reactions to emotional facial expressions. *Psychological Science*, *11*, 86–89.

Ekman, P., Davidson, R. J., & Friesen, W. V. (1990). The Duchenne smile: Emotional expression and brain physiology II. *Journal of Personality and Social Psychology*, *58*, 342–353.

Evans, J. St. B. T. (2008). Dual-processing accounts of reasoning, judgment, and social cognition. *Annual Review of Psychology*, *59*, 255–278.

Fridlund, A. J. (1991). Evolution and facial action in reflex, social motive, and paralanguage. *Biological Psychology*, *32,* 3–100.

Fridlund, A. J., & Cacioppo, J. T. (1986). Guidelines for human electromyographic research. *Psychophysiology*, *33*, 567–589.

Gomez, J. C. (1996). Ostensive behavior in great apes: The role of eye contact. In A. E. Russon, K. A. Bard, & S. T. Parker ST (Eds.), *Reaching into thought: The minds of the great apes* (pp. 131–151). New York, NY: Cambridge University Press.

Hall, J. A., Coats, E. J., & LeBeau, L. S. (2005). Nonverbal behavior and the vertical dimension of social relations: A meta-analysis. *Psychological Bulletin*, *131*, 898–924. doi:10.1037/0033-2909.131.6.898

Helminen, T. M., Kaasinen, S. M., & Hietanen, J. K. (2011). Eye contact and arousal: The effects of stimulus duration. *Biological Psychology*, *88*, 124–130. doi:10.1016/j.biopsycho.2011.07.002

Hess, U., Blairy, S., & Kleck, R. E. (2000). The influence of expression intensity, gender, and ethnicity on judgments of dominance and affiliation. *Journal of Nonverbal Behavior*, *24*, 265–283.

Hietanen, J. K., Leppänen, J. M., Peltola, M. J., Linna-aho, K., & Ruuhiala, H. J. (2008). Seeing direct and averted gaze activates the approach-avoidance motivational brain systems. *Neuropsychologia, 46*, 2423–2430. doi:10.1016/j.neuropsychologia.2008.02.029

Hietanen, J. K., Surakka, V., & Linnankoski, I. (1998). Facial electromyographic responses to vocal affect expressions. *Psychophysiology, 35*, 530–536.

Hofmann, W., Gawronski, B., Gschwendner, T., Le, H., & Schmitt, M. (2005). A meta-analysis on the correlation between the implicit association test and explicit self-report measures. *Personality and Social Psychology Bulletin, 31*, 1369–1385.

Keltner, D., & Buswell, B. N. (1997). Embarrassment: Its distinct form and appeasement functions. *Psychological Bulletin, 122*, 250–270.

Kleinke, C. L. (1986). Gaze and eye contact: A research review. *Psychological Bulletin, 100*, 78–100. doi:10.1037//0033-2909.100.1.78

Knutson, B. (1996). Facial expressions of emotion influence interpersonal trait inferences. *Journal of Nonverbal Behavior*, *20*, 165–182.

Kuzmanovic, B., Georgescu, A. L., Eickhoff, S. B., Shah, N. J., Bente, G., Fink, G. R., & Vogeley, K. (2009). Duration matters: Dissociating neural correlates of detection and evaluation of social gaze. *Neuroimage, 46*, 1154–1163. doi:10.1016/j.neuroimage.2009.03.037

Larsen, J. T., Norris, C. J., & Cacioppo, J. T. (2003). Effects of positive and negative affect on electromyographic activity over zygomaticus major and corrugator supercilii. *Psychophysiology*, *40*, 776–785

Lawson, R. (2015). I just love the attention: Implicit preference for direct eye contact. *Visual Cognition, 23*, 450–488. doi:10.1080/13506285.2015.1039101

Magnée, M. J. C. M., Stekelenburg, J. J., Kemner, C., & de Gelder, B. (2007). Similar facial electromyographic responses to faces, voices, and body expressions. *Neuroreport*, *18,* 369–372.

Mason, M. F., Tatkow, E. P., & Macrae, C. N. (2005). The look of love: Gaze shifts and person perception. *Psychological Science, 16*, 236–239.

Mojzisch, A., Schilbach, L., Helmert, J., Pannasch, S., Velichkovsky, B. M., & Vogeley, K. (2006). The effects of self-involvement on attention, arousal, and facial expression during social interaction with virtual others: A psychophysiological study. *Social Neuroscience, 1,* 184–195.

Myllyneva, A., & Hietanen, J. K. (2015). There is more to eye contact than meets the eye. *Cognition*, *134*, 100–109.

Nichols, K., & Champness, B. (1971). Eye gaze and the GSR. *Journal of Experimental Social Psychology, 7,* 623–626. doi:10.1016/0022-1031(71)90024-2

Niedenthal, P. M., Mermillod, M., Maringer, M., & Hess, U. (2012). The simulation of smiles (SIMS) model: Embodied simulation and the meaning of facial expression. *Behavioral and Brain Sciences, 33,* 417–480.

Parkinson, B. (2005). Do facial movements express emotions or communicate motives? *Personality and Social Psychology Review, 9*, 278–311.

Plutchik, R. (1980). *Emotion: A psychoevolutionary synthesis.* New York: Harper & Row.

Pönkänen, L. M., Alhoniemi, A., Leppänen, J. M., & Hietanen, J. K. (2011). Does it make a difference if I have an eye contact with you or with your picture? An ERP study. *Social Cognitive and Affective Neuroscience*, 6, 486–494. doi:10.1093/scan/nsq068

Pönkänen, L. M., Peltola, M. J., & Hietanen, J. K. (2011). The observer observed: Frontal EEG asymmetry and autonomic responses differentiate between another person's direct and averted gaze when the face is seen live. *International Journal of Psychophysiology*, *82*, 180–187.

Rychlowska, M., Zinner, L., Musca, S. C., & Niedenthal, P. M. (2012). From the eye to the heart: eye contact triggers emotion simulation. *Proceedings of the 4th Workshop on Eye Gaze in Intelligent Human Machine Interaction*, Article No. 5.

Schilbach, L., Wohlschlaeger, A. M., Kraemer, N. C., Newen, A., Shah, N. J., Fink, G. R., & Vogeley, K. (2006). Being with virtual others: Neural correlates of social interaction. *Neuropsychologia*, *44*, 718–730.

Schrammel, F., Pannasch, S., Graupner, S., Mojzisch, A., & Velichkovsky, B. (2009). Virtual friend or threat? The effects of facial expression and gaze interaction on psychophysiological responses and emotional experience. *Psychophysiology*, *46*, 922–931.

Skuse, D. (2003). Fear recognition and the neural basis of social cognition. *Child and Adolescent Mental Health*, *8*, 50–60. doi:10.1111/1475-3588.00047

Soussignan, R., Chadwick, M., Philip, L., Conty, L., Dezecache, G., & Grèzes, J. (2013). Self-relevance appraisal of gaze direction and dynamic facial expressions: Effects on facial electromyographic and autonomic reactions. *Emotion*, *13*, 330–337.

Tassinary, L. G., & Cacioppo, J. T. (1992). Unobservable facial actions and emotion. *Psychological Science*, *3*, 28–33.

Templeton, G. F. (2011). A two-step approach for transforming continuous variables to normal: Implications and recommendations for IS research. *Communications of the Association for Information Systems*, *28*, 1–58.

Van Boxtel, A., & Jessurun, M. (1993). Amplitude and bilateral coherency of facial and jaw-elevator EMG activity as an index of effort during a two-choice serial reaction task. *Psychophysiology*, *30*, 589–604.

Wirth, J. H., Sacco, D. F., Hugenberg, K., & Williams, K. D. (2010). Eye gaze as relational evaluation: Averted eye gaze leads to feelings of ostracism and relational devaluation. *Personality and Social Psychology Bulletin, 36*, 869–882. doi:10.1177/0146167210370032

Yamagiwa, J. (1992). Functioinal analysis of social staring behavior in an all-male group of mountain gorillas. *Primates*, *33*, 523–544.

Footnote

[1]Because data collection was continued until there were at least 6 trials in each five condition, the final number of trials in each condition was not the same. As the SCRs are known to habituate and as zero responses were included in our measure of the *magnitude* of the SCRs, it is possible that the magnitude of the responses could have been reduced in conditions including a higher number of trials compared to those with a lower number of trials. In order to investigate this possibility, we analyzed the results also by including only the first six trials from each condition. These analyses resulted in only slightly different mean values in each condition compared to those based on all accepted trials and, importantly, the pattern of statistically significant differences between conditions was indistinguishable from those based on all accepted trials and reported below.