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Genuine Eye Contact Elicits Self-Referential Processing
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Abstract

The effect of eye contact on self-awareness was investigated with implicit measures based on the use of first-person singular pronouns in sentences. These tasks tap into self-referential processing, a mode of information processing associated with self-awareness. In Experiment 1, the stimulus was a video clip showing another person and, in Experiment 2, the stimulus was a live person. In both experiments, participants were divided into two groups and presented with the stimulus person either making eye contact or gazing downward, depending on the group assignment. The gaze stimuli were presented alternating with the pronoun-selection task trials. Eye contact was found to increase the use of first-person pronouns, but only when participants were facing a real person, not when they were looking at a video of a person. The results indicate that eye contact elicits self-referential processing, but the effect may be stronger in, or possibly limited to, live interaction.

Keywords: eye contact, direct gaze, gaze direction, self-awareness, self-referential processing, self-focused attention

Genuine Eye Contact Elicits Self-Referential Processing

1 Introduction

In face-to-face contact, the gaze is mostly directed to another individual's eye region (Itier, Villate, & Ryan, 2007). The orientation of another's eyes communicates the direction of their attention and potential targets for intentions (Itier & Batty, 2009). Another individual's averted gaze informs the observer that there is something conceivably interesting and important in the environment, and, indeed, an extensive line of research has indicated that seeing another's averted gaze triggers and automatic shift of the observer's visual attention in the same direction (e.g., Driver et al., 1999; Friesen & Kingstone, 1998; Hietanen, 1999; Langton & Bruce, 1999). But what about if the perceived gaze is directed at the self? In mutual gaze (eye contact), the self is the object of another's attention. Another's direct gaze has been shown to attract (Conty, Tijus, Hugueville, Coelho, & George, 2006; Senju, Hasegawa & Tojo, 2005; von Grünau & Anston, 1995) and capture (Palanica & Itier, 2012; Senju & Hasegawa, 2005) the perceiver's attention, but is it possible that just as observing another's averted gaze at an object shifts the observer's attention to the same target, a gaze directed at an observer should turn the observer's attention upon themselves? It has been proposed that conscious attention is a bidirectional phenomenon, focused either inward toward the self or outward toward the external world, and when attention is directed to the self, it brings about self-awareness (Duval & Wicklund, 1972). Furthermore, it has long been theorized that eye contact turns the attention on the self, thereby increasing self-awareness (Argyle, 1975). Reddy (2003) has proposed that when engaged in eye contact, even infants as young as two months old are aware of others focusing attention on them and show reactions of self-awareness as a result. More recently, Conty, George, and Hietanen (2016) proposed that eye contact elicits self-referential processing – an information processing mode relating external information to the self, thus, facilitating and integrating perception and memory (Sui & Humphreys, 2015). They suggested that self-referential processing can, in fact, explain many of the effects of eye contact on cognition, one of them being the hypothesized enhancement of self-awareness. However, regardless of a lot of speculation, the effect of eye contact on self-referential processing and self-awareness has been little investigated.

Self-awareness entails more than just self-focused attention (Hull & Levy, 1979), though many other researchers have used these two terms interchangeably. Hull and Levy (1979) proposed a defining feature of self-awareness to be an enhanced sensitivity to self-relevant information in the immediate situation that serves to increase the understanding of contingencies of the situation related to one's present activities. Self-awareness also involves the activation of self-knowledge, a process which further guides subsequent perception of the situation (Hull, Van Treuren, Ashford, Propsom, & Andrus, 1988). They referred to this phenomenon as self-relevant encoding, but today the terms self-referential encoding and self-referential processing are more used in the literature. We propose that self-awareness can be conceptualized as comprising of an explicit and implicit component, the former corresponding largely to self-focused attention, and the latter to self-referential processing.

Self-awareness is a transient state and it can be directed to different sides of the self (Fenigstein, Scheier, & Buss, 1975; Govern & Marsch, 2001). Public self-awareness refers to the concern of how one presents oneself and how one is perceived by others. It often emerges in situations such as giving a presentation or being photographed, and it is associated with evaluation apprehension (Alden, Teschuk, & Tee, 1992). By contrast, private self-awareness

is an introspective state, characterized by examination and reflection on one's thoughts, feelings, and life (Govern & Marsch, 2001). Introspective self-awareness has been proposed to refine the perception of one's experience and facilitate self-knowledge (for a review, see Silvia & Gendolla, 2001). Enhanced self-awareness is associated, for example, with more accurate self-reports of sociability and dominance behavior (Pryor, Gibbons, Wicklund, Fazio, & Hood, 1977; Turner, 1978). Interoceptive awareness is yet another aspect of self-awareness characterized by awareness of afferent interoceptive signals from one's own body. Interoceptive self-awareness has been proposed to sharpen the perception of internal states, such as arousal and emotions (Silvia & Gendolla, 2001), and it has been found to enhance the perception of one's own heartbeat (Ainley, Maister, Brokfeld, Farmer, & Tsakiris, 2013; Ainley, Tajadura-Jimenez, Fotopoulou, & Tsakiris, 2012). Previous research has manipulated the level of self-awareness in a variety of ways. Efficient manipulations have included listening to recordings of one's own voice (Wicklund & Duval, 1971), being in front of cameras (Davis & Brock, 1975), writing about oneself (Silvia & Eichstaedt, 2004), running in place in an embarrassing way (Wegner & Giuliano, 1983), seeing one's reflection in a mirror (Wicklund & Duval, 1971), and being observed by an audience (Carver & Scheier, 1978).

Considering the relatively large amount of research on self-awareness and the well-established notion that self-awareness can be efficiently induced by exposing one to other individual's observation, it is, perhaps, surprising that the effect of eye contact, the most intimate form of direct observation, on self-awareness has received so little attention. Only relatively recently Hietanen and colleagues (Hietanen, Leppänen, Peltola, Linna-aho & Ruuhiala, 2008; Myllyneva, Ranta, & Hietanen, 2015; Pönkänen, Peltola, & Hietanen, 2011) demonstrated the effect of eye contact on self-reported evaluations of self-awareness. They measured self-awareness with the Situational Self-Awareness Scale, which is probably the most widely used tool for the purpose (SSAS; Govern & Marsch, 2001). SSAS is a self-report questionnaire that includes two subscales of self-awareness, awareness of the public and of the private side of the self, and a control scale of awareness of immediate surroundings to measure attention focused on other targets than the self. In the studies by Hietanen and colleagues, SSAS ratings were measured while the participants were looking at another person who either made eye contact or had an averted gaze. In all of the studies, higher levels of public self-awareness were measured in response to eye contact compared to averted gaze. The ratings of private self-awareness or awareness of immediate surroundings did not differ between the gaze conditions.

In another recent study, Baltazar and colleagues (2014) demonstrated the effect of eye contact on interoceptive self-awareness. Participants were presented with pictures of either a face with direct gaze or averted gaze, or a picture of a fixation cross on the screen. The picture of a face or a cross was followed by an emotional picture after which the participants evaluated their arousal response to the emotional picture. Skin conductance responses to the emotional pictures were recorded, and the correlations between the subjective ratings and the physiological responses were calculated. The results showed that the participants rated their subjective arousal to the emotional pictures more consistently with the objective measures of their physiological arousal after having seen direct gaze than averted gaze pictures. The authors proposed that the results were best explained by an enhancement of interoceptive self-awareness induced by eye contact.

The studies of the effects of eye contact on self-awareness by Hietanen and colleagues (Hietanen et al., 2008; Myllyneva et al., 2015; Pönkänen et al., 2011) relied exclusively on explicit self-report measurements. Even though self-evaluations have the advantage of being able to reveal conscious attitudes and emotions they may also suffer from serious shortcomings. People may have conflicting motives affecting their reporting, and even when attempting to answer honestly and accurately, they can be limited in their capacity to

accurately evaluate their own state (Paulhus & Vazire, 2007). Of specific limitation for self-awareness research are findings demonstrating that completing self-report questionnaires can, in fact, increase self-awareness (Osberg, 1985), presumably because of the introspection it requires (Eichstaedt & Silvia, 2004). In this regard, the above cited study by Baltazar and colleagues (2014) reporting enhanced accuracy of interoceptive evaluations in the context of direct gaze is an important finding because it relied on an indirect measure of self-awareness. However, sharpened interoception is a very specific effect of self-awareness, and further research examining more general aspects of self-awareness is warranted.

To overcome the shortcomings related to explicit self-reports, researchers have also developed implicit measures of self-awareness (Davis & Brock, 1975; Exner, 1973; Wegner & Giuliano, 1980, 1983). These measures consist of linguistic tasks in which the frequency of self-reference in participants' responses is counted. The most evident form of self-reference is the use of first-person singular pronouns, such as "I", "me", and "mine". In linguistic research, high and low frequency of first-person pronouns in creative writing have been associated with self-attachment/immediacy and self-distancing, respectively (e.g. Pennebaker & King, 1999). Individuals who are emotionally focused on themselves have been found to be particularly inclined to use first-person pronouns (e.g. Rude, Gortner, & Pennebaker, 2004), whereas people have been observed to reduce their use of first-person pronouns in a context of psychological distancing (Cohn, Mehl, & Pennebaker, 2004). Similarly, in the pronoun-selection task of self-awareness devised by Davis and Brock (1975), the frequency of first-person singular pronouns in participants' responses is used as an indicator of self-focus and heightened self-awareness. In this task, participants read sentences written in a language they do not understand (e.g., Swahili). The pronouns in the sentences are underlined, and the participants' task is to determine which English pronouns correspond to the pronouns in the sentences. The participants are led to believe that the task is a measure of sensitivity to foreign languages. In the study by Davis and Brock (1975), self-awareness was manipulated by the use of a television camera directed towards the participants. On average, participants in the camera condition chose 30 percent more first-person singular pronouns than participants in the no-camera condition. Another pronoun-selection measure of implicit self-awareness is the Linguistic Implications Form (LIF; Wegner & Giuliano, 1980, 1983). The LIF includes 20 incomplete sentences, each with a blank, that are completed by choosing pronouns to fill in the blanks. There are three alternatives for each sentence, one of which is always first-person singular. All of the alternatives are grammatically correct, and participants are instructed to choose the one they feel best fits the sentence. LIF is a widely used measure of self-awareness, and it has been found to be sensitive to many kinds of manipulations of self-awareness (Salovey, 1992; Silvia & Abele, 2002; Silvia & Eichstaedt, 2004; Snow, Duval, & Silvia, 2004; Stephenson & Wicklund, 1984; Wegner & Giuliano, 1980, 1983).

The methods based on pronoun selection have been suggested to measure self-awareness. We propose that an increase in the use of first person singular pronouns in one's responses is particularly indicative of enhanced self-referential processing. An enhanced use of self-referring pronouns reflects an increased accessibility of self-related cognitions (Wisman, Heflick, & Goldenberg, 2015) and an enhanced perception of external information as being related to the self, both of which are central to self-referential processing (Hull & Levy, 1979; Hull et al., 1988). In the current study, we report two experiments investigating the effect of eye contact on self-referential processing. We also collected explicit ratings of self-awareness with a self-report questionnaire (SSAS; Govern & Marsch, 2001).

2 Experiment 1

In Experiment 1, the effect of eye contact on self-referential processing was examined with an implicit measure based on pronoun selection in a foreign-language task (Davis & Brock, 1975). On each trial, participants were presented with a video clip of a person with direct or averted gaze followed by a multi-choice task regarding sentences in foreign languages. In each sentence, one pronoun was underlined, and participants' task was to guess which one of six possible Finnish translations for the target word is correct. Participants were randomly assigned to two groups: participants in one group were presented with video clips of a person with direct gaze, and those in the other group were presented with video clips of a person with averted gaze. A between-subjects design was used for two reasons. First, by presenting only one condition to each participant, the possible carryover effect of self-awareness from one condition to another was avoided. Second, we did not want the participants to be able to contrast the two experimental conditions against each other, which would likely alter their perception of them. To increase the potential effect of gaze direction, all participants were instructed to imagine that the person in the video was a real person. It was expected that participants in the direct gaze group would choose more first-person singular pronouns than participants in the averted gaze group. Participants also completed the Situational Self-Awareness Scale (Govern & Marsch, 2001). On the SSAS, the perception of direct gaze was expected to elicit higher ratings public self-awareness than the perception of averted gaze.

2.1 Method

2.1.1 Participants

The participants were 62 adults (age range = 19–31 years, mean age = 23.9 years, $SD = 3.2$, 33 females) recruited from e-mail lists of the University of Tampere, Tampere University of Technology, and Tampere University of Applied Sciences. The participants were all native speakers of Finnish with no history of neurological or psychiatric disorders. Participants were rewarded with a movie ticket, a 10-euro gift card to a retail chain, or course credit. The study was carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki). All participants gave their written informed consent.

2.1.2 Materials

The stimuli were video clips of a person with either direct gaze or averted (downward) gaze. Two males and two females acted as model persons. During preparation of the video clips, the model persons were asked to maintain a neutral expression and sit as still as possible without any gross facial, head, or body movements, but blinking was allowed. The models were filmed against a dark background. Two videos were made with each model, one with a direct gaze and another with a downward gaze. The videos did not contain a sound track.

The video clips were presented on a 19-inch LCD monitor with a resolution of 1280×1024. The participants were seated 100 cm from the computer screen. The videos had a resolution of 1024×768 and they were shown on full screen. The face of the model person covered a visual angle of approximately 11° horizontally and 15° vertically. For an illustration of the stimuli, see Figure 1.

INSERT FIGURE 1 HERE

The pronoun-selection task was presented on the same LCD monitor as the video clips. The task consisted of multi-choice tasks regarding sentences in foreign languages. In each sentence, one pronoun was underlined, and the task was to guess which one of the six possible Finnish translations for the target word was correct (see Appendix A for an English translation of the task). The six answer options were pronouns in each particular grammatical person, all conjugated in the same form. For each trial, the options were presented in a different, randomized order. The first 10 sentences were in Swahili, followed by 10 sentences in Basque. The sentences were extracted from language books (Benjamin, Mironko & Geoghegan, 1998; King, 1994; Mohamed, 2001). The task included following types of sentences: *Nakaa na dada yangu* (I live with my sister) and *Gu fruta saltzen ari gara* (We sell fruits).

2.1.3 Design and Procedure

Participants were randomly assigned to two groups, one that was presented with direct gaze videos and another that was presented with averted gaze videos. For each participant, the model person was looking at the same direction at all times. The genders and identities of the models as well as their gaze directions were counterbalanced across participants' gender. Three to four participants took part in the study at the same time in the same room. In each session, at least one of the participants was assigned to a different group (direct gaze vs. averted gaze) than the others. The computers were located in small cubicles. The participants wore earmuffs during the experiment.

Upon arrival to the laboratory, participants were informed on the general aspects of the experiment. They were told that the experiment would be carried out on a computer and it includes tasks, which would be later instructed on the computer screen. Participants were seated in the cubicles and a written consent was obtained. Before beginning the tasks, the participants filled in information regarding their age and gender. The experimenter announced that during the experiment he would be seated behind a partition wall and not be able to observe the participants.

The foreign-language task began with detailed instructions on how the task would be carried out. In the instructions, participants were explicitly told that they were not expected to know the answer, but to guess the word instead. To strengthen the effect of the gaze, the participants were instructed to imagine that the person in the video were a real person sitting opposite to them; someone they could see, hear, talk to, and touch. The task included 20 trials, each of which consisted of a 5-second video of a person and one multi-choice task. The person in the video was gazing straightforward or downward, depending on the participant's group assignment. After each video clip, a task item and its answer options were presented on the screen. After choosing one of the six answer options, the next trial began immediately.

After the foreign-language task, the computer program presented the participants with the Situational Self-Awareness Scale (Govern & Marsch, 2001). The SSAS measures three forms of situational awareness (public self-awareness, private self-awareness, and awareness of immediate surroundings), each of which is measured with three items. The items were translated to Finnish and modified so that they referred to the moment of watching the videos instead of the present moment. Public self-awareness was measured with items such as "I was concerned about the way I present myself", private self-awareness with items such as "I was conscious of my inner feelings", and awareness of immediate surroundings with items such as "I was keenly aware of everything in my environment". Participants were instructed to

answer based on how they were feeling when they were watching the eye gaze videos. All items were answered on a 7-point Likert scale, ranging from strong disagreement to strong agreement. After the SSAS items, three manipulation check items were presented. The participants were asked to self-evaluate whether the person they saw had looked like he or she was looking directly at the participant, and whether the participant had understood the sentences in Swahili or the sentences in Basque. These items were also answered on a 7-point Likert scale, ranging from strong disagreement to strong agreement.

After all the participants had completed the task and the questionnaires, the experimenter debriefed the participants, thanked them, and gave them the participation rewards.

2.2 Results

2.2.1 Manipulation checks

All participants correctly perceived whether the video model was looking at them or away from them. On a scale ranging from 1 (strongly disagree) to 7 (strongly agree), most of the participants in the direct gaze group strongly agreed ($M = 6.45$, $SD = 0.72$) with the statement “The person in the video appeared to be looking at me”, whereas most of the participants in the averted gaze group strongly disagreed ($M = 1.26$, $SD = 0.77$) with the statement, $t(60) = 27.32$, $p < .001$, $d = 6.96$. Participants reported that they had not understood the foreign languages in the foreign-language task. The mean score to the statement “I understood the sentences in Swahili” was 1.05 ($SD = 0.28$), and to the statement “I understood the sentences in Basque”, the mean score was 1.05 ($SD = 0.22$).

2.2.2 The foreign-language task

Self-awareness was measured as the number of first-person singular pronoun responses. On average, the direct gaze group gave 1.74 first-person responses ($SD = 1.29$), and the averted gaze group 2.16 responses ($SD = 1.24$). A t-test showed no statistically significant difference in the number of first-person pronoun responses between the two gaze groups, $t(60) = 1.30$, $p = .197$, $d = 0.33$. The use of other pronouns did not differ between the two groups either. The mean number of responses in each grammatical person is shown in Figure 2.

INSERT FIGURE 2 HERE

2.2.3 Situational Self-Awareness Scale

For the SSAS ratings, a t-test indicated no significant differences between the direct gaze and averted gaze group in their ratings of public self-awareness ($M_{\text{direct}} = 2.34$; $M_{\text{averted}} = 2.44$), $t(60) = 0.29$, $p = .77$, $d = 0.07$, private self-awareness ($M_{\text{direct}} = 4.01$; $M_{\text{averted}} = 3.69$), $t(60) = 1.06$, $p = .30$, $d = 0.27$, or awareness of immediate surroundings ($M_{\text{direct}} = 2.86$; $M_{\text{averted}} = 3.17$), $t(60) = 0.90$, $p = .37$, $d = 0.23$.

2.3 Discussion

Experiment 1 investigated whether eye contact elicits self-referential processing. The participants were randomly assigned to two groups, one group seeing video clips of models

gazing directly at them and the other seeing video clips of the same models looking downward. Self-referential processing was measured with a foreign-language task (Davis & Brock, 1975). In the task, participants were presented with sentences in foreign languages with one pronoun underlined and an assignment of guessing the correct meaning of each underlined pronoun. It was expected that participants in the direct gaze group would give more first-person pronoun responses compared to participants in the averted gaze group.

Contrary to the hypothesis, no difference was found in the number of first-person-pronoun responses between the two groups. This finding was somewhat surprising considering that, in previous studies, eye contact has been found to consistently induce explicit self-awareness (Hietanen et al., 2008; Myllyneva et al., 2015; Pönkänen et al., 2011) as well as implicit interoceptive self-awareness (Baltazar et al., 2014). Moreover, the foreign-language task has been demonstrated to be sensitive to different kinds of self-awareness manipulations (Davis & Brock, 1975; Wisman et al., 2015).

Three possible explanations arise for the unexpected results. First, in the present study, participants attended the experiment in groups of three to four people, whereas in the aforementioned studies (Baltazar et al., 2014; Hietanen et al., 2008; Myllyneva et al., 2015; Pönkänen et al., 2011) each participant performed the task alone with no other participants present. The presence of others has been demonstrated to increase public self-awareness (Franzoi & Brewer, 1984) and it is, thus, possible that, in this condition, the effect by gaze direction manipulation was not strong enough to exert an effect in the implicit pronoun-selection task. However, it should be noted that the participants were seated in separate cubicles and not in contact with other people during the experiment. Moreover, in our previous studies, participants were not completely alone, but in the same room with the experimenter, although the experimenter was seated behind a partition wall (Hietanen et al., 2008; Myllyneva et al., 2015; Pönkänen et al., 2011). Therefore, we do not find this explanation likely for the observed null findings.

Another possible explanation for not obtaining the expected results is related to the pronoun-selection task. In the task, heightened self-referential processing was expected to result in increased perception of the foreign-language sentences as self-referring, and this should have increased the first-person pronoun choices. However, as the sentences and target words were incomprehensible to the participants, they may have paid little attention to the pronoun choices and made their choices arbitrarily. Moreover, as the target words were different in every trial, participants may have reasoned that the correct answer was probably different, too, resulting in a fairly balanced number of answers in each person-pronoun category. Either answering tendency may have reduced the effect of gaze direction on the pronoun choices.

A third possibility for not finding an effect of eye contact on self-awareness is related to the used stimuli. Videos of model persons making eye contact or gazing downward were used as stimuli. To strengthen the effect, participants were asked to imagine that the person in the video were real. Yet the experience was likely different to eye contact with a live person. In fact, in our previous studies, the effect of gaze direction on explicitly measured public self-awareness was observed only when the participants were looking at a live person, but not when looking at an image of the same person on a computer screen (Hietanen et al., 2008; Pönkänen et al., 2011). It was suggested that this finding reflected the participant's experience of being the object of another person's attention. More recent studies from our laboratory have provided evidence for this possibility. Myllyneva and Hietanen (2015) showed that if the participants were led to believe that a one-way mirror was placed between the model and the participant in such a way that the model person was not able to see the participant, public self-awareness in response to direct gaze was lower than in the condition when the participants believed to be seen by the model person. And yet, the visual stimulus

was exactly the same in both conditions. The belief of being watched by another person has also been shown to be critical for the effects of eye contact on various gaze direction sensitive physiological and cognitive responses (Hietanen, Myllyneva, Helminen, & Lyyra, 2016; Myllyneva & Hietanen, 2015). Thus, it is possible that the effect of eye contact on self-referential processing can also be observed only in the context of genuine eye contact with a live person.

Admittedly, in the study by Baltazar and colleagues (2014), the effect of eye contact on self-awareness was observed when showing mere face images on a computer screen. However, as noted earlier, the enhanced accuracy of interoceptive evaluations observed in their study is a very specific effect, and it is possible that self-referential processing as measured in the present study is a phenomenon that can be dissociated from interoceptive self-awareness. Nevertheless, their results importantly demonstrate that the mere perception of watching eyes can lead to an enhancement of a certain aspect of self-awareness. It is worth pointing out that their study differs from the present study as well as from our previous studies (Hietanen et al., 2008; Myllyneva et al., 2015; Pönkänen et al., 2011) in one important respect, which may also account for the differing results. In the Baltazar et al. study (2014), participants were primed with the direct gaze image only for 1.5 s before an emotional picture was shown, whereas in the present study and our previous studies the direct gaze image was looked at for 5 s at a time. Conty and colleagues (2016) proposed that the self-awareness effect of eye contact may be canceled out when it is consciously dissociated from the experience of being observed by another. A briefly presented direct gaze image could possibly automatically trigger an experience of being watched, but when a direct gaze image is consciously attended to, it is dissociated from the experience of being observed by another and the effect is attenuated. Moreover, in our previous studies, the direct gaze image was contrasted with the live person's gaze, which may have further augmented the perceived difference between the two.

Based on the above reasoning, we decided to conduct another experiment. Three modifications were made for Experiment 2. Firstly, instead of using video clips as stimuli, live faces were used. Secondly, as the foreign-language task may have been limited in its ability to capture self-referential processing, another pronoun-selection task, the Linguistic Implications Form, was included (LIF; Wegner & Giuliano, 1980, 1983). The key difference between the two tasks is that, in the LIF, the presented sentences are in the participants' mother tongue. The LIF measures the interpretation of a comprehensible context as self-referring or other-referring, and it may thus be better able to assess self-referential processing. Thirdly, as the presence of others may have affected the participants' self-awareness (Franzoi & Brewer, 1984), in Experiment 2, the data were collected from one participant at a time.

3 Experiment 2

In Experiment 2, instead of video clips as in Experiment 1, faces of live models presented through a liquid crystal (LC) shutter served as stimuli. For the measurement of self-referential processing, two pronoun-selection tasks were used: the foreign-language task (Davis & Brock, 1975) and the Linguistic Implications Form (LIF; Wegner & Giuliano, 1980, 1983). The tasks were presented on a computer screen placed on a table between the participant and the model. Like in Experiment 1, in the foreign-language task, the participants' task was to guess translations for underlined pronouns in sentences they did not understand. In the LIF, the participants' task was to choose the best-fitting pronoun option to an incomplete sentence. All of the pronoun options were grammatically correct. In both tasks, each trial consisted of a presentation of the face of a model person with direct or averted gaze

through the LC shutter followed by a multi-choice task on the computer screen. The participants were divided into two groups: participants in the direct gaze group were presented with a face making eye contact, and participants in the averted gaze group were presented with a face looking downward. In both pronoun-selection tasks, it was expected that participants in the direct gaze group would choose more first-person singular pronouns than participants in the averted gaze group. Like in Experiment 1, we also measured self-reported self-awareness with the Situational Self-Awareness Scale (SSAS; Govern & Marsch, 2001). On the SSAS, the perception of direct gaze was expected to elicit higher ratings of public self-awareness than the perception of averted gaze.

3.1 Method

3.1.1 Participants

The participants were 42 people aged 16–35 years (mean age = 23.7 years, $SD = 4.2$, 35 females). They were recruited from bulletin boards and e-mail lists of the University of Tampere, Tampere University of Applied Sciences, and various upper secondary schools in Tampere. The participants were all native speakers of Finnish with no history of neurological or psychiatric disorders. Participants were rewarded with a movie ticket or course credit. The study was carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki). Written consent was obtained from each participant before the experiment.

3.1.2 Materials

The stimuli were the face of either a male or a female model person. Depending on the group assignment of the participant, the model was either making eye contact or gazing 30° downward. The model maintained a neutral expression on his or her face. The model person did not give any instructions to the participant. The faces were presented through a voltage sensitive liquid crystal (LC) shutter (NSG UMU Products Co) attached to a black panel. The state of the LC shutter (transparent or opaque) was operated by a desktop computer and the LC shutter switched between opaque and transparent states within an overall speed of 3 ms. The LC shutter panel was placed on a table between the participant and the model. A computer screen and a keyboard were placed on the participant's side of the LC shutter. The height of the computer screen was adjusted so that the participant was able to see the entire face of the model, but nothing below his or her chin. Participants were seated at a distance of 80 cm from the computer screen and 100 cm from the LC shutter. The face of the model was at a distance of 30 cm from the LC window. For an illustration of the arrangement, see Figure 3.

INSERT FIGURE 3 HERE

Two pronoun-selection measures of self-referential processing were used. They were presented on the computer screen. The foreign-language task was identical to the one used in Experiment 1 (Davis & Brock, 1975). In addition to that, the Linguistic Implications Form was included in the procedure (LIF; Wegner & Giuliano, 1980, 1983). In the LIF, participants were presented with Finnish sentences, each containing a blank in place of a person pronoun (see Appendix B for an English translation of the task). The task was to choose a pronoun for each blank. On each trial, there were three pronouns to choose from. One pronoun was

always first singular, and the two others were either first plural, third singular, or third plural, depending on the sentence context. For each trial, the options were presented in a randomized order. The task included 10 Finnish sentences, most of which were directly translated from the LIF by Wegner and Giuliano (1983). The task included following types of sentences: *Myyjä yritti taivutella (minua, häntä, meitä) ostamaan sanakirjan* [The salesman tried to persuade (me, her, us) to buy a dictionary] and *Meteli alkoi häiritä (meitä, heitä, minua) ennen pitkää* [The noise got to (us, them, me) before long].

3.1.3 Design and procedure

Participants were randomly assigned to two groups. Participants in the direct gaze group saw the model making eye contact and participants in the averted gaze group saw the model looking downward. For each participant, the model was looking at the same direction at all times. The genders of the models and gaze directions were counterbalanced across participants' gender. The data were collected from one participant at a time.

After arriving to the laboratory, the participant was told that the experiment will be carried out on a computer and that it includes tasks regarding linguistic perception, which would be later instructed on the computer screen. The participant was seated in front of the computer and the LC shutter, and a written consent was obtained. The experimenter demonstrated the participant the functioning of the LC shutter and explained that the model person would be sitting behind the LC shutter and the LC shutter would become transparent on each task trial. The experimenter announced that he or she would be in the next room during the experiment and not observing the participant, and left the room.

Before beginning the tasks, the computer program requested information regarding the participant's age and gender. Then, the program presented the participant with instructions of the foreign-language task (Davis & Brock, 1975). Each trial consisted of the LC shutter becoming transparent for 5 s and one multi-choice task. When the LC shutter switched back to opaque, the task was immediately presented on the computer screen in front of the LC shutter. After choosing one of the six answer options, there was an inter-stimulus interval (ISI) of 1 s, after which the next trial began. The foreign-language task consisted of 20 trials. After that, the Linguistic Implications Form followed (LIF; Wegner & Giuliano, 1980, 1983). Instructions for the LIF explained that to understand the meaning of a sentence, some words can be redundant, and the intention of the task was to investigate the redundancy of pronouns in sentences. The instructions said that the computer program would present Finnish sentences, each containing a blank, with the assignment of choosing the one from three pronoun options the participant thought would best fit the sentence. The instructions explained that all the options would be grammatically correct, and the participant's task was to choose, and when in doubt, to guess the one that makes most sense to them. Similarly to the foreign-language task, each trial consisted of the LC shutter becoming transparent for 5 s and one multi-choice task. After choosing one of the options and an ISI of 1 s, the next trial began. The LIF consisted of 10 trials. After the two tasks, the participant completed the Situational Self-Awareness Scale (Govern & Marsch, 2001) and the manipulation check items, exactly like in Experiment 1. Then, the experimenter returned to the laboratory and debriefed the participant. The participant was then thanked and given the participation reward.

3.2 Results

3.2.1 Manipulation checks

All participants correctly perceived whether the model person was looking at them or away from them. On a scale ranging from 1 (strongly disagree) to 7 (strongly agree), most of the participants in the direct gaze group strongly agreed ($M = 6.67$, $SD = 0.66$) with the statement “The model person appeared to be looking at me”, whereas most of the participants in the averted gaze group strongly disagreed ($M = 1.24$, $SD = 0.63$) with the statement, $t(40) = 27.41$, $p < .001$, $d = 8.42$. Participants reported that they had not understood the foreign languages in the pronoun-selection task. To the statement “I understood the sentences in Swahili”, the mean score was 1.40 ($SD = 1.27$), and to the statement “I understood the sentences in Basque”, the mean score was 1.21 ($SD = 0.95$).

3.2.2 The foreign-language task

Self-referential processing was measured as the number of first-person singular pronoun responses. A t-test indicated a trend approaching significance in the number of first-person singular responses between the gaze groups, $t(40) = 1.98$, $p = .055$, $d = 0.61$. Consistent with the prediction, the direct gaze group gave more first-person responses ($M = 2.62$, $SD = 1.63$) than the averted gaze group ($M = 1.81$, $SD = 0.93$). The direct gaze group gave less responses in the third-person singular form ($M = 2.57$, $SD = 1.43$) than the averted gaze group ($M = 3.52$, $SD = 1.54$), $t(40) = 2.08$, $p = .044$, $d = 0.63$. The use of other grammatical pronouns did not differ between the two groups. The mean number of responses in each grammatical person are shown in Figure 4.

INSERT FIGURE 4 HERE

3.2.3 Linguistic Implications Form

As expected, participants in the direct gaze group gave significantly more first-person responses ($M = 4.48$, $SD = 1.29$) than participants in the averted gaze group ($M = 3.57$, $SD = 1.03$), $t(40) = 2.51$, $p = .016$, $d = 0.78$. Also, a trend towards lower use of third-person singular pronouns in the direct gaze group ($M = 1.81$, $SD = 0.98$) than in the averted gaze group ($M = 2.38$, $SD = 0.97$) was observed, $t(40) = 1.90$, $p = .065$, $d = 0.58$. The number of responses in other grammatical pronouns did not differ between the two groups (see Figure 5).

INSERT FIGURE 5 HERE

3.2.4 Situational Self-Awareness Scale

Mean scores and standard deviations of the SSAS ratings are presented in Table 1. A t-test was conducted to compare the SSAS ratings between the two groups. The groups did not differ in their reports of public self-awareness, $t(40) = 0.36$, $p = .722$, $d = 0.46$, or private self-awareness, $t(40) = 0.87$, $p = .392$, $d = 0.42$. Surprisingly, however, a significant effect of gaze direction on the ratings of awareness of immediate surroundings was found, $t(40) =$

3.07, $p = .004$, $d = 0.94$, with the participants in the averted gaze group ($M = 4.11$, $SD = 1.25$) rating higher levels of awareness of immediate surroundings than participants in the direct gaze group ($M = 3.02$, $SD = 1.06$).

INSERT TABLE 1 HERE

3.3 Discussion

Like in Experiment 1, in Experiment 2, we investigated the effect of another person's gaze direction on self-referential processing. Three modifications were made to the stimuli and the procedure. Live faces were used as stimuli instead of video clips of faces. Self-referential processing was measured with the Linguistic Implications Form (LIF; Wegner & Giuliano, 1980, 1983) in addition to the foreign-language task (Davis & Brock, 1975). Furthermore, in Experiment 2, the data were collected from one participant at a time, whereas in Experiment 1 three to four participants participated simultaneously.

Results showed an increase in the number of first-person singular responses when preceded by eye contact with a live person. In both measures, the direct gaze group gave more first-person responses than the averted gaze group, though in the foreign-language task, the effect was only a trend close to statistical significance. On the SSAS, the participants of the two groups did not differ in their reports of public self-awareness or private self-awareness, but the averted gaze group reported heightened awareness of immediate surroundings. Because no difference in self-referential processing between the direct gaze and averted gaze groups was observed in Experiment 1 using video stimuli, the results of the two experiments together suggest that the enhancement of self-referential processing by the perception of direct gaze is stronger in—perhaps limited to—genuine eye contact, whereas a mere video clip of direct gaze may not have such an effect.

Experiment 2 demonstrated an increase in self-referential processing as a result of eye contact in two linguistic tasks. In the LIF, the effect was statistically significant, whereas in the foreign-language task, only a trend towards the effect was observed. In the discussion of Experiment 1 (section 2.3), the LIF was speculated to be better able to tap into self-referential processing than the foreign-language task, because the LIF requires the participants to make their pronoun choices based on the interpretation of a comprehensible context. Based on these results, it seems that an implicit task that includes interpretation of context may, indeed, be a better measure of self-referential processing than one where the context is presented in an incomprehensible language.

In the discussion of Experiment 1, the relatively long duration of the used video stimuli (5 seconds) was brought up as another possible explanation for not finding the effect of gaze direction. In the study by Baltazar and colleagues (2014), an image of direct gaze presented for 1.5 s was found to enhance interoceptive self-awareness and, hence, the stimulus duration was considered to be a possible explaining difference between their results and the results of Experiment 1. Moreover, after finding, in Experiment 2, that the effect of gaze direction was stronger in the LIF than in the foreign-language task, we decided to run an additional control experiment to investigate whether the effect of gaze direction on self-referential processing could be observed with video stimuli of shorter presentation duration (1 second) and the LIF as a complementary measure. In all other regards the control experiment was identical with Experiment 1. The results showed no difference in the use of first-person pronouns between the direct and averted gaze groups in either of the two tasks.¹ Thus, the results of the control experiment further suggest that only genuine eye contact elicits self-

referential processing, whereas a direct gaze in video clips, regardless of their length, does not have an effect on it.

Unexpectedly, the groups did not differ in their reports of public self-awareness. This result conflicts with our previous studies (Hietanen et al., 2008; Myllyneva & Hietanen, 2015; Myllyneva et al., 2015; Pönkänen et al., 2011) that have consistently found an increase in self-reported self-awareness as a result of eye contact with a live person. A likely explanation for the differing results stems from the fact that our previous studies used a within-subjects design, whereas the present study used a between-subjects design. It is possible that in a within-subjects design, the participants, probably unintentionally, contrast the two conditions against each other, which may augment the effect of the manipulation and increase the likelihood to observe the effect in the dependent variable.

Participants in the averted gaze group reported higher ratings of awareness of surroundings than participants in the direct gaze group. This was a surprising result and, to our knowledge, no such effect has been observed in previous studies. Conscious attention has been proposed to be a bidirectional phenomenon, directed either to the self or to the external world (Duval & Wicklund, 1972). Enhanced attention to the surroundings observed in the averted gaze group may thus reflect reduced self-focused attention. Conversely, lower attention to the surroundings in the direct gaze group may reflect higher self-focused attention, indicating an increase in self-awareness by eye contact.

4 General Discussion

We conducted two experiments to investigate whether eye contact induces self-referential processing. In Experiment 1, video clips of a person with direct or averted gaze were shown to participants followed by a foreign-language pronoun-selection task, an implicit measure of self-awareness proposed to tap into self-referential processing (Davis & Brock, 1975). Participants were randomly assigned to two groups, one group seeing the models gazing directly at them and the other seeing the same models looking downward. Experiment 2 was otherwise similar to Experiment 1, but instead of video stimuli, the participants were facing another live person, and they performed two pronoun-selection tasks: the same foreign-language task as in Experiment 1 and the Linguistic Implications Form (Wegner & Giuliano, 1980, 1983). In both experiments, the main hypothesis was that participants in the direct gaze group would give more first-person responses in the pronoun-selection tasks than participants in the averted gaze group. An increase in self-referential processing by eye contact was observed in Experiment 2 but not in Experiment 1. The most probable explanation for the differing results has to do with the use of live faces instead of video clips of faces as stimuli in Experiment 2. Taken together, the results tentatively suggest that only genuine eye contact with a live person induces self-referential processing, whereas watching videos of a person making eye contact does not. In addition to the implicit measures, explicit public and private self-awareness were measured with the Situational Self-Awareness Scale (SSAS; Govern & Marsch, 2001). The gaze direction, however, did not have an effect on these explicit measurements in either of the experiments.

The findings complement the picture of the self-awareness effect of eye contact. Self-referential processing is a key feature of self-awareness, and as far as we know, this is the first study to directly demonstrate that eye contact increases self-referential processing of incoming information. Previously, eye contact has been demonstrated to enhance self-awareness measured as heightened self-reported awareness of one's appearance (Hietanen et al., 2008; Myllyneva et al., 2015; Pönkänen et al., 2011) and as an enhancement of interoceptive self-awareness (Baltazar et al., 2014). The present results also further the knowledge regarding the use of pronoun-selection tasks in the measurement of self-

awareness. The pronoun-selection measures have been found to be sensitive to various manipulations, such as being in front of a television camera or a mirror (Davis & Brock, 1975), writing about oneself (Silvia & Eichstaedt, 2004), running in place (Wegner & Giuliano, 1983), imagining a happy event happening to oneself (Silvia & Abele, 2002), or perceiving a self-related figure in a central position among other figures (Snow, Duval, & Silvia, 2004). However, they have not been used with manipulations that include the direct observation of another individual. The present study introduces a new manipulation that affects the performance in pronoun-selection-based measures of self-awareness.

The implicit measures of the present study were based on the use of first-person pronouns, an increase in which was proposed to reflect enhanced self-referential processing. In the foreign-language task, participants were asked to guess a translation for an incomprehensible pronoun, and in the LIF, to fill in the blank in a sentence with the best-fitting pronoun. In both tasks, participants were asked to choose between pronoun options, one of which was always first-person singular and thus referring to the self. Davis and Brock (1975), who devised the foreign-language task, proposed that the number of self-referring responses should reflect the direction of one's attention in such a way that self-focused attention would lead to an increase in self-reference. They examined this by turning participants' attention upon themselves in a forthright way—by presenting them with their own image in a mirror—and found the use of self-referring pronouns to increase. However, Davis and Brock did not speculate on the mediating mechanisms between self-focused attention and self-referring responses. We propose enhanced self-referential processing to be such a mediator. Enhanced self-referential processing is central to self-awareness (Hull & Levy, 1979), and it is also associated with an increased accessibility of self-concept (Hull et al., 1988). The pronoun-selection tasks have been suggested to measure the accessibility of self-related cognition, and indeed, the prevalence of self-related thoughts is associated with the use of first-person pronouns (Wisman et al., 2015). We propose that the activation of self-referential processing results in an enhanced accessibility of self-related cognitions and this, in turn, biases the perception of intrinsically neutral sentences as self-referring and leads to an increase in the use of self-referring pronouns. As noted in the general introduction, Conty and colleagues (2016) recently proposed that eye contact elicits self-referential processing. The present results give empirical support to their proposition and complement the knowledge of the effects of eye contact on cognition.

Self-referential processing was found to be increased only by genuine eye contact with a live person, and not by perception of a model with straightforward gaze appearing on a video. The results from an additional control experiment described in the discussion of Experiment 2 (section 3.3) confirmed that the lack of gaze direction effect when using video stimuli was not related to the presentation time of the stimuli. Collectively, the results of the experiments suggest that, for self-referential processing to increase, the perception of direct gaze may need to be accompanied by the experience of being watched by another person (cf. Conty et al., 2016). This interpretation is in alignment with our previous studies that found an increase in self-reported self-awareness only when participants were facing a live person, and not when looking at an image on a computer screen (Hietanen et al., 2008; Pönkänen et al., 2011), or when the live person was presented through an alleged one-way mirror and the participants were led to believe that the other person could not see them (Myllyneva & Hietanen, 2015).

The difference between the two experiments can also be conceptualized as a presence or absence of interaction between the participant and the model. With a video stimulus, obviously, no reciprocal interaction can occur. In contrast, with a live model, even though no conversation took place and the model person was instructed to stay expressionless and motionless, the participant and the model both knew that they were looking at each other

mutually and, thus, that each was able to react to the other's behavior. Also, it is inevitable that limited transmission of subtle nonverbal information (e.g., blinks, cues of breathing etc.) occurred between the two. In this regard, the results lend support to the 'second-person' argument of social cognition. According to this argument, social cognition is fundamentally different when one is in interaction with another as compared to sheer observation of interaction between other people. Indeed, a growing number of studies indicate that being involved in social interaction has effects on cognition, as observed in both behavior and neural activity (for a review, see Schilbach et al., 2013). As self-referential processing was enhanced only by genuine eye contact, our results suggest that nonverbal social interaction occurring in eye contact may trigger self-referential processing, and this does not happen with the perception of direct gaze in the absence of an interaction.

Importantly, however, the present study does not compellingly demonstrate that only genuine eye contact induces self-referential processing, whereas an image of a direct gaze does not. The main aim of the study was to examine whether the perception of direct gaze elicits self-referential processing, not to compare different presentation forms of direct gaze against one another. Due to this reason, a direct comparison of live and video gaze was not carried out within a single experiment. As the results were obtained in separate experiments with slightly different test conditions, they cannot be directly compared. Further research examining the effect of different presentation forms of direct gaze on self-referential processing is therefore needed.

Interestingly, imaging studies investigating the activation elicited by eye contact and studies investigating the activation during self-referential processing have both reported increased activation in at least one common area of the brain, the medial prefrontal cortex (mPFC) (Kampe, Frith, & Frith, 2003; Northoff et al., 2006; Senju & Johnson, 2009). The area is associated with theory of mind processes. Studies on processing of direct gaze have indicated that direct gaze is first detected by a fast subcortical route followed by projections to various regions on the cortex (Senju & Johnson, 2009). One of the first cortical areas to be activated by direct gaze is the mPFC (Conty, N'Diaye, Tijus, & George, 2007). In the mPFC, the dissociation between direct and averted gaze processing occurs as soon as 160 ms after the presentation of the gaze stimuli. Imaging studies suggest that the mPFC is also implicated in self-referential processing (Fossati et al., 2003; Schilbach et al., 2006). In a study examining the self-referential processing of emotional words, the more dorsal part of the right medial prefrontal cortex (dmPFC) was found to be the main area mediating self-reference (Fossati et al., 2003). The increase of activation in the right dmPFC was observed only when the words were processed in reference to the self, and it was present irrespective of the valence of the words. In another study, the right dmPFC was found to activate differentially when participants were presented with a virtual character gazing at them directly in comparison to the same character with an averted gaze (Schilbach et al., 2006). The authors suggested that the dmPFC activation during eye contact reflects the detection of the self-reference of the perceived gaze. The present results converge with the imaging evidence and provide direct evidence that self-referential processing is induced by the perception of eye contact.

Of the two pronoun-selection task, the Linguistic Implications Form may be more sensitive to the self-awareness manipulation. In Experiment 2, a significant effect of gaze direction on the use of first-person pronouns was found for the LIF, whereas for the foreign-language task, only a trend towards the effect was observed. The results suggest that a pronoun-selection task that includes an interpretation of context may be a better measure of self-awareness than one where the pronoun choices are made regarding an incomprehensible context. Interestingly, in both tasks, the number of third-person singular responses was lower for the direct gaze group than for the averted gaze group. In the LIF, the number of third-

person responses was actually found to negatively correlate with the number of first-person responses, $r(40) = -.686, p < .001$. In a pronoun-selection task where one understands the sentences, the tendency to perceive and choose first-person pronouns seems to come specifically on the expense of the use of third-person pronouns. This suggests that in future research a decrease in the use of third-person responses or an increase in the ratio of first-person to third-person responses may possibly be used as measures of self-referential processing or self-awareness more generally.

In addition to the implicit measures, self-awareness was assessed with a self-report measure. For this purpose, the Situational Self-Awareness Scale was used (SSAS; Govern & Marsch, 2001). The SSAS measures awareness of the public side of the self (of one's appearance), awareness of the private side of the self (of one's thoughts and feelings), and awareness of one's surroundings. The participants in the direct gaze group were expected to rate their level of public self-awareness higher than the participants in the averted gaze group. However, no increase in self-reported self-awareness by eye contact was found in either of the two experiments. In the discussion of Experiment 2 (section 3.3), this finding was proposed to result from the use of a between-subjects design. Previous studies (Hietanen et al., 2008; Myllyneva & Hietanen, 2015; Myllyneva et al., 2015; Pönkänen et al., 2011) demonstrating the effect employed a within-subjects design. In a within-subjects design, the participants can contrast the direct gaze image against the direct gaze of a live person, which may augment the perceived difference between the two. The present results also imply that, in comparison to self-reports, implicit methods may be more sensitive measures of self-awareness.

Unexpectedly, in Experiment 2, the direct gaze group rated their awareness of immediate surroundings considerably lower than the averted gaze group. Based on the idea of attention as a bidirectional phenomenon (Duval & Wicklund, 1972), lower attention to the surroundings in the direct gaze group than in the averted gaze group may reflect higher self-focused attention. In the development of the Situational Self-Awareness Scale, the scale of awareness of immediate surroundings was included as a measure of “non-self-focus” (Govern & Marsch, 2001, p. 368). Govern and Marsch argued that when attention is not directed to one's self, it is usually directed to something else, such as the physical surroundings. They reasoned that including items that measure this non-self-focus would be a useful property for a measure of self-awareness. Coming from this perspective, the direct gaze group's lowered ratings on a scale of non-self-focus support the hypothesis of eye contact increasing self-awareness.

In future studies, it would be interesting to investigate the interplay of personal characteristics of the counterparts and the self-awareness effect of eye contact. For example, it has been found that the cognitive functioning of men (but not of women) is impaired by a mixed-sex interaction due to increased impression management, same-sex interactions having no such effect on either gender (Karremans, Verwijmeren, Pronk, & Reitsma, 2009). The increased attempt of men to control women's impression of themselves may be associated with increased self-focus and enhanced self-awareness. Impression motivation has also been shown to increase when one interacts with someone who is attractive, likable, or has a high status (Schlenker, 1980), all attributes which may potentially induce self-awareness in another. Moreover, as Conty and colleagues (2016) proposed that personal characteristics of the perceiver, such as anxiety, cultural background and gender, may modulate the effect that another's direct gaze has on them, it would be important to examine the influence of these characteristics on the effect of eye contact on self-awareness.

5 Conclusions

Eye contact was found to increase self-referential processing, a key feature of self-awareness. As far as the authors know, this is the first study to directly demonstrate that eye contact increases self-referential processing of incoming information. The results from the present experiments suggest that the effect is stronger in, and perhaps limited to, eye contact with a live person in comparison to the mere perception of a direct gaze image. The effect of eye contact was only observed with the implicit methods, and no increase in explicit self-awareness was seen in the self-report ratings. This indicates that implicit methods may be more sensitive in the measurement of self-awareness compared to self-report methods.

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References

- Ainley, V., Maister, L., Brokfeld, J., Farmer, H., & Tsakiris, M. (2013). More of myself: Manipulating interoceptive awareness by heightened attention to bodily and narrative aspects of the self. *Consciousness and Cognition*, *22*, 1231–1238. [doi:10.1016/j.concog.2013.08.004](https://doi.org/10.1016/j.concog.2013.08.004)
- Ainley, V., Tajadura-Jimenez, A., Fotopoulou, A., & Tsakiris, M. (2012). Looking into myself: Changes in interoceptive sensitivity during mirror self-observation. *Psychophysiology*, *49*, 1672–1676. [doi:10.1111/j.1469-8986.2012.01468.x](https://doi.org/10.1111/j.1469-8986.2012.01468.x)
- Alden, L. E., Teschuk, M., & Tee, K. (1992). Public self-awareness and withdrawal from social interactions. *Cognitive Therapy and Research*, *16*, 249–267. [doi:10.1007/BF01183280](https://doi.org/10.1007/BF01183280)
- Argyle M. (1975). *Bodily communication*. London: Methuen.
- Baltazar, M., Hazem, N., Vilarem, E., Beaucousin, V., Picq, J. L., & Conty, L. (2014). Eye contact elicits bodily self-awareness in human adults. *Cognition*, *133*, 120–127. [doi:10.1016/j.cognition.2014.06.009](https://doi.org/10.1016/j.cognition.2014.06.009)
- Benjamin, M., Mironko, & C., Geoghegan, A. (1998). *Swahili phrasebook*. Victoria: Lonely Planet Publications.
- Carver, C. S., & Scheier, M. F. (1978). Self-focusing effects of dispositional self-consciousness, mirror presence, and audience presence. *Journal of Personality and Social Psychology*, *36*, 324–332. [doi:10.1037/0022-3514.36.3.324](https://doi.org/10.1037/0022-3514.36.3.324)
- Cohn, M. A., Mehl, M. R., & Pennebaker, J. W. (2004). Linguistic markers of psychological change surrounding September 11, 2001. *Psychological Science*, *15*, 687–693. [doi:10.1111/j.0956-7976.2004.00741.x](https://doi.org/10.1111/j.0956-7976.2004.00741.x)
- Conty, L., George, N., Hietanen, J. K. (2016). *Watching eyes* effects: When others meet the self. *Consciousness and Cognition*, *45*, 184–197. [doi:10.1016/j.concog.2016.08.016](https://doi.org/10.1016/j.concog.2016.08.016)
- Conty, L., Tijus, C., Hugueville, L., Coelho, E., & George, N. (2006). Searching for asymmetries in the detection of gaze contact versus averted gaze under different head views: a behavioural study. *Spatial Vision*, *19*, 529–545. [doi:10.1163/156856806779194026](https://doi.org/10.1163/156856806779194026)
- Conty, L., N'Diaye, K., Tijus, C., & George, N. (2007). When eye creates the contact! ERP evidence for early dissociation between direct and averted gaze motion processing. *Neuropsychologia*, *45*, 3024–3037. [doi:10.1016/j.neuropsychologia.2007.05.017](https://doi.org/10.1016/j.neuropsychologia.2007.05.017)
- Davis, D., & Brock, T. C. (1975). Use of first person pronouns as a function of increased objective self-awareness and performance feedback. *Journal of Experimental Social Psychology*, *11*, 381–388. [doi:10.1016/0022-1031\(75\)90017-7](https://doi.org/10.1016/0022-1031(75)90017-7)
- Driver, J., Davis, G., Ricciardelli, P., Kidd, P., Maxwell, E., & Baron-Cohen, S. (1999). Gaze perception triggers reflexive visuospatial orienting. *Visual Cognition*, *6*, 509–540. [doi:10.1080/135062899394920](https://doi.org/10.1080/135062899394920)
- Duval, S., & Wicklund, R. A. (1972). *A theory of objective self-awareness*. New York: Academic Press.
- Exner J. E. (1973). The self focus sentence completion: A study of egocentricity. *Journal of Personality Assessment*, *37*, 437–455. [doi:10.1080/00223891.1973.10119902](https://doi.org/10.1080/00223891.1973.10119902)
- Fenigstein, A., Scheier, M. F., & Buss, A. H. (1975). Public and private self-consciousness: Assessment and theory. *Journal of Consulting and Clinical Psychology*, *43*, 522–527. [doi:10.1037/h0076760](https://doi.org/10.1037/h0076760)
- Fossati, P., Hevenor, S. J., Graham, S. J., Grady, C., Keightley, M. L., Craik, F., & Mayberg, H. (2003). In search of the emotional self: An fMRI study using positive and negative emotional words. *American Journal of Psychiatry*, *160*, 1938–1945. [doi:10.1176/appi.ajp.160.11.1938](https://doi.org/10.1176/appi.ajp.160.11.1938)

- Franzoi, S. L., & Brewer, L. C. (1984). The experience of self-awareness and its relation to level of self-consciousness: An experiential sampling study. *Journal of Research in Personality*, *18*, 522–540. [doi:10.1016/0092-6566\(84\)90010-2](https://doi.org/10.1016/0092-6566(84)90010-2)
- Friesen, C. K., & Kingstone, A. (1998). The eyes have it! Reflexive orienting is triggered by nonpredictive gaze. *Psychonomic Bulletin & Review*, *5*, 490–495. [doi:10.3758/BF03208827](https://doi.org/10.3758/BF03208827)
- Govern, J. M., & Marsch, L. A. (2001). Development and validation of the situational self-awareness scale. *Consciousness and Cognition*, *10*, 366–378. [doi:10.1006/ccog.2001.0506](https://doi.org/10.1006/ccog.2001.0506)
- von Grünau, M., & Anston, C. (1995). The detection of gaze direction: A stare-in-the-crowd effect. *Perception*, *24*, 1297–1313. [doi:10.1068/p241297](https://doi.org/10.1068/p241297)
- Hietanen, J. K. (1999). Does your gaze direction and head orientation shift my visual attention? *Neuroreport*, *10*, 3443–3447. [doi:10.1097/00001756-199911080-00033](https://doi.org/10.1097/00001756-199911080-00033)
- 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](https://doi.org/10.1016/j.neuropsychologia.2008.02.029)
- Hietanen, J. K., Myllyneva, A., Helminen, T. M., & Lyyra, P. (2016). The effects of genuine eye contact on visuospatial and selective attention. *Journal of Experimental Psychology: General*, *145*, 1102–1106. [doi:10.1037/xge0000199](https://doi.org/10.1037/xge0000199)
- Hull, J. G., & Levy, A. S. (1979). The organizational functions of the self: An alternative to the Duval and Wicklund Model of self-awareness. *Journal of Personality and Social Psychology*, *37*, 756–768. [doi:10.1037/0022-3514.37.5.756](https://doi.org/10.1037/0022-3514.37.5.756)
- Hull, J. G., Van Treuren, R. R., Ashford, S. J., Propsom, P., & Andrus, B. W. (1988). Self-consciousness and the processing of self-relevant information. *Journal of Personality and Social Psychology*, *54*, 452–465. [doi:10.1037/0022-3514.54.3.452](https://doi.org/10.1037/0022-3514.54.3.452)
- Itier, R. J., & Batty, M. (2009). Neural bases of eye and gaze processing: the core of social cognition. *Neuroscience & Biobehavioral Reviews*, *33*, 843–863. [doi:10.1016/j.neubiorev.2009.02.004](https://doi.org/10.1016/j.neubiorev.2009.02.004)
- Itier, R. J., Villate, C., & Ryan, J. D. (2007). Eyes always attract attention but gaze orienting is task-dependent: Evidence from eye movement monitoring. *Neuropsychologia*, *45*, 1019–1028. [doi:10.1016/j.neuropsychologia.2006.09.004](https://doi.org/10.1016/j.neuropsychologia.2006.09.004)
- Kampe, K. K., Frith, C. D., & Frith, U. (2003). “Hey John”: signals conveying communicative intention toward the self activate brain regions associated with “mentalizing,” regardless of modality. *Journal of Neuroscience*, *23*, 5258–5263.
- Karremans, J. C., Verwijmeren, T., Pronk, T. M., & Reitsma, M. (2009). Interacting with women can impair men’s cognitive functioning. *Journal of Experimental Social Psychology*, *45*, 1041–1044. [doi:10.1016/j.jesp.2009.05.004](https://doi.org/10.1016/j.jesp.2009.05.004)
- King, A. R. (1994). *The Basque language: A practical introduction*. Reno: University of Nevada Press.
- Langton, S. R., & Bruce, V. (1999). Reflexive visual orienting in response to the social attention of others. *Visual Cognition*, *6*, 541–567. [doi:10.1080/135062899394939](https://doi.org/10.1080/135062899394939)
- Mohamed, M. A. (2001). *Modern Swahili grammar*. Nairobi: East African Educational Publishers Ltd.
- Myllyneva, A., & Hietanen, J. K. (2015). There is more to eye contact than meets the eye. *Cognition*, *134*, 100–109. [doi:10.1016/j.cognition.2014.09.011](https://doi.org/10.1016/j.cognition.2014.09.011)
- Myllyneva, A., Ranta, K., & Hietanen, J. K. (2015). Psychophysiological responses to eye contact in adolescents with social anxiety disorder. *Biological Psychology*, *109*, 151–158. [doi:10.1016/j.biopsycho.2015.05.005](https://doi.org/10.1016/j.biopsycho.2015.05.005)

- Northoff, G., Heinzel, A., De Greck, M., Bormpohl, F., Dobrowolny, H., & Panksepp, J. (2006). Self-referential processing in our brain—a meta-analysis of imaging studies on the self. *Neuroimage*, *31*, 440–457. [doi:10.1016/j.neuroimage.2005.12.002](https://doi.org/10.1016/j.neuroimage.2005.12.002)
- Osberg, T. M. (1985). Order effects in the administration of personality measures: The case of the Self-Consciousness Scale. *Journal of Personality Assessment*, *49*, 536–540. [doi:10.1207/s15327752jpa4905_15](https://doi.org/10.1207/s15327752jpa4905_15)
- Palanica, A., & Itier, R. J. (2012). Attention capture by direct gaze is robust to context and task demands. *Journal of Nonverbal Behavior*, *36*, 123–134. [doi:10.1007/s10919-011-0128-z](https://doi.org/10.1007/s10919-011-0128-z)
- Paulhus, D. L., & Vazire, S. (2007). The self-report method. In R. W. Robins, R.C. Fraley, & R.F. Krueger (Eds.), *Handbook of research methods in personality psychology* (pp. 224–239). New York: Guilford Press.
- Pennebaker, J. W., & King, L. A. (1999). Linguistic styles: language use as an individual difference. *Journal of Personality and Social Psychology*, *77*, 1296–1312. [doi:10.1037/0022-3514.77.6.1296](https://doi.org/10.1037/0022-3514.77.6.1296)
- Pryor, J. B., Gibbons, F. X., Wicklund, R. A., Fazio, R. H., & Hood, R. (1977). Self-focused attention and self-report validity. *Journal of Personality*, *45*, 513–527. [doi:10.1111/j.1467-6494.1977.tb00168.x](https://doi.org/10.1111/j.1467-6494.1977.tb00168.x)
- 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. [doi:10.1016/j.ijpsycho.2011.08.006](https://doi.org/10.1016/j.ijpsycho.2011.08.006)
- Reddy, V. (2003). On being the object of attention: implications for self–other consciousness. *Trends in Cognitive Sciences*, *7*, 397–402. [doi:10.1016/S1364-6613\(03\)00191-8](https://doi.org/10.1016/S1364-6613(03)00191-8)
- Rude, S., Gortner, E. M., & Pennebaker, J. (2004). Language use of depressed and depression-vulnerable college students. *Cognition and Emotion*, *18*, 1121–1133. [doi:10.1080/02699930441000030](https://doi.org/10.1080/02699930441000030)
- Salovey, P. (1992). Mood-induced self-focused attention. *Journal of Personality and Social Psychology*, *62*, 699–707. [doi:10.1037/0022-3514.62.4.699](https://doi.org/10.1037/0022-3514.62.4.699)
- 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. [doi:10.1016/j.neuropsychologia.2005.07.017](https://doi.org/10.1016/j.neuropsychologia.2005.07.017)
- Schilbach, L., Timmermans, B., Reddy, V., Costall, A., Bente, G., Schlicht, T., & Vogeley, K. (2013). Toward a second-person neuroscience. *Behavioral and Brain Sciences*, *36*, 393–414. [doi:10.1017/S0140525X12000660](https://doi.org/10.1017/S0140525X12000660)
- Schlenker, B. R. (1980). *Impression management: The self-concept, social identity, and interpersonal relations*. Monterey, CA: Brooks/Cole.
- Senju, A., & Hasegawa, T. (2005). Direct gaze captures visuospatial attention. *Visual Cognition*, *12*, 127–144. [doi:10.1080/13506280444000157](https://doi.org/10.1080/13506280444000157)
- Senju, A., Hasegawa, T., & Tojo, Y. (2005). Does perceived direct gaze boost detection in adults and children with and without autism? The stare-in-the-crowd effect revisited. *Visual Cognition*, *12*, 1474–1496. [doi:10.1080/13506280444000797](https://doi.org/10.1080/13506280444000797)
- Senju, A., & Johnson, M. H. (2009). The eye contact effect: mechanisms and development. *Trends in Cognitive Sciences*, *13*, 127–134. [doi:10.1016/j.tics.2008.11.009](https://doi.org/10.1016/j.tics.2008.11.009)
- Silvia, P. J., & Abele, A. E. (2002). Can positive affect induce self-focused attention? Methodological and measurement issues. *Cognition and Emotion*, *16*, 845–853. [doi:10.1080/02699930143000671](https://doi.org/10.1080/02699930143000671)
- Silvia, P. J., & Eichstaedt, J. (2004). A self-novelty manipulation of self-focused attention for Internet and laboratory experiments. *Behavior Research Methods, Instruments, & Computers*, *36*, 325–330. [doi:10.3758/BF03195578](https://doi.org/10.3758/BF03195578)

- Silvia, P. J., & Gendolla, G. H. E. (2001). On introspection and self-perception: Does self-focused attention enable accurate self-knowledge? *Review of General Psychology, 5*, 241–269. [doi:10.1037/1089-2680.5.3.241](https://doi.org/10.1037/1089-2680.5.3.241)
- Snow, C., Duval, T. S., & Silvia, P. (2004). When the self stands out: Figure-ground effects on self-focused attention. *Self and Identity, 3*, 355–363. [doi:10.1080/13576500444000128](https://doi.org/10.1080/13576500444000128)
- Stephenson, B., & Wicklund, R. A. (1984). The contagion of self-focus within a dyad. *Journal of Personality and Social Psychology, 46*, 163–168. [doi:10.1037/0022-3514.46.1.163](https://doi.org/10.1037/0022-3514.46.1.163)
- Sui, J., & Humphreys, G. W. (2015). The integrative self: How self-reference integrates perception and memory. *Trends in Cognitive Sciences, 19*, 719–728. [doi:10.1016/j.tics.2015.08.015](https://doi.org/10.1016/j.tics.2015.08.015)
- Turner, R. G. (1978). Self-consciousness and speed of processing self-relevant information. *Personality and Social Psychology Bulletin, 4*, 456–460. [doi:10.1177/014616727800400320](https://doi.org/10.1177/014616727800400320)
- Wegner, D. M., & Giuliano, T. (1980). Arousal-induced attention to self. *Journal of Personality and Social Psychology, 38*, 719–726. [doi:10.1037/0022-3514.38.5.719](https://doi.org/10.1037/0022-3514.38.5.719)
- Wegner, D. M., & Giuliano, T. (1983). On sending artifact in search of artifact: Reply to McDonald, Harris, and Maher. *Journal of Personality and Social Psychology, 44*, 290–293. [doi:10.1037/0022-3514.44.2.290](https://doi.org/10.1037/0022-3514.44.2.290)
- Wicklund, R. A., & Duval, S. (1971). Opinion change and performance facilitation as a result of objective self-awareness. *Journal of Experimental Social Psychology, 7*, 319–342. [doi:10.1016/0022-1031\(71\)90032-1](https://doi.org/10.1016/0022-1031(71)90032-1)
- Wisman, A., Heflick, N., & Goldenberg, J. L. (2015). The great escape: The role of self-esteem and self-related cognition in terror management. *Journal of Experimental Social Psychology, 60*, 121–132. [doi:10.1016/j.jesp.2015.05.006](https://doi.org/10.1016/j.jesp.2015.05.006)

Footnotes

¹The control experiment included 40 participants (mean age = 23.9 years, $SD = 4.3$, 32 females). All participants passed the manipulation check questions regarding the perception of gaze direction and the comprehension of the languages. Two participants were excluded from the analysis because they guessed what the linguistic tasks were about. The use of first-person singular pronouns did not differ between the two gaze groups in either of the two tasks. In the foreign-language task, the direct gaze group gave 1.47 ($SD = 0.77$) and the averted gaze group 2.05 first-person responses ($SD = 1.35$), $t(36) = 1.62$, $p = .11$, $d = 0.33$. In the LIF, the direct gaze and averted gaze groups gave 4.21 ($SD = 1.18$) and 4.58 ($SD = 1.47$) first-person responses, respectively, $t(36) = 0.34$, $p = .40$, $d = 0.28$. The SSAS ratings of public self-awareness [$t(36) = 0.00$, $p = 1.00$, $d = 0.00$], private self-awareness [$t(36) = 0.28$, $p = .78$, $d = 0.09$], or awareness of surroundings [$t(36) = 0.61$, $p = .66$, $d = 0.15$] did not differ between the two groups.

Figure captions

Figure 1. Still images extracted from the video clips to illustrate the face stimuli used in Experiment 1.

Figure 2. Mean numbers (and standard errors) of responses in each grammatical person in the foreign-language task by participants in the direct gaze and averted gaze groups, in Experiment 1. Grammatical persons: 1SG = first singular, 2SG = second singular, 3SG = third singular, 1PL = first plural, 2PL = second plural, 3PL = third plural.

Figure 3. Illustration of the arrangement in Experiment 2. The participant is looking at the model person through the transparent LC shutter. The computer screen and the keyboard are placed in front of the LC shutter panel.

Figure 4. Mean numbers (and standard errors) of responses in each grammatical person in the foreign-language task by participants in the direct gaze and averted gaze groups, in Experiment 2. Grammatical persons: 1SG = first singular, 2SG = second singular, 3SG = third singular, 1PL = first plural, 2PL = second plural, 3PL = third plural.

* $p < .05$

† $p < .10$

Figure 5. Mean numbers (and standard errors) of responses in each grammatical person in the Linguistic Implications Form by participants in the direct gaze and averted gaze groups, in Experiment 2. Grammatical persons: 1SG = first singular, 3SG = third singular, 1PL = first plural, 3PL = third plural.

* $p < .05$

† $p < .10$

Table 1
Mean Scores and Standard Deviations on Situational Self-Awareness Scale by Gaze Group

Gaze group	Public		Private		Surroundings	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Direct	3.38	1.74	3.62	1.01	3.02	1.06
Averted	2.65	1.38	4.05	1.03	4.11	1.25

Note. A statistically significant ($p < .05$) difference between the gaze groups is indicated by bolding.

Appendix A
Foreign-language task (English translation)

In the following task, sentences in foreign languages are presented. The task is to guess which Finnish [English] word corresponds to the underlined word. The underlined words are person pronouns. Choose the one of the six different alternatives you suppose to correspond to the underlined word.

The sentence task investigates linguistic intuition. Thus, the purpose is not to deduce the correct answer from the structure of the sentence or the target words, but to intuitively guess the possibly correct alternative.

1. Bibi anasoma kitabu. (I, you, he/she, we, you, they)
2. Nakaa na dada yangu. (my, your, his/her, our, your, their)
3. Yeye ancheza mpira wa kikapu ingawa ni mfupi. (I, you, he/she, we, you, they)
4. Atakwenda kwa kaka yake. (my, your, his/her, our, your, their)
5. Ninyi hamli nyama. (I, you, he/she, we, you, they)
6. Ulipikia chakula kwa sisi. (me, you, him/her, us, you, them)
7. Labda wao watarudi mwaka keshoi. (I, you, he/she, we, you, they)
8. Wale ni wakulima na hawa ni wapagazi. (I, you, he/she, we, you, they)
9. Nitakuazima kila kitu ila gari langu. (my, your, his/her, our, your, their)
10. Yule bwana alikunywa bia hii. (I, you, he/she, we, you, they)
11. Gero lanera joan da. (I, you, he/she, we, you, they)
12. Bihar zure etxetik pasa behar dut. (my, your, his/her, our, your, their)
13. Gu fruta saltzen ari gara. (I, you, he/she, we, you, they)
14. Zuei arropa berriak gustatzen zaizkizue. (my, your, his/her, our, your, their)
15. Sei t'erdietako autobusean joango gara. (I, you, he/she, we, you, they)
16. Zuk nere lagunak ezagutzen dituzu. (I, you, he/she, we, you, they)
17. Haiek lore asko dituzte. (I have, you have, he/she has, we have, you have, they have)
18. Orain hona etorri naiz bizitzera. (I, you, he/she, we, you, they)
19. Gure haurrak ez dira etorriko. (my, your, his/her, our, your, their)
20. Ez zuen alde egingo. (I, you, he/she, we, you, they)

Appendix B
Linguistic Implications Form (English translation)

In the psychological research of language, it has been found that many single words are redundant for the meaning of the whole sentence. In this task, the significance of pronouns for the comprehension of a sentence is examined.

Finnish [English] sentences from various situations are presented in the task. In each sentence, one pronoun is replaced with a blank. In each task there are three alternatives, all of which fit the sentence grammatically. The task is to choose from the alternatives the pronoun that you think would most probably fit the context. Choose the pronoun that makes most sense to you. If you are uncertain of the answer, you can guess.

1. Myyjä yritti taivutella _____ ostamaan sanakirjan. (minua, häntä, meitä)
The salesman tried to persuade _____ to buy a dictionary. (me, her, us)
2. Meteli alkoi häiritä _____ ennen pitkää. (meitä, heitä, minua)
The noise got to _____ before long. (us, them, me)
3. Älä puhu _____ noin, se ei ole reilua. (hänelle, meille, minulle)
Don't speak to _____ like that, it is not fair. (him, us, me)
4. Kaikki saivat hylätyn kokeesta, paitsi _____. (minä, me, hän)
Everyone failed the test, except for _____. (me, us, her)
5. _____ meni niin paljon aikaa suunnitteluun, että työ ei valmistunut ajoissa.
(heillä, meillä, minulla)
_____ spent so much time planning that the work was not finished in time. (they, we, I)
6. Rankkasade kasteli _____ kauttaaltaan. (heidät, minut, hänet)
Rainstorm soaked _____ through. (them, me, him)
7. Joku pysäytti _____ kysyäkseen reittiä stadionille. (heidät, minut, meidät)
Someone stopped _____ to ask for directions to the stadium. (them, me, us)
8. Kassavirkailija velotti _____ liian vähän ostoksista. (häneltä, meiltä, minulta)
The cashier charged _____ too little for the groceries. (her, us, me)
9. Hyttyset eivät edes häirinneet _____. (häntä, meitä, minua)
The mosquitoes didn't even bother _____. (him, us, me)
10. Päivällinen odotti _____ pöydässä. (häntä, minua, meitä)
Dinner was waiting for _____ on the table. (him, me, us)