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**Title:**

Disentangling Relations between Attention to the Eyes and Empathy

**Running title**: Eye-looking and empathy

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**Disentangling Relations Between Attention to the Eyes and Empathy**

Abstract

Social interactions involve an interplay between lower-level social perceptual biases and higher-level cognition and affect. One particularly important building block of social interaction is attention to others’ eyes. Previous research has found links between individual differences in eye-looking and complex social capacities, including empathy. Such research, however, has predominately used non-naturalistic stimuli and has not addressed the directional relation between these processes. In this study, a large sample of adults (N=164) were eye-tracked while watching naturalistic videos of complex social interactions. Additionally, participants completed measures of empathy and spontaneous and explicit mentalizing. To disentangle relations between variables, participants were assigned to one of three conditions: first, a baseline condition with no instructions; second, an eye-looking condition, where participants were told to look at the eyes of the characters; and, third, an empathy condition, where participants were told to become involved with the characters’ thoughts and feelings. In the baseline condition, we found no relation between mentalizing and eye-looking, yet found that eye-looking and empathy were positively related. Inducing one behavior, however, did not affect the other. That is, participants in the eye-looking condition showed increased eye-looking but not consistently increased empathy, and participants in the empathy condition scored more highly on empathy and mentalizing measures with no corresponding changes in eye-looking. These results suggest that the relations between visual attention and social cognition are complex and difficult to manipulate. Future research should examine the developmental links between these behaviors, as understanding their emergence has implications for social disabilities and interventions.

**Keywords**: empathy; eye-tracking; social cognition; social attention; mentalizing

**Data:** Data and stimuli are available for viewing at < https://osf.io/8vstm/>

**Introduction**

Social interaction involves dynamic interplay between lower-level social attention and higher-level social cognitive and affective processes. One core perceptual bias that scaffolds more complex socialization is attention to the eyes of others (Shultz et al., 2018). The speed and frequency with which humans orient toward others’ eyes is driven not simply by low-level saliency, but by the eyes’ ability to provide dynamic social information (Birmingham, Bischof, & Kingstone, 2009), including information about others’ intentions and emotions (Emery, 2000). Attesting to the importance of eye-looking, disorders associated with social disability are frequently indexed by atypical eye-looking (Klin & Jones, 2009), which may play a causal role in higher-order social difficulties (Moriuchi, Klin, & Jones, 2016; Shultz et al., 2018). This link between basic attention to the eyes and more complex social processes may also be bidirectional, at least by adulthood; attributing mental states to an agent increases gaze following (Teufel, Fletcher, & Davis, 2010). In spite of the core role of eye-looking in human social experience, typical adults do vary in how frequently they look at others’ eyes (e.g., Davis et al., 2014; Freeth, Foulsham, & Kingstone, 2013; Hessels, Holleman, Cornelissen, Hooge, & Kemner, 2018). Understanding how individual differences in eye-looking relate to more complex social behaviors can help illuminate the interchange between perception and understanding that underlies human social life.

Although social cognition is multifaceted, one core component is empathy (Saxe, 2006). The literature contains varied definitions of empathy (cf. Cameron, 2018), but, at its core, empathy involves connecting with the internal states of another (Decety & Lamm, 2006). This connection with another involves both affective and cognitive components, which can include including feeling another’s emotions and understanding someone’s emotional and cognitive states (Decety & Lamm, 2006). Low levels of empathy are related to host of maladaptive social behaviors, including bullying, poor relationships, and aggression (Stern & Cassidy, 2018), whereas high empathy has been linked to altruism and other prosocial behaviors (Bloom, 2017). Thus, understanding variability in empathy has important implications for social outcomes in children and adults.

Various candidate mechanisms have been proposed to explain individual differences in empathy, including neural differences (e.g., Banissy, Kanai, Wlash, & Rees, 2012; Hein et al., 2010) and attachment style or temperament (e.g., Abramson et al., in press; Ungerer, Dolby, Waters, Barnett, Kelk, & Lewin, 1990; see Stern & Cassidy, 2018 for review). Another potential mechanism explaining empathy variability is differences in social perception. Even typical adults show great variation in emotion recognition (Hamann & Canli, 2004), and individuals with higher levels of empathy tend to score more highly on measures of emotion recognition (e.g., Besel & Yuille, 2010; Gery et al., 2009). Additionally, adults with higher levels of empathy show increased bias to look at social versus non-social stimuli (Hedger et al., 2018), indicating potential connections between social perceptual ability and empathy.

Studies finding links between social perceptual skill and empathy dovetail with other research showing relations between social perception and social cognition. For example, biological motion perception (i.e., the perception of point-light human figures) is related to mentalizing (i.e., theory of mind), but not to performance on non-social cognitive tasks, in studies of preschoolers, school-aged children, and adults (He et al., in press; Miller & Saygin, 2013; Rice et al., 2016). Such point-light stimuli, however, are not directly encountered in daily life. Examining visual attention to naturalistic stimuli allows more proximal insight into real-world social behaviors.

Although real-world social perception is multifaceted, attention to the eyes may be an important mechanism explaining variability in higher-order social processes such as mentalizing and empathy. Sensitivity to eye contact is early-emerging (Farroni, Csibra, Simion, & Johnson, 2002), evolutionarily-conserved (Mosher, Zimmerman, & Gothard, 2014), susceptible to pharmacological interventions (Auyeung et al., 2015), and has been linked to specific neural mechanisms in humans and non-human primates (Mosher, Zimmerman, & Gothard, 2014; Naples et al., 2017). In eye-tracking studies of visual attention, attention toward the eyes of others has been extensively investigated in autism (e.g., Jones & Klin, 2013; McPartland et al., 2011; Moruichi et al., 2017; see Guillon et al., 2014 and Hamner & Vivanti, 2019 for reviews) and eye-looking is related to social anxiety and autistic-like traits (Hessels, Holleman, Cornelissen, Hooge, & Kemner, 2018; Frischen, 2007), and emotion recognition (e.g., Bal et al., 2010; Dadds et al., 2006) in the general population. As these same traits and abilities have been linked to empathy, the bias to look at others’ eyes may be a basic social attentional mechanism influencing empathy.

In spite of this potential link between understanding others and looking others in the eye, only one study has directly measured the relation between empathy and eye-looking. Cowan and colleagues (2014) had fifty-nine adult participants watch two brief videos of a single actor talking to the camera in either an emotional (i.e., sad) or unemotional context and measured how the amount of eye fixations related to self-reported empathy. Results indicated that, for both conditions, eye-looking was related to cognitive empathy, specifically a measure of the tendency to take another’s perspective. Researchers termed this increased looking at the eyes “empathic gaze,” and suggested that variations in empathic gaze could explain variations in empathy. The study, however, was unable to dissociate whether eye-looking spurred increased empathy or whether individuals who scored higher on empathy were more likely to seek out social information from the eyes of others. Additionally, researchers did not include any other measures of social cognition in their assessment, making it difficult to disentangle whether the effects of increased eye-looking are specific to empathy or generalize to a broader set of social cognitive capacities. They also did not examine whether effects were specific to the eye-region or applied to the face region (e.g., mouth) more generally nor did they examine scenes involving more than one character engaged in interaction.

Thus, the goals of the current study were to both replicate and extend prior empathy and visual attention research. Specifically, we first aimed to replicate the relation between eye-looking and empathy using more complex, dynamic video stimuli in a larger sample. We also included additional eye-tracking and social cognition measures, to determine the specificity of this hypothesized relation. Given past research on the special role of the eyes in empathy in particular, we hypothesized that eye-looking would relate to empathy but not to other social cognitive measures.

Beyond this replication and extension, we collected additional data aimed to begin disentangling the relationship between eye-looking and empathy. Specifically, in addition to a baseline replication condition in which participants were given no particular instructions, we next collected data from two conditions in which participants were instructed to either pay attention to the eyes or to empathize with the thoughts and feelings of the individuals in the videos. We hypothesized that, by adulthood, the link between empathy and eye-looking would be bidirectional. That is, telling individuals to focus on the thoughts and feelings of individuals in the video would increase eye-looking compared to the baseline conditions and, given evidence that eye-looking plays a causal role in emotion recognition (e.g., Dadds et al., 2006), telling individuals to focus on the eyes would increase empathic responses. Evaluating this hypothesis has theoretical implications for debates about the relation between social perception and social cognition (e.g., Happe, Cook, & Bird, 2017) and practical implications for clinicians interested in social attention as both a target and outcome of interventions that are also designed to influence higher-order social processes (e.g., Fletcher-Watson & Hampton, 2018; Krstovska-Guerrero & Jones, 2016; Murias et al., 2018).

**Method**

**Participants**

183 adult university students (aged: 18-30, *M=*20.33, *SD*=3.73; 82 males) participated in this study in return for course credit or extra credit. Participants were native speakers of English with normal or corrected-to-normal vision and hearing visual abilities. All procedures were approved by the Texas State University Institutional Review Board and participants completed a 90-minute session in a laboratory setting. Participants also completed additional measures of social cognition collected for a separate project and these data were not analyzed as part of this project or reported on here.

**Eye-tracking Assessments**

*Eye-tracking Procedure & Stimuli*

Participants watched two silent clips from movies on a computer screen while their eye-movements were tracked by an infrared eye-tracking system (SMI REDn). Participants were viewed two naturalistic social scenes from two different movies (178 s and 130 s; available at http://www.movieclips.com; Rice & Redcay, 2015). In the first clip, a woman is breaking into a home while viewed by her two accomplices when the owner arrives back and discovers her. In the second, a woman and a man are returning home from a date while, unbeknownst to him, her friends are spying on them. Thus, both clips presented socially-rich scenes containing mental state and emotional information. Both of the clips were muted to prevent dependence on language to understand the character’s internal states. This is consistent with past administration of this paradigm and builds on work from individuals with social disabilities suggesting that dependence on language can lead to decreased, atypical levels of eye fixation (Klin et al., 2003); ensuring that non-verbal cues were the primary route to social understanding allowed us to best assess the meaning of individual differences in eye fixations. We used these clips given their previous use in studies of spontaneous social cognition which documented the clips’ ability to generate variability in participant reactions (Rice & Redcay, 2015).

When viewing the clips, participants sat 25 inches (63.5 cm) from a 22-inch (55.9-cm) computer monitor that had the eye tracker mounted to the bottom on the monitor. This setup allowed for free viewing by participants without using a chin rest (to allow for closer approximation to real-world situations). Videos were presented in an aspect ratio consistent with their release, such that the first clip took roughly 63% of the screen and the second video took up roughly 86.5% of the screen. Eye-tracking data was collected at 60Hz and a five-point calibration was performed at the beginning of the session followed by a four-point validation before each of the two clips. If the participant’s average deviation from the validation points was above 1 degree, calibration was repeated a maximum of four times. In cases where accurate calibration could not be achieved, or if videos had to be restarted midway through data collection due to computer error, participants completed the full paradigm, but their eye-tracking data were not analyzed. In total, nine participants were excluded due to failure to achieve calibration and validation levels necessary for data to be analyzed. An additional five were excluded due to technical issues with eye-tracker. Clips were programmed to alternate between starting so that roughly 50% of participants saw movie clip one first and 50% of participants saw movie clip two first. Only eye tracking data from participants’ right eyes were used in later analyses.

*Priming Conditions*

Before watching the clips, participants were assigned to one of three conditions: (1) told simply to watch the silent videos (baseline condition), (2) to pay close attention to the eyes of the characters (eye condition), or (3) to pay close attention to the thoughts and feelings of the characters and to put themselves in the mindset of the characters (empathy condition). We first collected data for the baseline condition in order to establish the replicability of previous findings (i.e., Cowan, Vanman & Nielsen, 2014). We targeted a sample of 67 individuals, which would have 80% power to detect correlations of approximately r=.33, a magnitude selected based on the midpoint of the strength of the correlations between eye-looking and empathy in the original study by Cowan and colleagues (2014). We deliberately overscheduled participants given the possibility that some participants would not yield usable eye-tracking data and stopped data collection after all scheduled participants (n=80) completed the session, yielding 69 participants with usable empathy and eye-tracking data.

After collecting and analyzing baseline data, we next collected data for the two instructional conditions (i.e., eye condition and empathy condition). Thus, data were collected in two phases. For this second phase, we randomly assigned participants to one of the two instructional conditions when they arrived for their session. For all participants, the eye-tracking task was the first one completed, ensuring no priming from other social cognitive instruments included later in the experimental session. We again overscheduled participants with the goal of getting 48 participants in each condition. Data collection was stopped when we believed there to be 48 usable participants in each condition, although, due to an error in making this assessment, one condition only had 47 usable participants. Given our interest in how each instructional condition would influence empathy and eye-looking compared to the baseline condition, this sample size yielded 80% power to detect moderate differences (*d*=.53) in pairwise comparisons with baseline (*n*=69; see **Supplemental Materials** for full details on power analyses). This moderate effect size is consistent with the limited number of studies which have attempted to experimentally induce changes in self-reported empathy (e.g., an average Cohen’s *d* of approximately .67 across four studies in Woltin et al., 2011). One limitation of the current study that our primed samples were underpowered, in part due to the between-participants design, limiting our ability to detect correlations between eye-looking and empathy or to conduct extensive mediation or moderation analyses.

In total, 54 participants (27 males) completed the empathy condition and 49 participants (20 males) completed the eye condition. Nine participants (5 from baseline, 2 from the eye condition, and 4 from the empathy condition) were excluded due to a failure to collect well-calibrated eye-tracking data, 5 participants (4 from baseline and 1 from the empathy condition) were excluded due to a technical issue presenting video clips, 2 participants from the baseline condition were excluded due to failure to complete the empathy measure, and 1 participant (empathy condition) was excluded due falling outside the age range of the study’s sample (18-30y). Thus, the final sample included in the study was 69 participants (31 male) from the baseline, no-instruction condition, 47 participants (20 male) from the eye condition, and 48 participants (22 male) from the empathy condition.

*Analysis*

SMI BeeGaze v. 3.7.40 software was used to draw ovoid areas of interest (AOIs) on the eye and mouth regions of the four main characters in the first film clips and the three main characters in the second film clip. Background characters were not included due to the fact that they were often obscured or out of focus, making it difficult to draw AOIs or interpret eye-looking.

Two independent research assistants drew the AOIs, manually adjusting AOIs for each frame of the video when necessitated by the changing positions of the characters. AOI location was verified by the lead author before any participant data was analyzed. The software automatically-calculated percent dwell time on eye and mouth AOIs and we extracted this data separately for both video clips. Because the percentage of time that the main characters’ eye and mouth AOI regions appeared on the screen varied across the two clips, we created composite eye- and mouth-looking variables. Specifically, we converted eye and mouth dwell time percentages to z-scores for each clip and then averaged the z-scores together to create a standardized eye- and mouth-looking score for each participant that collapsed across clips.

**Behavioral Assessments**

Participants completed two tasks designed to assess social cognitive capabilities: the Spontaneous Theory of Mind Protocol (STOMP) (Rice & Redcay, 2015) and the Reading Mind in the Eyes (Baron-Cohen, et al., 2001). The STOMP measured the spontaneous tendency to consider the internal states (thoughts, desires, emotions) of others from dynamic video stimuli and the Mind in the Eyes measured the explicit ability to determine another’s mental state based on a photograph of the eye region.

For the STOMP, after viewing each movie clip used in the eye-tracking analysis, participants were asked to freely describe the scene. Participants typed their responses and were asked to type roughly 7–10 lines, consistent with previous administrations of the paradigm (Rice & Redcay, 2015). These descriptions were then coded into five categories: physical description, physical inference, emotion, goal/intention, and belief state (Rice & Redcay, 2015). Data were scored by two independent coders who had high levels of reliability (Krippendorf’s alpha=.78) across all five categories, with reliability calculated from a subset of 24% of baseline condition participants. In addition to these more specific categories, we computed the number of internal statements (emotion, goal/intention, belief states) and external statements (physical inference and physical description), and for these categories, interrater reliability was .89. These composite values of internal and external statements were used to calculate a STOMP index for each participant: the percentage of total statements which referred to internal states. Higher values indicated a greater likelihood to spontaneously consider the internal states of the characters in the video.

The Reading Mind in the Eyes assessment was composed of 36 gray-scale photos of people that had been cropped so that only the eye area was visible to the participant (Baron-Cohen, et al., 2001). Participants were instructed to select which of four answer choices best described the mental state of the person in the picture (e.g., “thinking about something”). Participants earned a point for each correct answer. One baseline participant and two eye condition participants failed to provide data on the STOMP or Mind in the Eyes due to experimenter error and two empathy condition participants failed to provide data on the Mind in the Eyes due to experimenter error.

Participants also completed the Interpersonal Reactivity Index (IRI) which is a frequently used 28-item questionnaire used to assess empathy (Davis, 1980; 1983). In addition to assessing global empathy, the IRI consists of four 7-item subscales, each measuring its own dimension of empathy: Perspective Taking (PT) (e.g., “I try to look at everybody's side of a disagreement before I make a decision”), Empathic Concern (EC) (e.g., “I often have tender, concerned feelings for people less fortunate than me”), Fantasy Seeking (FS) (e.g., “After seeing a play or movie, I have felt as though I were one of the characters”) and Personal Distress (PD) (e.g., “When I see someone who badly needs help in an emergency, I go to pieces”) (Davis, 1980; 1983). Each item was scored on a 0-4 scale and subscale scores were the sum of all items in that subscale. We averaged these subscale scores together to create a global empathy measure. This measure is identical to the empathy measured used by Cowan and colleagues (2014).

The IRI is often considered a measure of trait empathy that would be invariant to context, but studies involving priming and other brief interventions (e.g., mindfulness) have found that scores on the assessment can be influenced by experimental manipulations (Moll, Frolic, & Key, 2015; Shapiro, Brown, Thorsesen, & Plante, 2010; Woltin, Corneille, Yzerbyt, & Forster, 2011). These findings are consistent with research from other domains indicating that state and context can influence self-report measures of ostensibly trait-like constructs (e.g., Griens et al., 2002; Fishbain et al., 2006, Karsten et al., 2012; Nery et al., 2009). We were thus interested both in the relation between IRI scores and general attention to the eyes in our baseline condition and in whether our experimental manipulations (i.e., telling participants to take an “empathic stance” or to focus on the eyes over several minutes of naturalistic viewing) influenced participant reports of their own empathic tendencies. This approach is consistent with the theoretical perspective that empathy interacts with context to predict real-world responses (reviewed in Nezlek et al., 2007).

As a follow-up exploratory analysis designed to more precisely titrate situational empathic responses toward the film clips specifically, participants in the two instructional conditions (i.e., eye and empathy conditions) also completed a questionnaire that assessed their feelings toward the characters in movies (e.g., “I did not feel very sorry for Character A.”). These items were designed to map onto the subscales in the original IRI, consistent with other studies that have modified the IRI to measure empathy in specific contexts (e.g., Cargile, 2016; Nomura & Akai, 2012). The addition of this scale allowed us to test more directly whether increased eye-looking resulted in increased empathy in response to the movie in particular or instead in more globally-reported increases in empathic responsivity (i.e., the standard IRI). One participant from the eye condition and one participant from the empathy condition failed to complete the movie IRI due to experimenter error.

**Data Analyses**

After examining descriptive statistics, we conducted two separate sets of analyses focused on our two main research questions: first, whether we could reproduce past relations between eye-looking and empathy, and second, whether manipulating eye-looking altered empathy, and vice versa. To address our first question and replicate and extend past research on empathy and eye-looking, we conducted a bivariate correlation analysis between eye-looking and empathy in the baseline condition (e.g., when participants were simply instructed to watch the videos). A priori, we hypothesized that we would find relations for global empathy. We then conducted follow-up analyses with the specific IRI subscales, as Cowan and colleagues (2014) found the strongest correlations between eye-looking and the empathic concern and perspective taking subscales. In order to determine the specificity of these effects, we conducted additional exploratory analyses examining whether there was a correlation between eye-looking and other measures of social cognition (i.e., STOMP and Mind in the Eyes), as well as analyses examining relations between our various social cognition measures.

After examining results for our baseline condition, we next addressed our second main research question using our explicit instructional conditions. Our goal for these analyses was to attempt to identify mechanisms that could account for results in the first set of analyses. We hypothesized that instructing participants to pay attention to the eyes would increase discussion of the character’s thoughts and feelings on the STOMP and empathy as measured by the IRI and that instructing participants to take an empathic stance would increase eye-looking, suggesting a bidirectional relation between these variables. In addition to these main analyses, we also conducted exploratory analyses examining relations between eye-looking and empathy within our experimental manipulations and empathic responses specific to the video stimuli. All analyses were conducted using SPSS 25.0. We converted our measures to z-scores using averaged values and standard deviations based on data for all participants. Full correlation tables between variables are available in **Supplemental Materials**.

**Results**

**Descriptive Statistics**

We began by examining our baseline condition. Behavioral measures and eye-tracking indices produced large variability (**Table 1;** see **Supplemental Materials** for descriptive statistics broken down by condition). For the first clip, the eyes AOIs corresponded to only 3.8% of the video on the screen, but participants looked at the eye region 19.6% of the time, and results were similar for the second clip (1.9% of the screen versus 11.3% of dwell time). The mouth, in contrast, did not capture as much attention. For the first clip, the mouth AOIs corresponded to 2.7% of video on the screen, but participants looked at the mouth region 5.2% of the time, and outcomes were comparable for the second clip (1.6% of the screen and 1.6% of dwell time). Eye-looking in the first clip was highly correlated with eye-looking in the second clip (*r*(162)= .521, *p* <.001), and this was also the case for mouth looking (*r*(162)= .692, *p* < .001), suggesting stability in individual differences on this variable beyond movie-specific characteristics. Collapsing across clips, eye-looking was inversely related to mouth looking (*r*(162)= -.674, *p* < .001). In order to more easily interpret our results, we computed standardized eye-looking and mouth-looking values for each participant. For each clip, we converted dwell percentage on the eye and mouth to z-scores based on the average and standard deviation of the full sample. We then averaged across clips to create a standardized eye-looking and mouth-looking value for each participant.

We next examined age and gender effects for visual attention (eye-looking and mouth-looking), empathy (IRI), and social cognitive ability (STOMP and Mind in the Eyes) and found no significant correlations between these variables and age. Consistent with prior literature, IRI scores were significantly higher for females than males (*t*(162)= -3.81, *p* < .001, Cohen’s *d*=.59), but since our groups (baseline, the eye condition, the empathy condition) were all matched on gender (*X*2(2, N=164)= .11, p=.95, Cramer’s V=.026) and gender did not have significant effects on any of our outcome variables (eye-looking or social cognitive capacities), results for age and both genders were combined for all subsequent analyses.

**Replicating relations between eye-looking and empathy**

In our first main experimental question, we examined the baseline condition, in which participants received no explicit task instructions. Eye-looking was positively correlated with IRI global empathy (r(67)=.279, *p*= .02, **Figure 1**). The Perspective Taking subscale of the IRI showed the strongest correlation with eye-looking (r(67)= .273, *p*= .023), although this was not significantly stronger than the correlations with the other subscales (EC: *r*(67)=.16; PD: *r*(67)=.19; FS: *r*(67)=.13, all *p*s>.1). In contrast, additional follow-up analyses revealed that eye-looking was not related to scores on either social cognitive assessment (STOMP or Reading the Mind in the Eyes; *r*s<.1), which in turn were not related to each other (*r*(61)=-.022, *p*=.87). Global empathy, however, was positively correlated with spontaneous social cognition (STOMP Index; *r*(64)= .291, *p*= .018), with the strongest correlation emerging for the empathic concern subscale (*r*(64)=.347, *p*<.01), although this was again not significantly greater than the correlations for the other subscales (PT: *r*(67)=.18; PD: *r*(67)=.04; FS: *r*(67)=.24, all ps>.05). Explicit social cognition (Mind in the Eyes), in contrast, was not related to global empathy (*r*(64)=.05, *p*=.72). Mouth-looking was not related to global empathy (*r*(67)=-.16, *p*=.18) or either social cognitive task (rs<.1).

**Establishing directional links between empathy & eye-looking**

To address our second main experimental question, we used MANOVA in order to simultaneously determine the effect of condition (eye, empathy, baseline) on our three main social cognitive and social perceptual variables of interest (Global IRI, STOMP Index, and eye-looking). Condition significantly influenced these outcome measures (*F*(6, 310)=3.88, *p*<.001, Pillai’s Trace=.14, partial eta^2=.07). We next conducted a series of targeted follow-up analyses in order to more fully probe these effects and test our a priori hypotheses about whether manipulating eye-looking could influence empathy and vice versa.

First, to establish that our explicit instructional conditions altered participant behavior, we conducted pairwise tests to compare them to baseline performance. The eye condition significantly increased eye-looking compared to the baseline condition (**Figure 2**), suggesting that participants understood and followed instructions. The empathy condition significantly increased the proportion of internal statements used when describing the videos (i.e., STOMP Index), indicating that, as instructed, participants were paying more attention to the thoughts and feelings of the characters. Interestingly, the participants in the empathy condition also scored more highly on global IRI empathy compared to the baseline condition (t(115)=2.287, p=.024, Cohen’s *d*=.43), suggesting that contextual effects are able to influence IRI scores.

Given that our instructions were effective in manipulating the directly targeted behavior, we next examined whether increased attention to thoughts and feelings (i.e., the empathy condition) increased eye-looking. We examined all three conditions (i.e., baseline, the empathy condition or the eye condition) in a one-way ANOVA and found that although condition had a significant effect on the amount of eye-looking (*F*(2, 161) = 4.894, *p*= .009, η2=.057) this was entirely driven by increased eye-looking in the eye condition. That is, post-hoc pairwise comparisons indicated that participants in the empathy condition showed no increase in eye-looking compared to baseline participants (t(115)=.89, p=.38, Cohen’s *d*=.17) and actually displayed significantly decreased eye-looking compared to the eye condition (t(93)=-3.14, p=.002, Cohen’s *d*=.64).

We next examined how increased attention to the characters’ eyes influenced empathy and performance on social cognitive tasks. In particular, we were interested in whether increased attention to the eye-region would increase participant’s spontaneous description of the thoughts and feelings of the characters in the videos. In a one-way ANOVA, there was a significant effect of condition on the percentage of internal statements used when describing the video (i.e., STOMP Index; *F*(2, 156) = 5.42, *p*= .005, η2=.065), but this was driven by the empathy condition. Despite looking more at the eye region than baseline participants, post-hoc pairwise comparisons indicated that eye condition participants were no more likely to describe the characters’ thoughts and feelings (t(111)=.77, p=.44, Cohen’s *d*=.15) and showed decreased focus on thoughts and feelings compared to empathy condition participants (t(91)=-3.08, p=.003, Cohen’s *d*=.64). Beyond movie-specific responses, there was a marginal effect of condition on global IRI scores (*F*(2, 163) = 2.68, *p*= .07, η2=.032), but this was driven by the empathy condition as there was no difference between the eye condition and baseline (*t*(114)=1.53, p=.13, Cohen’s *d*=.29).

In order to ensure the robustness of these null results in addressing one of our main experimental questions, we conducted additional follow-up Bayesian analyses in order to quantify support for our findings (e.g., that boosting one aspect of the eye-looking and empathy connection did not boost the other; Wetzels & Wagenmakers, 2012). As compared to baseline, the eye condition did not increase scores on the STOMP index nor did the empathy condition increase eye-looking. This evidence for the null was 4-5 times stronger than evidence for the alternative, a level that is considered substantial according to existing interpretive guidelines (Jeffreys, 1961; Wetzels and Wagenmakers, 2012; see **Supplemental Materials** for full Bayesian analyses). Effects were weaker but still in favor of the null for the comparison of global IRI scores between baseline and eye condition (BF=2.28), such that the increased eye-looking observed in this condition did not boost global IRI scores compared to baseline.

In exploratory analyses, we found that contrary to findings for the baseline condition, within the two instructional conditions, the relation between eye-looking and IRI scores was not significant (eye condition *r*(47)=.187, *p*=.21; empathy condition *r*(48)=.108, *p*=.47). There was no effect of condition on Mind in the Eyes scores (F<1).

For our two instructional conditions, we also included an additional follow-up measure in which we asked about empathic responses to the movie clips in particular. Comparing the two groups on their empathic responses to the movie clips specifically, the empathy condition group scored significantly higher than the eye condition group on the fantasy seeking subscale (*t*(91)= 7.77, *p* < .001, Cohen’s *d*=1.62), although the eye condition group scored higher on the personal distress subscale (*t*(91)= -4.87, *p* < .001, Cohen’s *d*=1.01). There were no significant differences between groups on the other two subscales. In our final exploratory analysis, we investigated a model treating Global IRI scores as an independent variable in order to determine if it interacted with condition when predicting eye-looking, STOMP performance, and movie-specific empathic responding, but we did not find evidence for an interaction between self-reported global empathy and condition for any of these responses (see **Supplemental Materials** for full details on analyses).

**Discussion**

The current study examined the relation between empathy and attentional bias toward the eye region. Specifically, we monitored adult participants’ eye-looking when watching dynamic, naturalistic, socially-complex scenes, and measured empathy on a questionnaire assessing everyday empathic tendencies. Our findings replicate past research by Cowan and colleagues (2014) finding significant positive correlations between empathy measures and the tendency to look at others’ eyes. We also extend this previous study—which used videotaped stimuli of a single person talking to the camera—by finding the same results using naturalistic and complex social scenes. We further found that this relation with eye-looking was specific to empathy and did not extend to measures of mentalizing. Additionally, we attempted to disentangle the relationship between empathy and eye-looking. We instructed participants to focus on either looking at the characters’ eyes or on empathizing with the characters when watching the naturalistic videos and examined whether these instructions changed other social cognitive or social perceptual behaviors. We found that although explicitly telling participants to pay attention to the eyes increased eye-looking, it did not increase empathy or the likelihood of spontaneously discussing thoughts and feelings of the characters. Similarly, telling participants to put themselves in the mindset of the thoughts and feelings of the characters did increase measures of empathy and the tendency to spontaneously discuss the thoughts and feelings of the characters, but did not increase eye-looking. Although findings should be replicated in varied contexts, these results suggest the relations between social perception and social cognition are complex and not easily manipulated in a laboratory setting.

 Our results extend past research (Cowan et al., 2014) by suggesting that even when multiple characters are interacting in a complex scene, the relation between empathy and attentional bias to the eyes still holds. Interestingly, we found no relation between mouth-looking and empathy, suggesting that this effect is specific to eye-looking and not to general attentional bias toward the face. This may be in part due to the fact that we deliberately used stimuli without verbal content, to ensure that verbal information alone could not provide a route to social understanding (cf. Klin et al., 2003). Future research should investigate whether the addition of linguistic information, especially verbal cues that belie nonverbal cues, alters the relation between mouth-looking and empathy. We also examined the total amount of eye-looking, and given that the temporal dynamics of gaze patterns may relate to individual differences in empathy (Hedger et al., 2018), future research should examine not just the quantity but the timing of eye-looking.

Additionally, although our stimuli were socially-complex, they were still prerecorded, commercially-available videos. Although clips from feature films have been used extensively as stimuli in previous social cognition research (e.g., Hasson et al., 2004; Klin et al., 2002; Moraczewski, Nketia, & Redcay, in press; Rice et al., 2012), little research has systematically examined whether and how specific film clips influence participant behavior. Systematically researching the effects of film content and style on empathy and viewing patterns is an important future direction. For example, commercial films often employ directorial strategies (e.g., close-ups) that may not mimic our real-world socio-perceptual experiences. Thus, beyond the use of films, examining how the relation between eye-looking and empathy is modulated in real-world contexts is an especially interesting future direction, given research suggesting that visual attention is altered toward real-world social partners (Mundy & Newell, 2009) and that social disabilities are more acute in real-world contexts (Hessels, Holleman, Cornelissen, Hooge, & Kemner, 2018).

In addition to finding a positive relation between eye-looking and empathy, we found no relation between eye-looking and our other social cognitive measures, both of which have been construed as mentalizing assessments. Contextualizing this null finding is difficult, as the literature on common and distinct components of empathy and mentalizing is mixed (Bloom, 2017, Freeman, 2016). Some researchers even consider mentalizing to be synonymous with what is termed cognitive empathy (e.g., Saxe, 2006), making it especially interesting that the IRI subscale linked to cognitive empathy (perspective taking subscale; Shamay-Tsoory, Aharon-Peretz & Perry, 2009), showed the strongest links to eye-looking in the current sample (although this relation was not significantly different from those of the other subscales). One explanation for the differential relations between eye-looking and empathy versus eye-looking and mentalizing may be measure-specific. Both our mentalizing measures assessed manifest behavior, either explicit accuracy (Mind in the Eyes) or degree of spontaneous mentalizing (STOMP). In contrast, our empathy measure (IRI) was a self-report measure that assessed individuals’ beliefs about their tendencies, rather than those tendencies themselves. Including self-report measures of one’s propensity to mentalize (e.g., Fongay et al., 2016) could help disentangle whether more superficial features of our measures versus the underlying constructs led to our divergent findings for empathy and mentalizing. Future research should also include additional measures of empathy, such as real-world responding and prosocial behavior. Finally, our results also speak to recent literature arguing for reconceptualization of component parts of social cognition (Schaafsma, Pfaff, Spunt, & Adolphs, 2016). Our two mentalizing measures were not related to each other, but our spontaneous mentalizing measure was related to empathy, suggesting that more real-world mentalizing measures may better capture empathy.

In addition to examining correlations between empathy and eye-looking, we used explicit instruction to disentangle the relationship between these two constructs, but results from this procedure were not straightforward. First, we did find that explicit instruction could manipulate empathy and eye-looking. Although many studies manipulate eye-looking by placing fixation crosshairs on the eyes or using other bottom-up cues (e.g., de Lissa et al., 2014; Perlman et al., 2011), we found that simply telling participants to pay close attention to the eyes more than tripled attention to the eye region. Similarly, consistent with previous research finding that prosocial behavior and empathy can be increased via experimental manipulation (e.g., Berenguer 2010; Sasaki et al., 2011; Stocks et al., 2009), we found that telling participants to put themselves in the mindset of the characters in the video increased their spontaneous tendency to talk about the internal states of those characters.

Especially interesting is that our empathy condition also increased scores on the IRI, which asks participants about general tendencies. Thus, it is possible that after paying additional attention to thoughts and feelings over several minutes of a naturalistic video clips, participants were biased to overestimate their general tendency to engage in such empathic responding. This finding is consistent with arguments that empathic responding interacts with context (Nezlek et al., 2007) and that IRI scores are influenced by experimental primes and interventions (Moll et al., 2015; Shapiro et al., 2010; Woltin et al., 2011). Future research should examine whether such tendencies when watching a video clip alter real-world behavior and how long such effects may last, in order to more precisely titrate the relationship between self-reported underlying traits and situational, potentially state-based responses. Overall, we found that our explicit instructions were effective at manipulating the directly targeted behavior (e.g., eye-looking or empathy).

In spite of the success of the explicit instructions, however, only the directly associated behaviors changed, and not the hypothesized connected behaviors. Contrary to work finding that increasing eye-looking can influence other responses, such as normalizing brain responses to faces in autism (Perlman et al., 2011), and in spite of finding a link between empathy and eye-looking in our baseline condition, we did not find any effects of artificially increasing eye-looking on any of our empathy or mentalizing measures, neither for measures specific to the video nor for those that were more trait-like.

One possible explanation is that we did not have the right dependent measures, as ours were administered after the conclusion of the video. Effects of eye-looking may be more transient, such as increased physiological response during the video. There is some evidence for this as the eye condition group did show higher levels of personal distress related specifically to the movie (e.g., items about feeling anxiety as opposed to general concern), although they showed no differences on our other measures of general and movie-specific empathy. Similarly, if we paused the video after a set number of frames and asked targeted questions about the level of empathy participants were experiencing (cf. Dziobek et al., 2006), we may have found an effect of our eye-looking instruction. Examining how the effects of increased eye-looking persist over time might illuminate the direct consequences of this behavior. It would also be informative to conduct within-participants designs that allowed for the measurement of behaviors both before and after manipulations, in order to better isolate the effects of our experimental primes. Such replications should also investigate our exploratory hypotheses with corrections for multiple comparisons. Additionally, future studies should also be conducted with larger samples, as our primed samples considered separately were underpowered to detect small effects or conduct complicated mediation or moderation analyses. Given that our results suggest a null effect, increasing the sample size is especially important in order to determine if the effects of primes are truly near zero or simply smaller than past work might suggest. Such investigation should also consider the meaningfulness of potentially small effect sizes when considering interventions designed, for example, to increase empathy.

Another possible explanation for the fact increasing eye-looking did not increase empathy is that the link we observed between eye-looking and empathy in our baseline sample is due to a developmental cascade in which the two behaviors reinforce each other, a cascade that cannot be artificially induced in a transient laboratory setting. That is, early attention to the eyes might support the development of successful, reciprocal social interactions, which in turn spurs empathy, which then reinforces the desire to look at the eyes to gain important social information about others’ thoughts and feelings (cf. Brooks & Meltzoff, 2014). Thus, the relation between empathy and eye-looking in the baseline condition is not so much driven by attention to the characters’ eyes in that particular moment as it reflects a history of eye-looking that is present across a variety of contexts. This perspective is consistent with other recent developmental evidence finding that attention to the eyes is highly heritable even early in development (Constantino et al., 2017). In this model, telling participants to increase eye-looking can artificially increase that specific behavior, but because that increase is not due to a mutually-reinforcing developmental history, increased eye-looking does not lead to increased empathy.

A similar perspective can explain why instructing participants to increase focus on thoughts and feelings in the videos did not lead to greater eye-looking. There are other routes to understanding or even mimicking internal states than looking at the eyes, including a focus on other non-verbal information. Participants may have even engaged in processes outside of what can be captured by visual attention, such as greater cognitive elaboration while viewing the film. When individuals are artificially told to put themselves in the mindset of a character, they most likely employ a varied suite of strategies based on past experiences. These strategies do not necessarily match the eye-looking strategies of those who more naturally and spontaneously display empathy in the baseline condition. That fact that artificially increasing empathy does not increase eye-looking is consistent with research involving the administration of oxytocin, finding that the neuropeptide can increase empathy without increasing their eye-looking (Hubble et al., 2017). Future research should compare in more detail the behaviors of individuals in the instructional conditions by monitoring other physiological responses or explicitly asking about how they followed the instructions in that condition. In clips with verbal information, mouth looking may be greater for individuals who are explicitly attempting to increase their social understanding (cf. Klin et al., 2003). Given the theorized developmental links between social perception and social cognition, longitudinal research will be especially important for figuring out the causal relationship between empathy and eye-looking. Examining whether early differences in eye-looking predict later differences in prosocial or empathic responding, or whether children who begin to show empathy earlier show increased levels of eye-looking, can help determine the mechanisms linking these varied processes.

Overall, our findings have both theoretical and practical implications for understanding relations between higher-order social processes and social perception. Theoretically, our results inform discussion of when and how social cognitive and social perceptual systems relate to each other (Happe, Cook, & Bird, 2017). For example, our findings that attention to the eyes relates to empathy but not mentalizing intersects with debate about the potentially fractionated nature of theory of mind and associated constructs (see Preckel et al., 2018 for review). In spite of these ongoing debates, much experimental work on the underlying structure of social processes involves examining correlations between tasks. Here, we provide a different approach for examining these links via experimental priming, finding that correlations alone are not informative about underlying mechanisms. Practically, literature on autism and social anxiety has postulated that increasing attention the eyes could serve as both a target of intervention and a measure of intervention success (e.g., Fletcher-Watson & Hampton, 2018; Hogstrom et al., 2019; Krstovska-Guerrero & Jones, 2016; Murias et al., 2018), predicated on the model that altering visual attention can alter the higher-order behaviors that are often correlated with levels of visual attention. Our findings suggest that, at least by adulthood, the superficial social perceptual behavior can be altered without necessarily changing the underlying social responses that are important for adaptive functioning. Future research should extend our findings to clinical settings to determine whether and how changing social perception can alter social cognition and behavior.

Overall, our results indicate that the previously discovered link between eye-looking and empathy is robust for dynamic, socially-complex scenes. This link, however, is not easily manipulated in a laboratory setting. That is, increasing eye-looking does not increase empathy, nor does increasing empathy increase eye-looking. This finding suggests that interventions designed to promote empathy may need to consider not only what factors correlate with empathy or cause empathy over the course of development, but can, in the moment, alter empathy. Recent research has begun to promote teaching mindfulness or compassion instead of empathy per se (Baer, 2003), and such approaches may be able to help promote better social functioning. Ultimately, disentangling the complex relationships between attentional, perceptual, cognitive, and affective processes will help explain the building blocks of the core human faculty of social interaction.

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**Table 1**. Individual differences in behavioral measures and eye-tracking indices.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Mean | 95% CI | SD | Minimum | Maximum |
| **Behavioral Measures** |
| ***Empathy*** |  |  |  |  |  |
| IRI Empathic Concern Scale | 18.80 | [18.25, 19.36] | 3.59 | 8 | 26 |
| IRI Fantasy Scale | 18.95 | [18.07, 19.83] | 5.72 | 4 | 28 |
| IRI Personal Distress Scale | 11.96 | [11.16, 12.76] | 5.20 | 0 | 25 |
| IRI Perspective Taking Scale | 18.86 | [18.16, 19.56] | 4.56 | 6 | 28 |
| IRI Global Score | 17.14 | [16.64, 17.64] | 3.26 | 8.75 | 23.5 |
| ***Spontaneous Social Cognition*** |  |
| STOMP Internal Statements | 9.38 | [8.70, 10.07] | 4.35 | 1 | 24 |
| STOMP External Statements | 23.72 | [22.31, 25.13] | 9.01 | 3 | 50 |
| STOMP Total Statements | 33.10 | [31.36, 34.84] | 11.12 | 4 | 65 |
| STOMP Index | 29.12% | [27.42, 30.81] | 10.79% | 9.00% | 77.00% |
| ***Explicit Social Cognition*** |
| Mind in the Eyes Accuracy | 72.24% | [70.71, 73.76] | 9.68% | 44% | 97% |
| **Eye Tracking Indices** |
| Dwell-time on the eyes  | 15.44% | [14.38, 16.51] | 6.91% | 1.05% | 30.35% |
| Dwell-time on the mouth  | 3.41% | [2.84, 3.98] | 3.71% | 0% | 18.00% |

Note: Eye-tracking data is averaged together across clips to give percentages for this table. STOMP Index represents the percentage of total statements which deal with internal states. STOMP: Spontaneous Theory of Mind Protocol; IRI: Interpersonal Reactivity Index.

**Figure Captions**

**Figure 1.** Relations between empathy and eye-looking. In a baseline condition, global empathy (total IRI score) was significantly correlated with the amount of dwell time on the eye region on characters during naturalistic, socially-complex scenes. Error bars represent 95% confidence interval.

**Figure 2**. Effects of instructing participants to attend to the eyes or take an empathic stance. Participants in the eye condition significantly increased eye-looking compared to baseline and participants in the empathy condition significantly increased their global empathy score (total IRI score) and their use of emotional and mental state descriptors when describing the video (STOMP Index). Eye condition participants did not differ from baseline in their empathy score or use of emotional and mental state descriptors when describing the videos and empathy condition participants did not differ in their eye-looking compared to baseline. Error bars represent +/- 1 SE. IRI: Interpersonal Reactivity Index; STOMP: Spontaneous Theory of Mind Protocol. \*, *p*<.05; \*\*, *p*<.01



**Figure 1.** Relations between empathy and eye-looking. In a baseline condition, global empathy (total IRI score) was significantly correlated with the amount of dwell time (z-score) on the eye region on characters during naturalistic, socially-complex scenes. Error bars represent 95% confidence interval.



**Figure 2**. Effects of instructing participants to attend to the eyes or take an empathic stance. Participants in the eye condition significantly increased eye-looking compared to baseline and participants in the empathy condition significantly increased their global empathy score (total IRI score) and their use of emotional and mental state descriptors when describing the video (STOMP Index). Eye condition participants did not differ from baseline in their empathy score or use of emotional and mental state descriptors when describing the videos and empathy condition participants did not differ in their eye-looking compared to baseline. Error bars represent +/- 1 SE. IRI: Interpersonal Reactivity Index; STOMP: Spontaneous Theory of Mind Protocol. \*, *p*<.05; \*\*, *p*<.01