The link between eye contact and storytelling:
How the storyteller's gaze influences immersion into a story

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Abstract

In storytelling, theories of narrative comprehension emphasize the role of self-referential processing and story immersion in creating rich mental representations of narratives (Brunyé et al., 2011). Here, we used recent proposals of eye contact perception (Conty et al., 2016) and narrative comprehension (Brunyé et al., 2011) to investigate the effects of direct eye gaze on processes involved in storytelling: immersion, visual attention allocation and storyteller evaluation. In the first experiment, participants evaluated storytellers after watching them narrate stories in either a front view (eye contact) or a side view (no eye contact). Some also believed that their faces were recorded and would later be seen. No effects of eye contact were found on storyteller evaluation. In a second eye-tracking experiment, we measured subjects' story immersion and visual attention allocation while manipulating the storyteller's gaze direction, the participants' belief of being seen or not and the perspective from which stories were narrated. The first two manipulations had significant main effects on story immersion and influenced where participants looked on the speaker's face. Findings validate a theoretical starting point for the joint exploration of eye contact and storytelling.

1 Introduction

'The Kubrick stare' captures a viewer's attention into a movie's story, and uses direct gaze to break the 4th wall in cinema. In storytelling[1], audio-visual information from a speaker, including lip movements and facial expressions, is integrated into narrative comprehension and speech perception (Galantucci et al., 2006; Speer et al., 2009). Although eyes are key to verbal communication (Richardson et al., 2007), the direct relationship between storytelling and eye gaze has not been investigated in past research. Eyes both perceive and signal information (Gobel et al., 2015) and 18-month infants use another person's direct gaze as a cue to learn about the surrounding environment (Csibra & Gergely, 2009). Behavioural and neurophysiological data also highlight dedicated neural mechanisms that process eye contact[2] and produce unique psychological effects, such as mimicking a partner's actions and perceiving direct gaze as an intention to communicate (George & Conty, 2008; Schilbach et al., 2013, Hamilton, 2016). The present paper aims to establish whether the storyteller's gaze direction affects the viewer's story perception and the mechanisms involved.

1.1 How is direct eye gaze special?

Direct gaze (DG) and averted gaze (AG) have different effects on an observer. In a visual search task participants detect the presence of eyes with DG more quickly than AG (Conty et al., 2006). Still, the advantage only holds if the eyes come from a deviated head direction (30°) and not from a front view. Authors conclude that the perceived attention focused on the viewer explains the quicker response times in the interaction between DG and head direction. In other studies, people recognize faces better if encoded with DG as opposed to AG (Hood et al., 2003) and discriminate the gender of DG faces much more quickly (Macrae et al., 2002). Direct gaze also increases sensitivity to stimuli, compared to averted gaze: faces with DG elicit an orienting response, as measured by increased heart rate deceleration (Akechi et al., 2013). The orienting response amplifies sensitivity to environmental stimulation and directs attention to relevant external inputs, accompanied by intensified heart rate

[1] Throughout the paper we refer to storytelling as the experience of hearing a narrative from another person, as opposed to producing it.
[2] We use *eye contact* and *direct gaze* interchangeably in the current paper, as opposed to having eye contact imply that the other person can see the viewer as well (Hamilton, 2016).

deceleration (Graham et al., 1966). Finally, people don't require focused attention to distinguish between DG and AG faces, compared to different orientations of AG (Yokoyama et al., 2014). Therefore, quicker response times and an enhanced orienting response describe a priority in DG processing and may reflect distinct neural networks involved in processing direct and averted gaze.

Converging evidence from electrophysiology studies of macaques and fMRI data in humans support neural selectivity for different gaze directions, also potentially suggesting the phylogeny of eye gaze perception (Nummenmaa & Calder, 2009). Single cell recordings in the macaque anterior superior temporal sulcus (aSTS) reveal clusters of neurons selective for different gaze directions: distinct cell populations respond maximally to right, left and front gaze directions (Perrett et al., 1992). Visual adaptation fMRI experiments also identified separate activation patterns in the aSTS for different gaze directions in humans (Calder et al., 2007, 2008). While neural selectivity for DG is confirmed, both EEG and fMRI data suggest that no single area can solely account for processing eye contact. Source reconstruction suggests that direct gaze evokes larger and longer lasting potentials in centro-parietal and lateral occipito-temporal areas as early as 160ms, compared to AG (Conty, N'Diaye, Tijus & George, 2007).

Activation likelihood estimates from fMRI data show other areas beyond the aSTS to be involved in processing eye contact (Nummenmaa & Calder, 2009). Specifically, processing the intention of another agent's gaze involves the posterior STS (Pelphrey et al., 2004). Eye contact in emotional faces elicits stronger activation in the amygdala than averted gaze (Kawashima et al., 1999). Also, assigning mental states to pairs of eyes (i.e. a Theory of Mind (ToM) process) engages the STS region, with modulation from the medial prefrontal cortex (mPFC) and the temporoparietal junction (TPJ) (Calder et al., 2002). The modulation of aSTS and pSTS by the mPFC and the TPJ in visual adaptation to gaze direction indicates that the involvement of social cognition areas may reflect top-down feedback on low-level visual processes (Hamilton, 2016). However, these areas are not unique to processing eye contact. The pSTS is engaged in processing mouth movements in speech perception, as well as dynamic gaze direction shifts (Puce et al., 1998) and together with the aSTS, in updating information about characters, objects and goals during narrative reading

(Speer et al., 2009). Neuroimaging data suggests that the distinct brain areas identified support processes central to eye contact perception: emotional reactions, mental state attribution and social intention of gaze direction. Therefore, studying eye gaze requires moving beyond the perspective of passive observers to integrate aspects relevant to social context. Such a shift is also key to understanding the observed overlap on areas involved in both narrative comprehension and DG processing.

1.2 Somebody is watching: how social context modulates eye contact perception

Eye contact in natural interaction does not resemble the DG of a face in a photo, as people's perspective shifts from being detached observers to active agents (Schilbach et al., 2013). Socially relevant stimuli, such as eye gaze and body movements, are processed in an enactive manner, as one becomes emotionally engaged and aware of the other person's affective state, intentions and actions (Schilbach et al., 2013, Hamilton, 2016). Some studies have overcome the spectatorial barrier by manipulating social context and observing differences in neural activity and behavioural effects (Hamilton, 2016). For instance, participants attend the eyes of a person of lower social status more than for a person of higher social status, but only if believing that the recording of their face will be seen by the actor in the video afterwards (Gobel et al., 2015). The belief of being seen (BoS) or not (BoNS) reveals the dual function of eye gaze when subjects perceive the situation to resemble a two-way interaction. However, the BoS may be sufficient to change the 'passive' status of an observer to becoming 'active' upon mere the perception of DG.

Indeed, manipulating the belief of being seen when perceiving eye contact does emphasize the pitfall of using static pictorial stimuli. Participants seeing the DG of a real person through a computer-controlled liquid crystal screen, as opposed to the same stimuli in picture format, show higher mean skin conductance responses (SCRs) and more prominent hear rate deceleration than to AG (Myllyneva & Hietanen, 2015; Hietanen et al., 2008; Pönkänen, Peltola, & Hietanen, 2011). Believing that they cannot be seen by the other person cancels the effect on SRCs and heart rate deceleration (Myllyneva & Hietanen, 2015). Adding a pair of sunglasses to the actor does not dissolve the effect of DG in BoS on mean SCRs, suggesting that seeing the eyes is not needed for the enhanced sympathetic arousal. People also report higher levels of public self-awareness and enhanced self-assessed arousal in BoS conditions, but not in BoNS (Hietanen et al., 2008). Neuroimaging data also confirms that eye contact perception cannot be reduced to a visual description of gaze direction. Seeing the DG of a real person in a reflecting mirror engages the inferior frontal gyrus (IFG), the anterior cingulate cortex (ACC), the pSTS and the anterior rostral medial frontal cortex (arMFC) more than their DG in a picture or than their AG (Cavallo et al., 2015). Functional connectivity identified between the IFG and the arMFC suggests that the belief of being seen adds a communicative intent to be perceived in a DG. So, the network involving the IFG and the arMFC may prepare one for communication and social interaction upon making eye contact (Conty et al., 2012; Cavallo et al., 2015).

Clearly, the belief of being seen engages distinct neural mechanisms in eye contact perception compared to static stimuli. However, what mechanisms underlie the psychological (e.g. enhanced self-awareness) and physiological effects (e.g. enhanced SRC) of DG in combination with BoS?

1.3 The belief of being seen revisited

Self-referential processing may explain how the BoS leads to unique behavioural effects and different activation of brain areas in eye contact perception (Conty et al., 2016). Direct gaze processing and self-referencing converge in a wide range of psychological effects: enhanced self-awareness and memory for self-relevant information, pro-social behaviour and attention capture (Conty et al., 2016). For instance, processing self-relevant social cues via DG enhances subsequent face memory (Conty & Grèzes, 2012). Similarly, people are quicker and more accurate in perceptual association tasks and better at remembering words and objects, when processing task information in relation to the self (Sui & Humphreys, 2015). Self-referencing and DG processing also use similar brain areas. Cortical medial structures (e.g. anterior cingulate cortex, medial PFC and medial orbitofrontal cortex) are associated with processing information in a self-referential manner, independent of sensory modality and across a wide-range of tasks (Northoff et al., 2006). The ACC and the mPFC are regions that are involved in both self-referential processing and perceiving DG with the belief that one is watched (Cavallo et al., 2015; Kuzmanovic et al., 2009). So, Conty et al. (2016) propose that DG capture's one attention via a quick subcortical pathway (Senju & Johnson, 2009), subsequently modulating activation of cortical areas. Then, a belief of being seen activates self-referential processing, leading to the encounter becoming a potential two-way interaction. Therefore, the neural overlap between DG and relating information to the self contributes to the shared psychological effects: enhanced self-awareness, better memory, more positive appraisal of others and increased prosocial behaviour (Conty et al., 2016). The proposal involving self-referential processing in how one perceives eye gaze in social contexts links eye contact to storytelling, as detailed below.

1.4 How direct gaze relates to storytelling: proposed mechanisms

Hearing a story from another person involves rich multisensory input that may aid both speech perception and narrative comprehension. Visually attending lip movements (Haxby et al., 2000; Giraud et al., 2002) and iconic gestures (Holle et al., 2010) helps disambiguate and comprehend speech. Also, eye gaze synchronizes between two people to establish a common ground in conversation (Richardson & Dale, 2005; Richardson et al., 2007). Still, eye contact has not been investigated directly in relation to storytelling. To this end, self-referential processing and the social nature of direct gaze prove to be highly relevant to narrative comprehension and speech perception. Here, we propose three ways in which gaze direction may influence story perception: relating story content to the self, allocating attention to particular areas of a storyteller's face and a positive evaluation of the storyteller.

In storytelling, people make use of narrative comprehension. Self-referential processing is key to theories of narrative comprehension that argue for embodied representations of actions and events in stories (Zwaan, 2004; Brunyé et al., 2011). Situational models are mental representations of multidimensional aspects in narratives (e.g. time, space, characters, emotions, expectations) that integrate information to coherently structure stories and to understand them (Zwaan & Radvansky, 1998). Readers do simulate protagonist actions in stories covertly (Richardson, Spivey, McRae, & Barsalou, 2003) and taking an egocentric perspective in narratives leads to better memory for spatial dimensions and emotions described (Brunyé et al., 2011). The more immersed one is into a narrative, the richer in their representations situational models may be (Brunyé et al., 2011). Specifically, immersion can be achieved through self-referential processing: reading a story describing events in the 2nd person pronoun ('you'), compared to 1st person ('I') and 3rd person ('he' or 'she') pronouns, leads to embodying a 1st person perspective of the narrative (Brunyé et al., 2009), better memory for spatial aspects (Brunyé et al., 2011), for actions and emotions (Ditman et al., 2010). Therefore, we identify 2 possible ways for direct gaze to influence narrative comprehension via self-referencing (see ***Table 1***).

The possible relationship between eye contact, self-referential processing (perspective taking) and immersion in narrative comprehension

<table>
<tr><th></th><th colspan="2">Eye contact</th><th colspan="2">No eye contact</th></tr>
<tr><td>2nd person pronoun</td><td>Egocentric perspective</td><td>Highest levels of NI</td><td>Egocentric perspective</td><td>Significantly higher levels of NI than the baseline</td></tr>
<tr><td>3rd person pronoun</td><td>Egocentric perspective</td><td>Significantly higher levels of NI than the baseline</td><td>Observer perspective</td><td>Baseline levels of NI</td></tr>
</table>

Table 1. NI – level of immersion into narrative. A baseline condition with average NI can be considered when an observer perspective is elicited by using the 3rd person pronoun in the narrative and the storyteller displays no eye contact. If eye contact does have a main effect on self-referential processing, then the observer perspective would change to an egocentric one, potentially resulting in higher levels of NI than the baseline. A main effect of the pronoun when no eye contact is perceived should also result in assuming an egocentric perspective and significantly higher levels of NI than the baseline. Finally, an interaction between eye contact and using a 2nd person pronoun would make the viewer take an egocentric perspective and may enhance NI with an interaction effect.

First, an assumed egocentric perspective may elicit even higher levels of story immersion when a storyteller holds eye contact, compared to simply eliciting a first-person perspective through personal pronouns. A main effect of eye contact presence or an interaction between eye contact and 2nd person pronouns used in narratives would confirm this prediction. Second, an observer perspective assumed through 3rd person pronouns in a narrative may be changed to an egocentric one if the storyteller maintains DG. A shift in perspective would result in higher levels of immersion compared to a baseline elicited in observer-like processing by 3rd person pronouns. Both mechanisms assume that DG paired with BoS triggers self-referential processing (Conty et al., 2016), which in turn enables the egocentric perspective that facilitates immersion in stories and richer situational models (Brunyé et al., 2011). So, a two-stage process can be described. First, eye contact must enhance immersion via self-referencing. Second, the effects need to be strong enough to affect the representations in situational models. Here, we will focus on the first stage.

Understanding a storyteller's speech is also essential to hearing a story. Speech perception integrates auditory and visual information, particularly from the face area (Haxby et al., 2000; Galantucci et al., 2006; Giraud et al., 2002). People allocate more visual attention to lip movements when having to disambiguate speech from background noise (Vatikiotis-Bateson et al., 1998), and under low levels of background noise the eyes and the mouth regions are attended equally. Still, when extracting prosodic information from speech, participants overtly attend the top region of the face and the mouth area for identifying words (Lansing & McConkie, 1999). So, findings showing that social status (Gobel et al., 2015) modulates visual attention allocation become relevant to speech perception. Also, people attend the eyes of a storyteller less if seen from the front, compared to a 45° viewing angle (Street & Richardson, 2010). Therefore, DG paired with the belief of being seen might influence where on a storyteller's face a viewer allocates visual attention while hearing a story. Moreover, different areas of visual attention focus may relate to extracting specific info relevant to speech perception, such as prosody (Lasling & McConkie, 1999).

We also considered how a viewer evaluates the storyteller depending on their gaze direction. Faces are perceived as more approachable, more competent and more credible if presented with DG, compared to AG (Kleinke, 1986). Increased eye contact duration correlates with how likeable the other person is judged (Kuzmanovic et al., 2009) and compared to AG, actors with DG receive more positive personality trait ratings (Wirth, Sacco, Hugenberg, & Williams, 2010). So, the positive appraisal effects of eye contact may extend to how a person and what they say is perceived.

Specifically, would the storyteller be perceived as a better person, as sincerer and as more likeable if maintaining eye contact? Would the actions and beliefs of the speaker make more sense to people? Finally, would viewers relate the events described to their own experiences if the storyteller makes eye contact?

1.5 The current study

1.5.1 Online experiment

The first experiment was designed to investigate whether gaze direction affects one's evaluation of the storyteller. Participants saw multiple stories of two speakers from both front and side angles and answered questions about how sincere and likeable the storyteller seemed and how well they could understand the storytellers' actions and beliefs and relate them to their own. As DG elicits more positive ratings of faces and actors compared to AG (Kleinke, 1986), we hypothesized that the ratings of the storyteller would be more positive for stories where viewers see the speaker from the front (eye contact), compared to a side view (no eye contact). To test the effect of BoS, an extra sample was recruited. The same stimuli were used and subjects were informed that they would be recorded via their webcam. So, it was predicted that having the camera on would results in different ratings of the storyteller compared to not being recorded.

1.5.2 Laboratory experiment

The second experiment tested the proposed mechanisms for how eye contact may influence levels of story immersion through self-referential processing. Transportation is defined as the extent to which one is immersed/absorbed into a story (Green & Brock, 2000) and becomes part of the fictional world (Lombard et al., 1997). People feeling more transported into stories also report higher levels of self-referential processing and are more willing to quit smoking after reading antismoking narratives (Dunlop et al., 2008). Therefore, transportation was used as a measure of immersion. In the laboratory, participants saw the storyteller from the front (eye contact) or from a side angle (no eye contact). The belief of being seen was also manipulated by telling them that their faces are recorded while watching the narratives. Second versus third person personal pronouns ('you' vs 'he/she') were used to trigger self-referencing by taking an egocentric perspective, or to process the story as a detached observer, respectively (Brunyé et al., 2009). Based on the findings linking egocentric processing to higher levels of transportation (Brunyé et al.,2009) and of DG triggering self-referencing (Conty et al., 2016), it was hypothesized that participants seeing the storyteller from a front view would report higher levels of story transportation than those seeing the storyteller from the side. Also, stories narrated in the 2nd person should elicit higher levels of transportation in participants than those in the 3rd person.

The influence of eye contact and the belief of being seen on attention allocation to a storyteller's face was also explored using an eye-tracker. The interaction found by Gobel et al. (2015) between the belief of being seen and social status motivated the last hypothesis: the belief of being seen will modulate visual attention allocation, resulting in different areas of the speaker's face being looked at in the 2 conditions.

2 Experiment one

2.1 Methods

2.1.1 Participants

Eighty participants were first tested for the main effect of eye contact. Then, 30 extra people were recruited and told that the camera would be recording their faces. All participants (M_{age}=31.5 years, 68 females) were recruited online through the Gorilla platform. Ethical approval was covered by ethics number CPB/2013/009.

2.1.2 Materials & Apparatus

Eight stories were recorded, each in 2 viewing angles (front and 30° from the side) with two male acting students from the Royal Academy of Dramatic Art (RADA) in London. The front view corresponds to the eye contact condition, while the side to the no eye contact condition. The storytellers were recorded after being given visual and verbal prompts with a few details (e.g. "Hawaii, ex-partner, honeymoon") to improvise short stories upon. Stories had a mean duration of M=77.69 s, SD=34.53 and the speakers can be seen from the neck upwards (see *Figure1*). Eight statements were developed to assess the participants' perception of the storyteller and their stories (e.g. 'Based on the video, I thought that the speaker was likeable', see ***Appendix 1***).

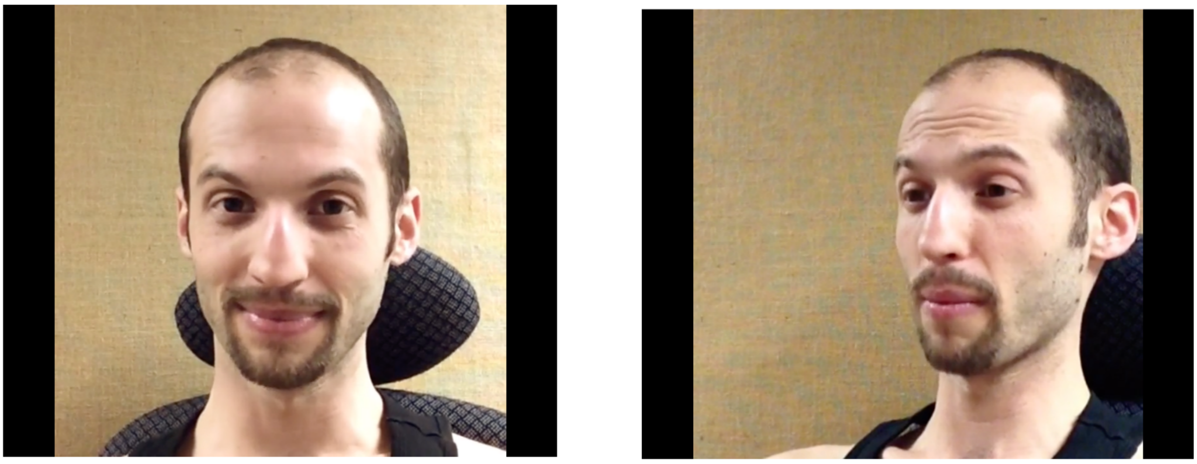

Figure 1, showing one of the two actors in the 2 viewing angle conditions: front (left) and side (right).

2.1.3 Design & Procedure

A mixed design was used with 2 independent variables. The within independent variable had 2 levels: eye contact vs no eye contact; while the belief of being seen (BoS) or not (BoNS) represented the between independent. Each question represented a dependent variable, measured on a Likert Scale from 1 (completely disagree) to 7 (completely agree).

Participants were told to use headphones and to close other applications in order not to be distracted from the task. Each person saw four unique stories per viewing angle in random order, with an equal split between the 2 storytellers. After each video subjects were asked the set of questions relating to the storyteller in random order. In the belief of being seen condition, participants were also informed before each video that they would be recorded and their webcam LED turned on. No actual video recordings were made.

2.2 Results

Eight paired-samples *t*-tests were conducted to assess whether differences for each rating of the storyteller between the eye contact and no eye contact stories were significant. No significant results were found (all $p>.05$). The within-participants design for the viewing angle manipulation raised the possibility that any effects of eye contact were cancelled out by stories containing no DG. However, the same analysis was done only on the first videos presented, revealing no significant differences. Independent-samples *t*-tests comparing the BoS and the BoNS conditions for each rating's mean scores also found no significant results.

3 Experiment two

3.1 Method

3.1.1 Participants

Forty participants (*M*age=20.5, 34 females, 30 non-native English speakers) with normal to corrected-vision received either course credits or £3 for participation. Ethical approval was covered by ethics number CPB/2013/009.

3.1.2 Materials & Apparatus

Two stories were taken from the online interactive literature piece *'Photopia'* by Adam Cadre, an acclaimed text-based interactive story. One described an adventure on Mars, while the other a car ride (see ***Appendix 3***) and within one story only the pronouns used differed. Each story was recorded using the 2^{nd} person pronoun ('You wake up…') and the 3^{rd} person pronoun ('She wakes up…'), each in 2 angles: front (eye contact) and 30° side (no eye contact). The 2^{nd} person pronoun stories corresponded to egocentric processing, the 3^{rd} person ones to an observer perspective. One of the researcher (21-year old white male) learned the stories and trained to appear natural in front of the camera (see ***Figure2***). The speaker talked directly to the camera, not suppressing facial expressions. The mean story duration was M=100s and their lengths were 283 and 311 words, respectively. Videos were edited in iMovie to capture the same amount of light on the speaker's face for all videos. The open-source Pupil Capture software and hardware (Pupil Labs) were used to eye-track the participants, who watched the stories while wearing headphones and on a 12inch monitor running on a MacBook Pro. The eye-tracker was not head-fixed, allowing one to move freely while recording eye gaze. To measure immersion, 7 items were selected as relevant to spoken stories from the transportation scaled developed by Green & Brock (2000). For example: 'While I was reading the narrative, I could easily picture the events in it taking place'. These were changed to fit the current experiment: 'While I was listening to the narrative, I could easily picture the events in it taking place' (see ***Appendix 2***).

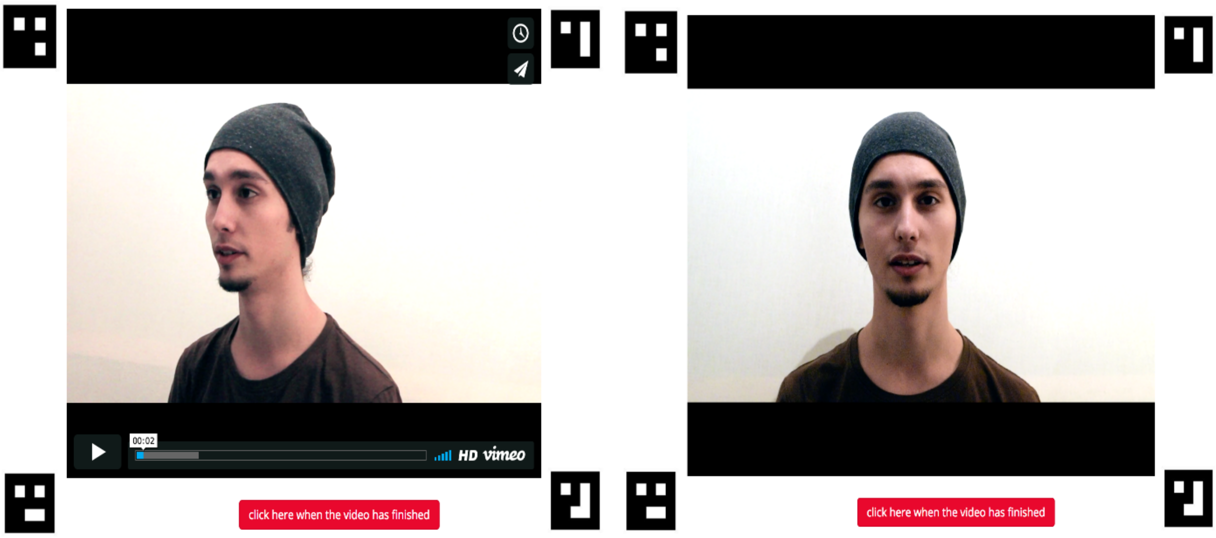

Figure 2, showing the 2 viewing angle conditions (side angle, no eye contact – left, front angle, eye contact – right). The markers defined the corners of the region of interest for the eye-tracking analysis.

3.1.3 Design & Procedure

The mixed design had viewing angle (front vs side) and belief of being seen or not as between-subjects factors and pronoun (2nd vs 3rd) as the within-subjects factor. The dependent variable was the transportation score and for the eye-tracking data the top-to-bottom ratio, described below.

Participants were seated 30cm away from the monitor. No instruction was given to not move while watching the videos, potentially causing different viewing distances. A different researcher from the actor calibrated the eye-tracker on an adjacent screen that was then turned off. Lights in the room were on during calibration and then turned off during video presentation, possibly introducing inaccuracies due to change in pupil size. Subjects were either told that the person in the video, also the one who contacted them for participation, would be watching videos of their faces (BoS condition), while the other half was told that nobody will ever watch them (BoNS condition). In both conditions the camera LED was on, but nothing was recorded. Technical issues required a second calibration in between the videos by the researcher for all participants. Each participants watched one story in the 2nd person pronoun and the other in the 3rd person pronoun, with the order counterbalanced. Questions about transportation were randomized.

3.1.4 Eye-tracking data analysis

Errors in eye-tracker recordings, displaced gazes and calibration issues left data from 24 participants for the analysis. Four markers placed on the video display defined the corners of a region of interest (ROI) (see *Figure2*). The Pupil Capture software gave gaze position within this region in 1000x1000 arbitrary units, scaling the x and y coordinates for the ROI in each video. Researchers tried to define two other ROIs: one around the eyes and one around the mouth. However, technical problems with the eye tracker introduced enough variability in gaze coordinates relative to screen locations that it was not possible to objectively define these 2 regions for each participant. Despite this, we used past research to estimate looking times to the top and bottom regions of the face. We assumed that participants looked mostly at 2 regions: the eyes and the mouth (Street et al., 2010; Vatikios-Bateson et al., 1998). So, we plotted looking times against y coordinates on the surface, and assumed the two largest peaks to correspond to top and bottom regions of the face (see *Figure 3*). A horizontal line was drawn through the midpoint of the two and all gazes below the line (bottom region) were assumed to represent in majority looks at the lower part of the face, including the mouth. Anything above (top region) was considered as gaze to areas above the nose (eyes, eyebrows). Of course, this analysis is not sensitive to x coordinates of gaze positions and the underlying assumptions are coarse. The difference between the 2 peaks was checked for each video, and they mostly ranged between 100-200 surface units, which did correspond to actual surface length in the video recordings of the eye tracker, and so our assumptions appeared to be validated.

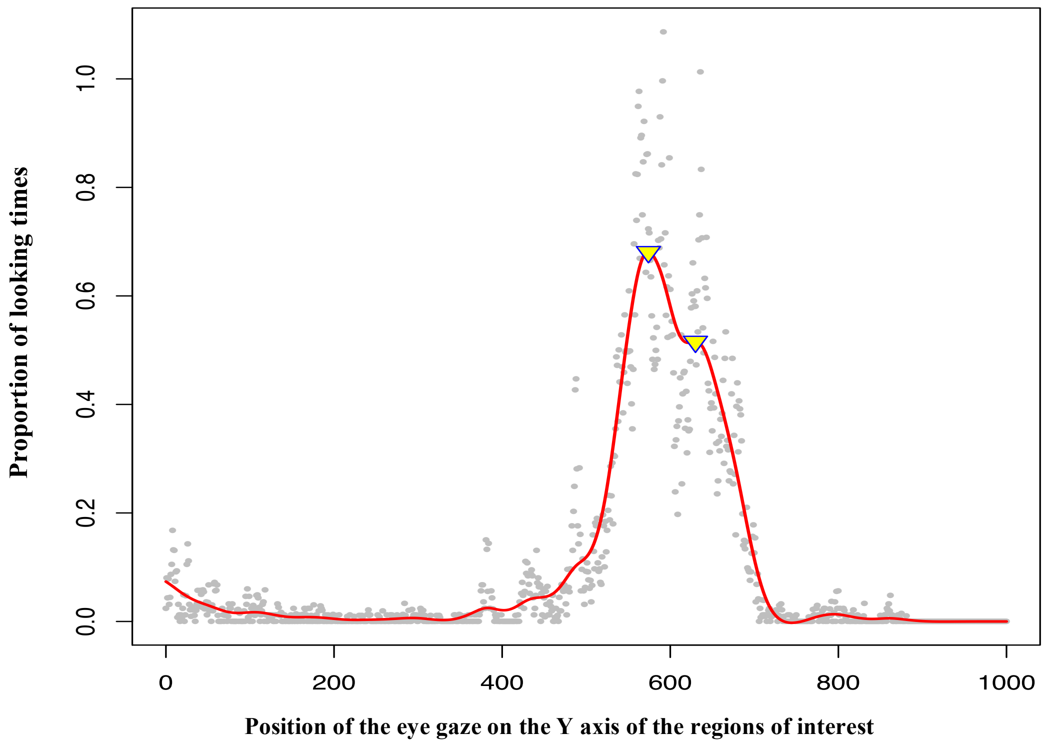

Figure 3. One graph taken from a participant to exemplify how the peaks were computed. Looking times are on the y axis and y positions are on the x axis)

Based on looking times in the top and bottom regions, a top-to-bottom ratio (TBR) was calculated as *time spent looking at the top region* divided by the *time spent looking on the surface* (top + bottom). A higher ratio represented more time looking at the top region. The subset of data from 24 participants (M_{age}=25.2, SD_{age}=7.7, 7 males) was almost equally distributed into the 4 between-subjects groups (see ***Table 2***).

	BoS	**BoNS**
Front angle	7	6
Side angle	5	6

Table 2, showing the distribution in groups of the subset of participants used for eye-tracking data analysis.

3.2 Results

Ratings from the transportation scale were averaged to obtain a transportation score. A mixed ANOVA model was constructed with viewing angle and belief of being seen as between factors and the pronoun condition as a within factor. The ANOVA model revealed a significant main effect of gaze direction ($F(1, 37)=17.92$, $p<.001$) on the transportation score. No other significant main effects or interactions were found. Due to a high *p*-value ($p=.46$) for the pronoun condition factor, we dropped it from further analyses. A 2 (front vs side) X 2 (BoS vs BoNS) between-subjects ANOVA revealed a main effect of gaze direction on the transportation score ($F(1, 37)=17.92$, $p<.001$), but no effect of BoS. The interaction between viewing angle and BoS also approached significance ($F(1,37)=3.09$, $p=.09$), suggesting a trend. Participants reported higher levels of transportation when seeing the storyteller from the front ($M=3.93$, $SD=1.07$), compared to from the side ($M=3.17$, $SD=1.09$) (see ***Figure 3***).

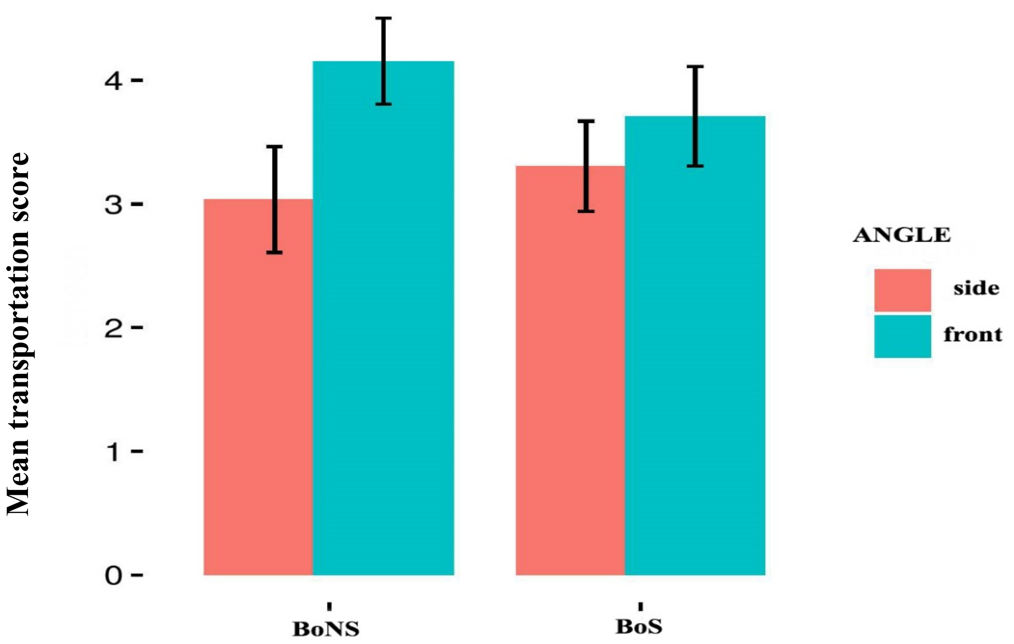

Figure 3. The means and error bars for transportation scores in relation to the two between-subjects factors: viewing angle and the belief of being seen (BoS) or not (BoNS).

To test the main effects of BoS and eye contact on the TBR, the same 2X2 between-subjects ANOVA model was used. Participants believing that their recordings would be later seen (M=0.75, SD=3.54) looked more at the top region, as indexed by the TBR, compared to the BoNS condition (M=0.58, SD=2.72) ($F(1, 26)=5.32$, p=.03) (see ***Figure 4***). There was no main effect of viewing angle.

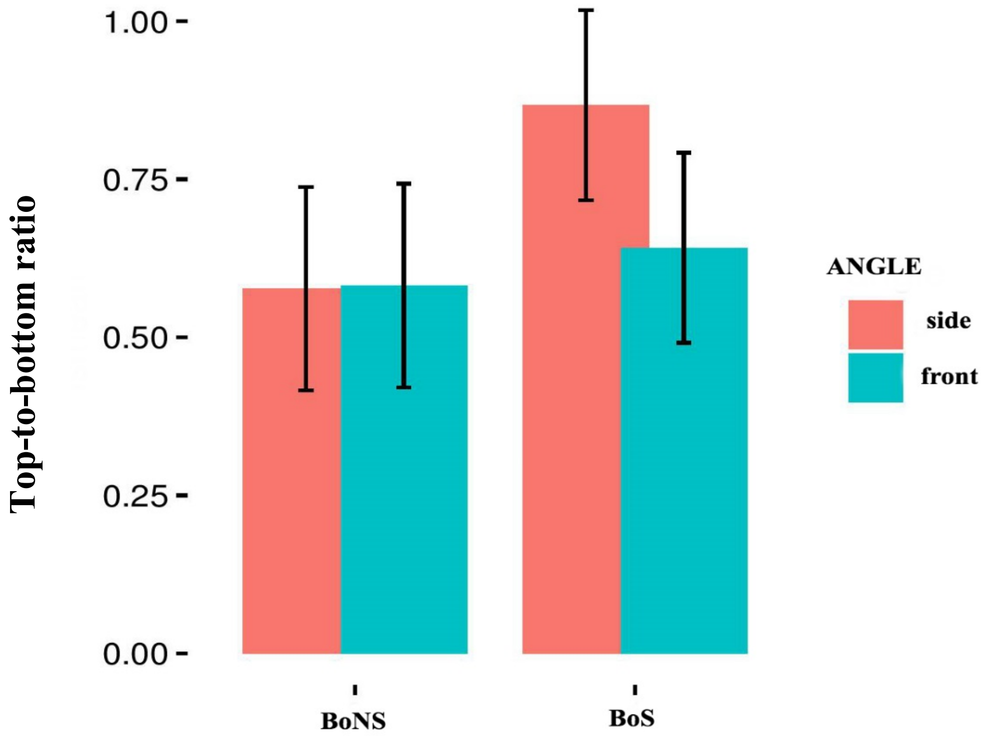

Figure 4. The mean top-to-bottom ratio (TBR) and error bars in relation to the 2 independent variables: viewing angle and the belief of being seen (BoS) or not (BoNS).

4 General discussion

Two experiments explored how eye contact may affect story immersion, visual attention allocation and storyteller perception. Results help evaluate the proposed links between direct gaze and storytelling and provide a starting point for further investigation.

4.1 Experiment one

While listening to a story, a front view of the storyteller's face did not influence participants' perception of the speaker when compared to a side angle view. In past work eye contact led people to rate faces as more likeable, more approachable and competent (Kleinke, 1986) and to infer more positive personality traits of actors in comparison to an averted gaze (Wirth, Sacco, Hugenberg, & Williams, 2010). In the current study these effects did not translate into storytellers being perceived as more emotional, likeable, sincerer or as better persons. Also, DG did not make participants report understanding the speaker's actions and beliefs better, think of behaving in similar ways to the storyteller or relate the person's actions and thoughts to their own experiences. Believing that their faces were being recorded while watching the videos also had no effect on the ratings. Two explanations arise. Eye contact in videotaped stories may not suffice to elicit more positive appraisal of actors. However, pictures and videos as stimuli did find main effects of DG on positive appraisal (Kleinke, 1986), making this explanation improbable. Alternatively, the short length of the stories may have not engaged speakers enough to change storyteller evaluation or even to take an egocentric perspective when listening to the narratives. The link between gaze direction and perspective taking is further discussed below.

4.2 Experiment two

4.2.1 Eye contact and immersion: mechanisms & future studies

The higher levels of transportation elicited by the storyteller making eye contact support the hypothesis that there would be a main effect of viewing angle on levels of transportation. One is therefore tempted to conclude that DG enabled an egocentric perspective in stories told in the 3rd person, in turn leading to higher levels of immersion, as outlined in the *Introduction*. However, the null main effect of pronoun manipulation questions whether egocentric perspectives were indeed assumed in narrative comprehension. Failing to replicate higher levels of immersion elicited by stories narrated in the 2nd person compared to the 3rd person (Brunyé et al., 2009, 2011) suggests that the pronoun manipulation did not shift the assumed perspective in the narratives. Brunyé et al. (2009, 2011) took memory performance related to situational models as an implicit measure of immersion. In contrast, we used a transportation scale that combines aspects relevant to situational models (e.g. 'I could picture myself in the scene of the events described in the narrative.') but also questions about the experience (e.g. 'While I was listening to the narrative, activity going on in the room around me was on my mind.') (Green & Brock, 2000). Two possibilities arise: either 2nd person pronouns failed to shift perspective, or the different measure of immersion was not sensitive enough to detect a significant difference, despite an egocentric perspective being assumed. Therefore, two measures become relevant for future studies: assessing self-referential processing through perspective taking (Brunyé et al., 2009) and the measure of memory performance on different narrative dimensions to indicate immersion (Brunyé et al., 2010). Assessing self-referential processing through the change in perspective can also give insight into exactly how eye contact may influence story immersion and subsequently, memory for different narrative dimensions. Brunyé et al. (2011) identify two ways in which self-referencing could enhance memory: people either conceive of the information to be relevant and important to the self or they embody aspects of the narrative in grounded representations. The current experiments did not address this question, but highlight its relevance in future studies. We further discuss the link between embodiment and eye contact in the next section.

Individuals may also perceive time differently in a narrative if assuming an egocentric perspective and becoming immersed. The link between self-referential processing and time perception is illustrated by the time dilation illusory effect: people estimate the presentation duration of looming circles as significantly longer than static circles, but the effect is not obtained for receding ones (Wittman et al., 2010). Authors suggest that looming circles are processed in relation to the self, as gradually they occupy a higher degree of visual angle, giving the illusion that the circle is coming closer. Also, looming circles elicit stronger activation in the ACC and the middle frontal cortex, areas involved in self-referential processing, compared receding ones (Wittman et al., 2010). Altered time perception has also been associated with being immersed into fictional worlds (Lombard et al., 1997). So, the focus of future investigations should also be the link between self-referencing, defined here as egocentric perspective-taking, and time perception in oral narratives. Klein (2005) emphasizes the use of diverse methodologies and measures of self-referential processing for a more comprehensive understanding. The same logical can then be applied to the concept of immersion into narratives.

4.2.2 Visual attention allocation in storytelling: functions and theoretical considerations

The belief of being seen had a main effect on visual attention allocation: participants believing that the storyteller would be watching the recording of their faces later looked more at the top ROI compared to the bottom ROI. However, no interaction between eye contact and the belief of being seen was found, having to reject the hypothesis proposed in relation to attention allocation. Street & Richardson (2010) found a front view of a storyteller to result in looking less at the eye region compared to a side view. Also, Gobel et al. (2015) found an interaction between speaker social status and time spent looking at the eye region: less gazing time at the eyes if the speaker was of higher social status and the belief of being seen was embedded into the task. These findings led to one assumption underlying our hypothesis: perceived mutual eye contact makes people look less at the eyes, reflecting what is observed in natural interactions (Laidlaw, Foulsham, Kuhn, & Kingstone, 2011). Still, one possibility is that the communicative function of eye gaze is relevant in social situations when a top-down influence exists (e.g. social status). The current study provided no explicit social context and participants looked more at the top region of the face. Therefore, we reject our initial assumption and propose that for narrative comprehension, allocating attention to distinct areas of the face differently may serve speech perception.

In storytelling, the modulation of gaze patterns by BoS is relevant to speech perception. Faces provide rich sensory information to viewers when disambiguating speech (Galantucci et al., 2006). People look more at the eyes and the forehead of a speaker when extracting prosodic information in speech, such as intonation (Lasling et al., 1999; Swerts et al., 2008). In contrast, attention is allocated to the mouth region when the goal is identifying individual words. In turn, prosodic cues have been associated with communicative intent in child-directed speech (Fernald, 1989). As the BoS is linked to communicative intent in eye contact perception (Schilbach et al., 2013), one may speculate that if prosodic cues are deemed more relevant, the top region of the face offer rich sensory information to be extracted. However, the claim needs to be tested directly in future investigations and cannot be taken as an interpretation for the current findings.

As a theoretical consideration for future research, we describe a rather speculative account put forward by Conty et al. (2016): eye contact may facilitate memory for aspects of narratives through language embodiment and motor resonance in speech perception. People engage facial muscles congruent with a virtual character's facial emotion if eye contact is maintained and not otherwise (Schrammel et al., 2009). Motor resonance refers to using neural systems involved in action production when seeing the same actions performed by others (Hommel et al., 2001). Motor theories of speech perception also suggest that when one perceives and understands speech, the motor system is used to simulate the perceived material to aid comprehension (Galantucci et al., 2006). Neuroimaging data also supports the embodiment of actions, emotions and space described in narratives by showing greater activation in brain areas associated with motor action, spatial navigation and emotional processing when these narrative dimensions are encountered in reading (Speer et al., 2009). A unifying account of these ideas is that eye contact may enable people to construct richer mental representations in orally narrated stories, via motor resonance in perceiving the storyteller's speech and the embodiment of narrative content. Richer mental representations in situational models would then result in higher levels of immersion and better memory (Brunyé et al., 2011; Ditman et al., 2010). As Conty et al. (2016) point out, the proposal rests on mechanisms not directly investigated (e.g. how motor resonance facilitates the embodiment of narrative dimensions, remaining highly speculative. However, in studying the link between eye contact and narrative comprehension, one may consider such ideas as relevant.

4.2.3 Eye gaze and narrative comprehension

During narrative comprehension, multiple processes occur: the situational model is initially constructed and updating processes keep information in the model up-to-date (Zwaan & Radvansky, 1998). Changes in several narrative dimensions (characters, spatial location, goals and objects) engage specific brain areas, including the aSTS, pSTS, medial frontal cortex and the TPJ (Speer et al., 2009). Self-referential processing and eye contact perception also share these regions in processing (Northoff et al., 2006; Cavallo et al., 2015). So, a neural overlap between the 3 processes motivates the following question: could direct gaze be perceived as a cue relevant to updating situational models in narrative comprehension, with self-referential processing as an underlying mechanism?

Infants use ostensive communicative signals, such as eye contact, to learn about subsequent actions and information that is relevant (Csibra & Gergely, 2009). Nine-month old infants generalize kind properties of objects if cued by a direct gaze beforehand, compared to an averted gaze that rather signals the importance of object location (Csibra & Gergely, 2009). Authors suggest that the innate preference for direct gaze in infants (Farroni et al., 2002) and for following adults' gaze after eye contact is established (Yoon et al., 2008) illustrates a mechanism used by humans to learn about relevant information in their environments before language acquisition. Critically, eye contact is not the only ostensive signal used by infants, as demonstrated by similar findings with child-directed speech (Cooper et al., 1990). Following the same logic, the main effect of eye contact on story immersion in the current study and previous findings linking better memory for narrative dimensions when highly immersed (Brunye et al., 2011) may suggest an analogous mechanism in adults. We propose that similar to infants using ostensive signals to make generalizations of object kind representations, adults may perceive eye contact as a cue to relevant information needing additional attention. In the context of situational models and narrative updating, a direct gaze directed towards a viewer may convey the need for subsequent information to be updated. Therefore, the prediction is that 'cueing' a change in narrative dimension (e.g. change in characters) through a movement of eye gaze towards the viewer may further enhance self-referential processing temporarily and result in a richer representation of that aspect in the situational model. If the effect is strong enough, better memory is expected for the change in narrative dimension. Our focus in the current study was on maintained eye contact in a front viewing angle. However, we recognize that eye contact needs to be studied in the context of gaze shifting, to be perceived as an ostensive communicative signal relevant to situational model updating (i.e. moving the gaze to make eye contact with the viewer). Therefore, expected psychological effects would include better memory for 'cued' dimension changes. In a neurophysiological investigation, fMRI data would expect a shift from averted gaze to direct gaze to the viewer to elicit stronger activation in the regions involved in situational model updating: the TPJ, the STS region and the medial frontal cortex (Speer et al., 2009). As highlighted throughout the discussion, relevant independent variables include the perspective elicited by language in stories (egocentric vs allocentric) and the belief of being seen or not. Further considerations include eye contact duration (Kuzmanovic et al., 2009) and gaze shifting (Puce et al., 1998).

4.3 *Conclusion*

The current study aimed to unify previous accounts of eye contact perception and storytelling and provide evidence for the proposed mechanisms. Manipulating the storyteller's gaze direction had no effect on how they were evaluated by participants. Findings suggest that the positive appraisal of others elicited by direct gaze in previous studies did not extend to evaluating the storyteller and what they said. However, the same manipulation resulted in higher levels of story immersion when the speaker maintained eye contact in the second study. This finding, together with increased looking times to the top region of the face caused by the belief of being seen indicate that eye contact may influence speech perception and situational models in narrative comprehension. Specifically, a direct gaze may influence perspective taking in stories via self-referential processing. Also, storytelling may require one to focus on particular areas of the face to extract information relevant to speech perception. However, this proposal remains speculative and needs further investigation. To summarize, the current study motivates the further joint exploration of eye contact and storytelling and provides a starting point for theoretical considerations and predictions.

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Appendix

1. Items used in experiment one to measure storyteller evaluation

1. The speaker was emotional during this story.
2. I think that the story made the speaker seem like a good person.
3. Based on the video, I thought that the speaker was likeable.
4. The speaker was being sincere about their thoughts and feelings
5. I understand why the speaker thought and behaved as he did in the story.
6. The story reminded me of some of my own experiences.
7. If I was in that situation, I would have behaved or thought in the same way as the speaker.
8. I was engaged in the speaker's story.

2. Transportation scale items used in experiment two – adapted from Green & Brock (2000)

1. While I was listening to the narrative, I could easily picture the events in it taking place.
2. While I was listening to the narrative, activity going on in the room around me was on my mind.
3. I could picture myself in the scene of the events described in the narrative.
4. I was mentally involved in the narrative while listening to it.
5. The narrative affected me emotionally.
6. I found my mind wandering while listening to the narrative.
7. I found myself thinking of ways the narrative could have turned out differently.

3. Stories used as stimuli in the second experiment

First story narrated in the 2^{nd} person

The streetlights are bright. Unbearably bright. You have to squint as hard as you can to keep your retinas from bursting into flame. "Welcome back to the land of the LIVING, bud," Rob says. "You planning to stick around for a while or you gonna pass out again? You hear me? So if that's, like, your PLAN, then I'm droppin' you off and showin' up solo." You don't exactly remember where the day went, but as you listen to Rob rant on, bits of it start to float back to you: a day on the slopes, the brisk February wind against your face; polishing off a keg back at the lodge; those two girls you and Rob had hit it off with, the ones who'd given you their address in town. "We all should get together sometime!" they'd said. Of course, Rob insisted that by "sometime" they'd meant "later tonight." You hadn't been so sure, but then you'd blacked out before you could argue the point. How Rob came to be driving your car you're not exactly sure. Apparently he couldn't wait till you were sober enough to drive it yourself. From the way he's weaving all over the road, he also apparently couldn't wait till HE was sober enough to drive it, either. Rob changes the radio station a few times, eventually settling on the station you were listening to in the first place. The Chili Peppers are blasting in your ears. You ask Rob about his alcohol blood level. "Lower than yours, bud.". He looks over his shoulder as if about to change lanes but then turns on the windshield wipers instead of the turn signal. "Oops," he says.

Second story narrated in the 3rd person

Wendy Mackaye is the first woman on the red planet. When she signed up for this mission, she thought that she was going to be coming to a habitable colony. See, the orbiter was supposed to drop all the pieces of the colony onto the planet's surface. Wendy's job was going to be to take a tour of the place and verify that everything was up and running. Instead, something went wrong on the orbiter, and it blew up before it had a chance to drop off its payload. So, this has become a salvage mission. Her instruments indicate that there's at least 2 pieces that are still functioning. Her job is to find them. So she climbs down the ladder and stands at the base of her ship. The battered rust-red landscape stretches out before her in every direction, pitted and pockmarked and littered with boulders. The ladder leads up to the hatch of her ship. Wendy takes a few steps to the east, amazed at how the light gravity turns each step into a great bounding leap. She is next to what seems to be a piece of a bulldozer or some sort of construction equipment, its wheels wrapped in a tread like on an army tank. As she walks further north, Wendy finds first one geodesic panel, then another. Soon, the clear plastic panels are as plentiful as the rust-red boulders – must be where the dome for the living quarters landed. Scattered around her are the remains of what would have been home to the first wave of colonists. Most of the housing units have been reduced to unidentifiable splintered heaps, but there's one that seems not to be fully damaged. The entrance is partially obstructed by debris, but Wendy's small enough to probably squeeze through. There's a terrifying chill coming out, as she enters the housing unit.