Gaze-aversion & visual-spatial imagination

In press, British Journal of Psychology

Effects of gaze-aversion on visual-spatial imagination

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Abstract

Research suggests that averting gaze from an interlocutor can improve both children’s and adults’ performance in a range of cognitive tasks (e.g., Glenberg, Schroeder & Robertson, 1998; Phelps, Doherty-Sneddon & Warnock, 2005). With the present experiments, we investigated the effect of gaze aversion on adults’ visual-spatial imagination, using a methodology adapted from Kerr (1987). Participants mentally kept track of a pathway through an imaginary matrix, while either maintaining eye contact with the experimenter, closing their eyes, gazing at a static or a dynamic visual stimulus (in Experiment 1), or fixating an upright or inverted image of the experimenter’s face (in Experiment 2). The results show that whereas maintaining eye contact with another person disrupts accurate imagination of this pathway, averting gaze or looking at other visual stimuli does not. We conclude that gaze aversion benefits cognitive performance, not just by disengaging visual attention from irrelevant visual information, but also by interrupting social interaction processes involved in face-to-face communication.
It has been widely observed that in situations involving interlocutory interaction, adults and children often avert their gaze at certain points, especially when questions are difficult (e.g., Doherty-Sneddon & Phelps, 2005; Doherty-Sneddon, Bruce, Bonner, Longbotham & Doyle, 2002; Glenberg, Schroeder & Robertson, 1998). Indeed, the observation that children who are encouraged to avert their gaze from an interlocutor are able to answer more questions correctly than when they are instructed to look continuously at the interlocutor’s face has led some researchers to advocate teaching gaze aversion strategies to children in order to promote and enhance learning (e.g., Doherty-Sneddon, Bonner & Bruce, 2001; Doherty-Sneddon et al., 2002; Doherty-Sneddon & Phelps, 2005; Phelps, Doherty-Sneddon & Warnock, 2005).

That gaze aversion plays a role in interlocutory interactions has been known for some time. For instance, Kendon (1967) filmed conversations between adult participants and found that participants tended to avert their gaze for longer periods when speaking than when listening, while Ehrlichman (1981) found that when participants interacted with an interviewer on a video screen, they tended to look away from the screen more frequently when they were thinking or speaking than when they were listening to the interviewer. Beattie (1981) found that looking continuously at the face of the interviewer interfered with the production of spontaneous speech, and suggested that emotional arousal brought about by eye contact disrupts the process of formulating effective responses to questions.

More recently, Glenberg et al. (1998) investigated the effects of gaze aversion on memory recall. Participants in one experiment answered general knowledge or autobiographical questions of varying difficulty, asked either by an experimenter or presented on a computer screen. Participants were observed to avert their gaze under both conditions, and the frequency of this behaviour increased as question difficulty increased. In other experiments, participants closed their eyes, or looked continuously either at the experimenter’s nose, a static visual stimulus (i.e., a picture of a sunset), or a dynamic visual stimulus (i.e., a segment of silent film). When asked general
knowledge and mathematics questions, performance was superior when participants had their eyes closed, poorer when gazing at a static visual stimulus, poorer still when gazing at a dynamic visual stimulus, and poorest when gazing continuously at the experimenter’s nose. Glenberg et al. argued that these findings demonstrate that gaze aversion is motivated in part by a need to control cognitive load, thereby enabling a person to switch off from environmental stimuli that may be irrelevant but disruptive to the task they are trying to perform. Doherty-Sneddon and her colleagues (e.g., Doherty-Sneddon, McAuley, Bruce, Langton, Blokland, & Anderson, 2000; Doherty-Sneddon et al., 2001; Doherty-Sneddon et al., 2002; Doherty-Sneddon & Phelps, 2005; Phelps et al., 2005) conducted a series of studies, similar in design to those of Glenberg et al. (1998), to assess effects of gaze aversion on children’s cognitive performance. In one study, children were questioned face-to-face or via a live video-link (Doherty-Sneddon & Phelps, 2005). The questions tested arithmetic calculation, verbal reasoning, and autobiographical and episodic memory, and varied in difficulty. It was observed that children spent more time looking away when questioned face-to-face, although gaze aversion also increased in duration in both face-to-face and video-link conditions as the questions increased in difficulty. Based on these findings, it was argued that although social factors play a role in children’s use of gaze aversion, the primary function of this behaviour is to manage the cognitive load created by visual stimuli.

Other research has focused on the effects of gaze aversion on participant’s performance in tasks that assess visual-spatial memory. According to current theoretical approaches (e.g., Baddeley, 1986; Baddeley & Hitch, 1974), human memory is a multiple-component working memory system comprising a central executive and several modality-specific slave systems. The slave-system for visual-spatial working memory, often called the visual-spatial sketchpad, is a passive, time-limited store that provides an interface between visual and spatial sensory input and long-term memory. This system is assumed to be capable of temporarily maintaining and manipulating visual-spatial information. The manipulation of information in visual-spatial working
memory includes creating and navigating mental maps and forming mental images, and it is argued that visual spatial information is maintained, and ultimately may be consolidated in long-term memory, by a process of visual-spatial rehearsal (Logie, 1995). There is considerable evidence that performance on visual-spatial memory tasks, such as the Corsi-Blocks task (Corsi, 1972), in which a participant views a sequence tapped out on a collection of blocks, and must retain the information about which blocks had been tapped and in which order, and reproduce this information at test, is disrupted by procedures that compete for visual-spatial working memory resources (e.g., Baddeley & Lieberman, 1980).

Doherty-Sneddon et al. (2001) suggested that processing the appearance of someone’s face requires visual-spatial working memory resources and that averting gaze from a person’s face can preserve these resources for use in other cognitive tasks, and reported several experiments that assessed this claim. These experiments involved child participants, who had either to maintain eye contact with the experimenter, close their eyes, look at the floor, or monitor a dynamic visual stimulus (in this case a moving visual-spatial pattern). Participants performed different visual-spatial memory tasks, including a task in which they listened to descriptions of abstract shapes and then had to identify which shape had been described. Performance was best when participants closed their eyes or averted gaze by looking at the floor, poorer when they gazed at the dynamic visual stimulus, and poorest when they maintained eye contact with the experimenter (and similar evidence for face-to-face interference in the abstract shapes task was reported by Doherty-Sneddon et al, 2000). In post-experiment interviews, children reported using mental imagery or a combination of mental imagery and verbal rehearsal as a strategy for performing the task, and Doherty-Sneddon et al. concluded that performance was impaired when maintaining gaze on visually complex stimuli because this disrupted visual-spatial processing strategies. Similar results were obtained when children performed the Corsi Block Task. As before, performance was best
when children averted their gaze or closed their eyes and performance was poorer when they gazed continuously at the experimenter or a moving visual stimulus.

The visual-spatial tasks that Doherty-Sneddon et al. (2001) used clearly provided an effective assessment of the effects of gaze aversion on memory for visual-spatial information. However, it is not clear whether benefits observed in these experiments were due to face-to-face contact interfering with the processing of visual-spatial information or disrupting its maintenance in working memory. The present experiments were designed to more fully reveal the effects of gaze aversion on visual-spatial processing by employing a task that directly assesses visual-spatial imagination without testing memory recall. A good example of such a task is the matrix task developed by Kerr (1987). In this task, participants must mentally keep track of a pathway through matrices that vary in both size and complexity, and identify the path’s endpoint. In a typical trial, the participant is told to imagine a particular matrix and is told the starting point. The direction of each successive step in the pathway is then described verbally (usually by an audio recording), and at the end of the trial the participant is asked to indicate the end-point of the path, and given a point for each correct response. This matrix task has been used successfully to investigate the optimal speed for 2D and 3D imagery processing (Kerr, 1987, 1993), and the capacity of visual-spatial memory (Attneave & Curlee, 1983; Cornoldi, Cortesi & Preti, 1991).

The present experiments employed the matrix task to investigate the effects of gaze aversion on adult participants’ visual-spatial imagination. Following Kerr (1993), task difficulty was manipulated by employing a 2D (i.e., 3x3) matrix and a 3D (i.e., 3x3x3) matrix, and, in line with previous research, we employed audio-recorded directional instructions. For each matrix, a participant was instructed to focus his or her gaze where directed and to maintain this gaze while performing successive trials of the matrix task. Performance on the matrices was compared across block of trials in which participants engaged concurrently in gaze behaviours investigated in previous research (e.g., Doherty-Sneddon et al., 2001; Glenberg et al., 1998). Thus, participants in
Experiment 1 performed the matrix task while either maintaining eye contact with the experimenter, keeping their eyes closed, or gazing continuously at a blank computer screen, or one depicting a static visual image (i.e., a picture of a sunset) or a dynamic visual stimulus (i.e., a silent movie clip). Glenberg et al. (1998) and Doherty-Sneddon et al. (2001) found that performance on cognitive tasks was best when participants closed their eyes or averted their gaze by looking at the floor, poorer when gazing continuously at a static visual image (e.g., a picture of a sunset; Glenberg et al., 1998), poorer still when gazing at dynamic visual stimuli, such as a silent movie clip (Glenberg et al., 1998) or a moving visual-spatial pattern (Doherty-Sneddon et al., 2001), and poorest when either maintaining eye contact with an experimenter or merely looking at the experimenter’s face. In line with these findings, we expected performance on the matrix task to be superior when participants closed their eyes or gazed at a blank computer screen, poorer when they gazed at static visual image (i.e., an image of a sunset), poorer still when viewing a dynamic visual stimulus (i.e., a highly animated silent movie clip), and poorest when eye contact was maintained with the experimenter.

Experiment 1

Method

Participants

Twenty undergraduate psychology students from the University of Leicester, who had normal or corrected to normal vision, took part in the experiment as a course requirement.

Design

The experiment manipulated two within-participants independent variables. The first, the number of dimensions in the matrix, had two levels: 2D (3x3) and 3D (3x3x3) matrices. The second independent variable, the gaze condition, had five levels: eye contact with the experimenter, eyes closed, or gazing at a blank computer monitor screen or one showing either a static or dynamic visual stimulus. The dependent variable was the number of correct responses in the matrix task (i.e., responses that accurately identified the correct end-point in the matrix).
**Materials**

The 2D matrix was drawn in black ink on white cardboard. Each square of the matrix was 4cm² resulting in a total size of 144cm². The 3D matrix was built from wooden blocks, each measuring 3cm³, with a total size of 729cm³. For each matrix, 34 different pathways were generated, each with a designated starting square or block and seven statements expressing a sequence of one unit moves in either *up, down, left and right* directions for the 2D matrix and also *forward and backward* directions for the 3D matrix. No directional term appeared more than twice consecutively in each sequence. These directional statements were audio-recorded and this audio recording was used to provide directional instructions to participants in each gaze condition. The directional statements were audio-recorded with an interval rate of 0.5 seconds, read to the time of a metronome, as it was at this presentation rate that Kerr (1993) observed a difference in performance for 2D and 3D matrices. Static and dynamic visual stimuli were presented on a 17-inch computer monitor. The static stimulus was a picture of a sunset and the complex stimulus was an approximately 5-minute segment of a battle sequence from the *Lord of the Rings* movie, which was highly animated, and therefore likely to be visually interesting to the participant.

**Procedure**

Participants were informed that they were taking part in a study of perceptual processing. Written instructions were given on how to complete the task as well as two demonstration trials, one per matrix, and six practice trials, three per matrix. Participants were instructed to maintain eye contact with the experimenter in the live experimenter condition, and they were instructed to gaze continuously at the computer screen in conditions where participants viewed either a blank computer screen or a static or dynamic visual stimulus. In the eyes closed condition, participants were instructed to keep their eyes closed throughout the trial. Participants were instructed to adhere to these instructions until required to give their answer, and the experimenter checked compliance
on each trial. Participants sat approximately 1.5 metres from the computer screen or the experimenter, depending on the experimental condition.

At the beginning of each trial, the experimenter pointed to one of the matrices to indicate the relevant matrix and indicated that matrix’s starting point verbally and by pointing to the relevant square or block. The matrix was then hidden from view, and the audio-recorded directional instructions for that trial were played to the participant. The experimenter remained silent, stationary, and expressionless throughout each trial. At the end of the trial, the experimenter uncovered the matrix and asked the participant to indicate the final square or block in the path, either verbally or by pointing, or both, and the Experiment recorded the participant’s response. The experiment lasted approximately 40 minutes per participant.

Results

Mean and standard error data are shown in Table 1.

---------------Table 1 about here---------------

Task performance was analysed using a 2 (matrix complexity: 2D and 3D) x 5 (gaze condition: eye contact, eyes closed, blank screen, static visual stimulus, and dynamic visual stimulus) Analysis of Variance (ANOVA). This analysis revealed a significant main effect of matrix complexity, $F(1,19)=64.57$, $p<.001$, with more correct responses for the 2D matrix ($M=23.2$) than for the 3D matrix ($M=16.3$). There also was a significant main effect of gaze condition, $F(4,76)=7.50$, $p<.001$. Post hoc Tukey tests indicated that maintaining eye contact with the experimenter produced fewest correct responses ($p<.05$), and that the other gaze conditions did not differ significantly from one another ($p>.05$). The interaction of matrix complexity and gaze condition was not significant ($F<1$).

Discussion

Two clear effects were found. Imagining a pathway through a matrix was significantly more difficult in 3D than 2D matrices. This replicated Kerr’s (1993) finding that, at a 0.5 second interval
between successive directional instructions, greater accuracy is observed with 2D than 3D matrices. Having replicated this finding, we could be confident that the matrix task was effective in assessing visual-spatial processing in the present experiment. Crucially, the results also revealed that maintaining eye contact with the experimenter disrupted task performance. By contrast, gaze aversion (by closing the eyes or looking at a blank screen) produced superior performance, although this was no better than performance when gazing continuously at either a static visual image or a dynamic visual stimulus. Thus, it appeared that while maintaining eye contact with the experimenter disrupts visual-spatial imagination, averting gaze has no greater benefit on visual-spatial imagination than gazing at simple or complex visual stimuli.

Experiment 2 further investigated the difficulty experienced in the matrix task when eye contact is maintained. Specifically, it examined whether disruption to performance is caused by the presence of a face per se or is due to the presence of the individuals in the face-to-face interaction. Therefore, in Experiment 2, performance in the matrix task with eye contact and with eyes closed was compared to performance when participants gazed continuously at a photographic image of the experimenter’s face. Research indicates that images of faces presented upright and inverted may be processed differently, and that processing this information may be more difficult when viewed in inverted faces (e.g., McKelvie, 1995, Thomas & Jordan, 2002). In addition, previous research into gaze aversion suggests that although gaze aversion may serve to reduce the influence of social interaction on cognitive processing it also functions to manage cognitive load (e.g., Doherty-Sneddon & Phelps, 2005; Glenberg et al., 1998). Therefore, the processing complexity of the image of the experimenter’s face was manipulated by presenting this face upright or inverted to investigate the effect of cognitive load on visual-spatial imagination.

Experiment 2

Method
Participants

Twenty undergraduate psychology students from the University of Leicester students took part in the experiment as a course requirement. Participants had normal or corrected to normal vision and had not participated in Experiment 1.

Design

The experiment manipulated two within-participants independent variables. The first, the number of dimensions in the matrix, had two levels: 2D and 3D. The second independent variable, the gaze condition, had four levels: eye contact, eyes closed, or gazing continuously at either a photographic image of the experimenter’s face presented upright, or inverted, on a computer screen. The dependent variable was the number of correct responses in the matrix task.

Materials

Experiment 2 used the same matrices, pathways, and audio-recorded directional instruction as Experiment 1. Upright and inverted images of the experimenter’s face were created from a digital photograph and were presented on a 17-inch computer screen.

Procedure

The procedure was identical to Experiment 1. As in Experiment 1, participants were instructed to maintain eye contact with the experimenter during the live experimenter condition and, in addition, to fixate the eyes in upright and inverted images of the experimenter’s face. In the eyes closed condition, participants were instructed to keep their eyes closed until required to give their response at the end of each trial.

Results

Mean and standard error data are shown in Table 2.

Performance was analysed using a 2 (matrix complexity: 2D and 3D) x 4 (gaze condition: eye contact, eyes closed, upright image of the experimenter’s face, inverted image of the
Experiment 2 once again replicated Kerr’s (1993) finding that imagining pathways is more difficult in 3D than 2D matrices. As in Experiment 1, this finding confirmed that the matrix task provided an effective assessment of visual-spatial processing in this experiment. The results also confirmed the other key finding from Experiment 1; namely, that maintaining eye contact with another person is disruptive to performance in a visual-spatial imagery task. As in Experiment 1, it was observed that performance was poorest when eye contact with the experimenter was maintained, and performance was equally superior when participants averted gaze (by closing their eyes) or gazed continuously at an image of the experimenter’s face (either upright or inverted). Thus, gazing at an image of a person’s face did not disrupt task performance. It therefore appears that the social interaction associated with face-to-face interaction and not face processing alone is important in explaining the disruptive effect that occurs in a task that assesses visual-spatial imagination.

General Discussion

The results of the two experiments were clear. In Experiment 1, maintaining eye contact with an experimenter disrupted performance in the matrix task. Closing the eyes or looking at a blank screen produced better performance, but this did not differ in comparison to when participants gazed continuously at either a static or a dynamic visual stimulus, i.e., a picture of a sunset or a
highly animated silent movie clip. In Experiment 2, maintaining eye contact with the experimenter again disrupted performance in the matrix task, and closing eyes again produced better performance; but in this experiment, performance with eyes closed was not superior to performance when gazing continuously at an upright or inverted photographic image of the experimenter’s face. Thus, across two experiments there is clear evidence that maintaining eye contact with another person impairs performance in a task that assesses visual-spatial imagination, whereas averting gaze, by closing eyes, or viewing a blank computer screen or a static or dynamic visual stimulus, does not. Although performance was significantly poorer for 3D than for 2D matrices, matrix complexity did not modulate the effects of gaze aversion in either experiment.

These results replicate the major finding of previous research; namely, that averting gaze from another person (usually an interlocutor) can improve performance on cognitive tasks (Doherty-Sneddon et al., 2001; Doherty-Sneddon et al., 2002; Doherty-Sneddon & Phelps, 2005; Glenberg et al., 1998; Phelps et al., 2005). As in the present study, previous research has shown that maintaining eye contact with another person can interfere with cognitive performance (e.g., Doherty-Sneddon et al., 2001), as can merely gazing at someone’s face (Glenberg et al., 1998). It has been argued that gaze aversion might have specific benefits for visual-spatial processing, and researchers have attempted to reveal these benefits using tasks, such as the Corsi Blocks task, that assess short-term memory for visual-spatial information (Doherty-Sneddon et al., 2001). The present research re-examined this possibility using a task that directly assessed the effects of gaze aversion on visual-spatial imagination without testing memory recall. The results clearly indicate that maintaining eye contact with another person disrupts visual-spatial imagination and that averting gaze from that person’s face improves performance. Thus, it seems clear that gaze aversion is particularly beneficial to performance in tasks requiring visual-spatial imagination, as Doherty-Sneddon et al. had suggested. Moreover, whereas previous research has revealed that maintaining
gaze with another person can disrupt children’s performance on tasks with a high visual-spatial component, the present results shows that adults’ too are susceptible to these effects.

Other aspects of the present findings differed from findings from previous research. Previous research has shown that averting gaze from an interlocutor improves performance in cognitive tasks, but it also has shown that gazing continuously at a static visual stimulus, such as a picture of a sunset (Glenberg et al., 1998), or a dynamic visual stimulus, such as a silent movie clip (Glenberg et al., 1998) or a moving visual pattern (Doherty-Sneddon et al., 2001), impairs cognitive performance more so than closing eyes or gazing at the floor. Although the studies by Doherty-Sneddon et al. show that visual stimuli can disrupt children’s cognitive performance, the studies by Glenberg et al. reveal that these effects are observed for adults too. Doherty-Sneddon et al. proposed that continuously monitoring a dynamic visual stimulus can impair cognitive performance by disrupting visual-spatial processing. However, as we have already observed, this previous research has focused on the effects of gaze aversion on memory recall, including short-term memory recall for visual-spatial information. This research therefore does not reveal if the observed beneficial effects of gaze aversion are due to face-to-face contact interfering with the processing of visual spatial information or disrupting the maintenance of this information in short-term memory. By contrast, the present experiments more fully revealed the effects of gaze aversion on visual-spatial processing by employing the matrix task (Kerr, 1987, 1993), which directly assessed visual-spatial imagination without testing memory recall.

Experiment 1 revealed that averting gaze from the experimenter by looking either at a simple, static visual stimulus or at a complex and dynamic visual stimulus did not disrupt performance in the matrix task, and that gazing continuously at these stimuli was just as effective as a form of gaze aversion as looking at a blank screen. Similarly, in Experiment 2, gazing continuously at an upright or inverted image of the experimenter’s face did not disrupt task performance, whereas maintaining eye contact with the actual experimenter did. Thus, it appears
that whereas previous research indicates that visual stimuli may interfere with some aspects of
cognitive performance, particularly in tasks requiring memory recall, the present results show that it
does not interfere with performance on the matrix task, and therefore may not be disruptive to
visual-spatial imagination. Thus, the results suggest that positive effects of gaze aversion on visual-
spatial imagination may not just be due to a reduction in the cognitive load associated with
environmental stimuli. Indeed, in the present experiments it appeared that the complexity of the
visual stimuli was unimportant. What appears to be crucial to the positive effect of gaze aversion on
visual-spatial imagination is the elimination of social aspects of the stimulation that occurs during
face-to-face communication or when maintaining eye contact with another person.

Much of the interest surrounding gaze aversion research concerns its potential significance
as a technique within teaching and education. In particular, Doherty-Sneddon and her colleagues
have suggested that gaze aversion is a useful pedagogical tool that can produce more effective
learning (e.g., Phelps et al., 2005; Doherty-Sneddon et al., 2001). They have argued that by
encouraging the use of gaze aversion, teachers and parents can provide support for children engaged
in everyday problem-solving activities (Phelps et al., 2005). The present findings suggest that
although averting gaze improves performance, gazing upon other visual stimuli is not especially
disruptive to visual-spatial imagination. Thus, the particular gains that gaze aversion might bring to
learning may relate to the suspension of social aspects of the stimulation that occurs during face-to-
face communication or when maintaining eye contact with another person rather than just to a
reduction in cognitive load associated with averting gaze, particularly in tasks requiring visual-
spatial imagination. This finding has implications for interventions with children that have been
proposed, and the exact benefits thought to derive from gaze aversion in this learning environment
may need to be considered further.

The present research provides an insight into the effects of gaze aversion on visual-spatial
imagination but it is, nevertheless, the first study to have addressed this question directly. A more
complete understanding of the disruptive effect of either maintaining eye contact with another person or gazing continuously at someone’s face has on visual-spatial imagination is likely to be gained by further research that investigates, amongst other factors, the dimensions of social interaction across which this disruption operates. For example, an effect of intimacy may well modulate effects of gaze aversion, and this could be investigated by varying the physical distance between a participant and the experimenter when maintaining eye contact, using short distances to create higher levels of intimacy and longer distances to create lower levels of intimacy. Such research should also consider whether it is the physical presence of another person alone that is important or the social interaction involved in maintaining eye contact with that person. This question could be addressed by, for example, comparing performance when a participant either maintains eye contact with the experimenter or the experimenter turns away from the participant, or by comparing face-to-face and video-mediated interactions between a participant and an experimenter. Previous research suggests that gaze aversion is less frequent in video-mediated interactions than in face-to-face interactions (e.g., Doherty-Sneddon & Phelps, 2005). A comparison of performance on the matrix task in face-to-face and video-mediated communication would reveal if disruption to visual spatial imagination is found only when participants maintain face-to-face contact with an actual person or whether similar, but perhaps diminished, effects are observed in video-mediated interactions.

Another potential avenue of research would be to compare performance on the matrix task by participants who score high or low on measures of social anxiety or shyness to investigate whether this has an effect on performance when eye contact is maintained or gaze is averted (and for a discussion of individual differences in children’s gaze aversion, see Doherty-Sneddon, Phelps, & Clark, 2007). If it transpires that gaze aversion has specific benefits for participants who suffer acutely from social anxiety or shyness, then it may be advantageous to encourage the adoption of gaze-aversion by these individuals, especially in educational settings; although this and other
interventional approaches should be tempered by the knowledge that negative social judgments frequently are made of people who avert their gaze or turn their face away from an interlocutor (e.g., Larson & Shakelford, 1996). Finally, as the present studies involved adult participants only and much previous research has focused on children’s cognitive performance, an obvious next step would be to examine how children perform in the matrix task, in experiments that are similar in design to those reported here, to determine if the specific benefits of gaze aversion on visual-spatial imagination are observed for children as well as adults.
References


Table 1: Mean correct responses (with standard errors) in the matrix task in Experiment 1

<table>
<thead>
<tr>
<th>Gaze condition</th>
<th>Matrix 2D</th>
<th>Matrix 3D</th>
<th>Overall performance (maximum = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye contact</td>
<td>3.90 (.39)</td>
<td>1.85 (.36)</td>
<td>5.75 (.70)</td>
</tr>
<tr>
<td>Eyes closed</td>
<td>4.90 (.24)</td>
<td>2.85 (.46)</td>
<td>7.75 (.56)</td>
</tr>
<tr>
<td>Blank screen</td>
<td>4.50 (.32)</td>
<td>2.85 (.39)</td>
<td>7.35 (.63)</td>
</tr>
<tr>
<td>Sunset</td>
<td>5.00 (.27)</td>
<td>3.10 (.38)</td>
<td>8.10 (.56)</td>
</tr>
<tr>
<td>Film clip</td>
<td>4.90 (.30)</td>
<td>2.75 (.45)</td>
<td>7.65 (.66)</td>
</tr>
</tbody>
</table>
Table 2: Mean correct responses (with standard errors) in the matrix task in Experiment 2

<table>
<thead>
<tr>
<th>Gaze condition</th>
<th>Matrix 2D</th>
<th>Matrix 3D</th>
<th>Overall performance (maximum = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye contact</td>
<td>4.20 (.34)</td>
<td>1.75 (.32)</td>
<td>5.95 (.53)</td>
</tr>
<tr>
<td>Eyes closed</td>
<td>5.10 (.20)</td>
<td>3.15 (.43)</td>
<td>8.25 (.55)</td>
</tr>
<tr>
<td>Upright image of face</td>
<td>5.10 (.20)</td>
<td>2.35 (.37)</td>
<td>7.45 (.50)</td>
</tr>
<tr>
<td>Inverted image of face</td>
<td>5.30 (.23)</td>
<td>2.70 (.41)</td>
<td>8.00 (.58)</td>
</tr>
</tbody>
</table>