



Don't look now... I'm trying to think

WHAT was the name of your first headteacher? Stop and think for a while... did you just look to the heavens for the answer?

During difficult cognitive activity, for example remembering information, thinking of an answer to a question, planning what we are going to say, and speaking, we often close our eyes, look up at the sky, or look away from the person we are in conversation with. Adults are very good at switching off from environmental stimulation (both live faces and other sorts of visual display) in order to concentrate better.

Until recently we knew very little about whether children use gaze aversion in a similar way. This is a potentially important omission, since the efficiency with which children process information influences many aspects of their development, including school progress. In this article I'll describe what our research team at Stirling has been doing to investigate children's gaze aversion, including past and current



GWYNETH DOHERTY-SNEDDON *on the importance of children's eye gaze.*

work. Children's patterns of gaze promise to yield important cues to their thinking, concentration and mental processing that will be useful to parents, teachers, psychologists and anyone engaged in assessing children's knowledge and development.

Visual communication signals and cognitive effort

Considerable research effort has been expended on examining the role played by visual communication signals in human interaction. There is much evidence that visual communication signals (such as eye gaze, gesture and facial expression) are often important sources of information. Indeed, many researchers propose that such signals play a facilitatory role in human communication (e.g. Clark & Brennan, 1991; Goldin-Meadow *et al.*, 1992; McNeill, 1985). However, the fact that such signals are informative means that they carry a cognitive load: if you are forced to look constantly at your listener

while speaking, your speech will become less fluent and contain more 'ers' and 'ums' (Beattie, 1981). In addition, adults avert their gaze from other people's faces more when they're dealing with difficult questions, and this typically improves accuracy of response (Glenberg *et al.*, 1998). These sorts of findings have led to the 'cognitive load hypothesis' of gaze aversion – we avert our gaze at critical points within a task or interaction to avoid processing of unnecessary, distracting or arousing visual cues from our environment.

Switching off from environmental stimulation (sometimes other people's faces) is documented in real-world situations. Feyereisen and Lignian (1981) investigated gaze behaviour in normal and aphasic speakers. They found evidence that gaze avoidance reflects difficulty with verbal encoding. Difficult memory questions (e.g. 'Give me a word with five syllables') produce more frequent eye movements than questions involving less

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Gwyneth Doherty-Sneddon's homepage:

www.stir.ac.uk/staff/psychology/gds

extensive memory search (De Gennaro & Violani, 1988). Similarly, the perceived importance of gaze aversion for accurate memory recall is exemplified in Fisher and Geiselman's (1992) recommendation that a witness's eyes should be closed during cognitive interviews used for eyewitness testimony.

Not everyone agrees with a direct 'cognitive interference' hypothesis of gaze aversion. Beattie (1981) suggests that the cognitive load hypothesis is difficult to reconcile with the fact that adults are very good at dual-tasks and selectively attending to relevant stimuli. As an alternative, he suggests that too much gaze between adults can interfere with task accomplishment because it produces increased physiological arousal, which in turn influences cognitive processing. In other words, we gaze away from interlocutors' faces when doing demanding tasks not because information from faces produces an increased cognitive load, but because mutual gaze between people results in physiological changes (such as increased electrodermal activity: Nichols & Champness, 1971) that can influence cognitive functioning negatively.

Children's strategies

So it may be difficult to catch an adult's eye as you question them, but what about children? Until recently no one had investigated this phenomenon in children. Is disengaging from environmental

stimulation a skill that is learned? Children are especially dependent on non-verbal signals in both their comprehension and production of communicative messages. My own research has shown that young children rely on visual communication to support their relatively poor language (Doherty-Sneddon & Kent, 1996). An extract from a dialogue between two six-year-olds doing a map task illustrates just how much young children sometimes struggle with verbal expression of difficult information and how often they fall back on non-verbal strategies (see box).

Because children use visual non-verbal cues so often, might they look more at their interlocutors? And will this influence their ability to process information when visual cues distract rather than facilitate the task in hand?

In a recent study we investigated children's communication abilities in face-to-face and audio-only interaction using a communication task called the shape description task (Doherty-Sneddon *et al.*, 2000). In this task children attempted to describe and to understand descriptions of complex abstract shapes (see below for one set of shapes used). Such a task required that the information sender scrutinise the shapes for distinctive visual properties, and the information receiver built a visual representation of the described shape over time, sufficient to select the correct target shape from distractors.

FALLING BACK ON NON-VERBAL STRATEGIES

One child, the instruction giver (A), is explaining a route on a map to another child, the instruction follower (B), who has to draw this route on their own copy of the map. The bold words represent speech that was accompanied by communicative hand gestures that the children purposefully expressed to one another. Indeed, being able to see one another's gestures allowed young children to perform significantly better on this task.

A: Ehm, now do three straight lines.

B: Straight?

A: Uh huh.

B: **Like this?**

A: **No.**

B: **Like this, like this?**

A: **No 'dunk' 'dunk' straight down the way.**

B: **Down? Then do do do.**

A: **No just three lines straight down the way just three.**

With so much reliance on visual information, will young children still show gaze aversion?

In contrast to all our previous comparisons of face-to-face and audio-only interaction, the children performed less well when they could see one another than when they could not. This supported the argument that, in certain tasks, visual communication signals might interfere with task demands. Indeed, when they couldn't see one another, both senders and receivers focused more on verbal strategies that helped them establish understanding. In later work (Doherty-Sneddon *et al.*, 2001) we found that 'forcing' children to look at a sender's face while listening to descriptions of abstract shapes interfered with their abilities to understand these descriptions. In addition, children are less able to retain visuospatial information (such as a pattern of dots within a picture) when they have to monitor a face during retention than when they are allowed to look away.

We can look at gaze aversion as an overt strategy for shifting one's attention from environmental stimulation (such as faces). A vast literature has shown that older children are better than younger children in tasks that require the ignoring of irrelevant information. In addition, children's social understanding of gaze develops throughout early and middle childhood. For example, a child typically won't interpret high amounts of mutual gaze between two people to indicate liking



A set of shapes that children had to describe to each other

and attraction (in the way that adults do) until around six years old. We therefore expected that gaze aversion, as a strategy to shift attention, would develop with increasing age.

Development of gaze aversion

However, certain gaze aversion behaviours develop from a very early age. Aversion behaviour in response to social stimuli is reported in infants who often break mutual gaze with their caregivers during interaction (Bruner, 1977). It has been suggested that this relates to arousal control. Field (1981) conducted a literature review of studies investigating infant attention and affective behaviour, and their relationship to behavioural and psychophysiological measures. Field concluded that gaze aversion is a way of shutting off from external stimulation, typically occurring when the infant experiences too much stimulation or heightened physiological arousal.

These findings suggest that from an early age gaze aversion is a mechanism with which children control their own internal states. We were interested in finding at what age children use gaze aversion to control their mental load.

Our first studies of children's gaze aversion looked at different age groups of children answering questions of varying difficulty while face-to-face with an adult who was asking the questions. We predicted that the younger children would not increase their gaze aversion as questions got harder.

In one study, in which we compared five- and eight-year-olds, we found that children of eight years of age averted their gaze from a questioner's face more when thinking about and making their response to harder questions compared with easier ones (as expected children seldom looked away from their questioner when listening to the question, presumably because of the usefulness of visual cues such as lip configuration in speech perception). This was found with both verbal reasoning and arithmetic questions. We concluded that children of this age use gaze aversion to control their cognitive load in a similar way to adults.

This finding is potentially important for the way children are seen to engage in learning situations. There is a tendency in many cultures to encourage children to 'look at me while I'm speaking to you', and to interpret looking away as a sign of



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disengagement or lack of interest. What our research clearly showed was that primary-school-aged children used gaze aversion to help them concentrate on difficult material.

'gaze aversion in response to difficult questions is a skill that develops with age'

Therefore, provided the aversion is appropriately timed within the interaction (i.e. especially during thinking, and to a lesser extent during speaking), it is something to be encouraged rather than discouraged.

In contrast, five-year-old children only looked away more when answering difficult verbal questions, not arithmetic. These younger children only sometimes used gaze aversion when they had to concentrate hard. So gaze aversion in response to difficult questions is a skill that develops with age, rather than being an innate behavioural response to questions. Furthermore, the younger children generally looked at the questioner more. This suggests a higher reliance on visual cues at lower ages and perhaps an

attempt to elicit help from the adult rather than work things out themselves (Doherty-Sneddon *et al.*, 2002).

Preliminary work from another study suggests that gaze aversion by six-year-olds can be used as a cue to whether they are in their zone of proximal development (Vygotsky, 1934/1962). In this study the children worked through a series of arithmetic problems with a 'teacher'. Each child progressed through different stages of competence from being consistently incorrect, to giving partially correct responses, to consistently correct responses. Gaze aversion peaked for each child when they were working on sums that they gave partially correct responses to. We suggest that high amounts of gaze aversion reflect that the child is 'on task' but is having to try very hard to work out the problem (Doherty-Sneddon *et al.*, 2002). Gaze aversion may therefore be a useful cue that teachers and parents can use to judge children's 'readiness to learn'. These patterns of gaze promise to be important cues helping adults decide when to provide or withdraw additional help to a child they are teaching.

This research adds to what we know about how visual communication signals function in children's cognition. Visual



communication cues provide a rich source of information to adults and children alike and often produce significant communication benefits.

New research

We know that older children look away more when they are trying hard to concentrate, but what we don't know is whether this actually helps. Do children

who look away then answer more accurately? The first goal of our new ESRC project is to explore whether (and why) looking away from a questioner during difficult mental activity helps children's performance. If gaze aversion does have a functional benefit, this has important educational implications. It may be that encouraging young children to look away from their teacher when thinking (although not listening), helps them learn more effectively.

We are in the process of finishing two studies relating to this. In these studies we have looked at five-year-olds, since they typically avert their gaze from the face of an adult asking them questions far less than older children do. We have investigated the efficacy of encouraging these young children to look away more while thinking about arithmetic and verbal reasoning questions. So far we have found that children of this age are amenable to such 'training' and readily take gaze aversion on as a 'thinking strategy'. Furthermore, looking away while thinking *does* seem to result in more accurate responses to moderately difficult questions (Phelps *et al.*, 2003).

Our second goal is to examine whether the source of any such benefit is social or cognitive. In other words, does looking away help because children feel embarrassed or self-conscious when they find questions difficult? Or does gaze aversion work because the child reduces the amount of complex visual information they are processing when they look away? Perhaps both explanations play a part. To address this question we will look at

children's aversion behaviours when questioned face-to-face compared with across live video links, which reduce the social impact of visual cues (Doherty-Sneddon & McAuley, 2000).

Our earlier work shows that gaze cues promise to be useful external indicators of thinking and concentration. For example, children's levels of gaze aversion are much higher when they are just about to understand something compared with both when they fully understand and when they don't understand at all. Our final goal is to establish the extent to which teachers use patterns of gaze as cues within learning contexts in order to, for example, time the offering or withdrawal of instruction. The project will provide information relating to the use of non-verbal cues to promote learning. We are using a variety of methods to measure teacher responsiveness to pupil gaze, ranging from questionnaires to detailed video analyses of one-to-one teacher-pupil interactions. Teachers and primary school pupils from Stirling, Clackmannanshire and Glasgow are taking part in the studies.

We are only just beginning to understand the link between children's patterns of eye gaze and their cognition; there are many questions still to be addressed. If we look long enough into space perhaps we will fathom at least some of these.

■ *Dr Gwyneth Doherty-Sneddon is in the Department of Psychology, University of Stirling. E-mail: gwyneth.doherty-sneddon@stir.ac.uk.*

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