Journal of Experimental Child Psychology 116 (2013) 443–452

Contents lists available at SciVerse ScienceDirect

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

Toddlers' gaze following through attention modulation: Intention is in the eye of the beholder

Pieter F. de Bordes [a,*], Ralf F.A. Cox [b], Fred Hasselman [c], Antonius H.N. Cillessen [c]

[a] Department of Special Education, University of Utrecht, 3508 TC Utrecht, The Netherlands
[b] Department of Developmental Psychology, University of Groningen, 9712 TS Groningen, The Netherlands
[c] Behavioural Science Institute, Radboud University Nijmegen, 6525 HR Nijmegen, The Netherlands

ARTICLE INFO

Article history:
Available online 13 October 2012

Keywords:
Gaze following
Attention
Ostensive cues
Intention
CONSPEC
Natural pedagogy

ABSTRACT

We investigated 20-month-olds' ($N = 56$) gaze following by presenting toddlers with a female model that displayed either ostensive or no ostensive cues before shifting her gaze laterally toward an object. The results indicated that toddlers reliably followed the model's gaze redirection after mutual eye contact was established but did so equally reliably after the model's eyes had been made salient nonostensively. Moreover, both conditions elicited gaze following more prominently than when children's attention was initially directed away from the eyes either by specifically accentuating the mouth or by covering the entire face before the model redirected her eyes laterally. These findings suggest that gaze following by toddlers is more likely to be driven by general attention mechanisms than by their appreciation of somebody else's communicative intent through perceiving eye contact.

Introduction

It is a fundamental issue in the study of social development how infants learn to perceive the referential nature of other people's nonverbal behaviors such as facial expressions, pointing, and (in particular) eye contact and gaze (re)direction. First of all, within minutes from birth, infants are more likely to attend to face-like stimuli than scrambled or random patterns (Goren, Sarty, & Wu, 1975). Newborns also prefer to look at face-like stimuli that show the eyes compared with stimuli that do not (Batki, Baron-Cohen, Connellan, & Ahluwalia, 2000). Moreover, newborns show a preference for faces with direct (mutual) gaze as opposed to averted gaze (Farroni, Csibra, Simion, & Johnson, 2002).

* Corresponding author.
E-mail address: p.f.debordes@uu.nl (P.F. de Bordes).

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http://dx.doi.org/10.1016/j.jecp.2012.09.008

To elaborate, within the first year of life, infants are able to use an adult's eyes as an informative source, following their gaze direction toward objects or events that indicate where the adult's visual attention is directed (Carpenter, Nagell, & Tomasello, 1998). This is known as joint attention, where an infant joins in the attention of another person toward an entity. Unlike dyadic interactions such as protoconversations, joint attention is typically triadic in the sense that it involves both the coordination of the infant's interactions with another person and an entity or event to which they share attention, resulting in a referential triangle of child, adult, and entity/event (Tomasello, 1999). The significance of gaze following as an important cornerstone of social development is generally recognized (e.g., Baron-Cohen, Campbell, Karmiloff-Smith, Grant, & Walker, 1995; Carpenter et al., 1998; Flom, Lee, & Muir, 2006; Slaughter & McConnell, 2003; Tomasello, 1999). By following gaze, infants are able to redirect their own attention toward whatever is relevant to another person. By doing this, infants can discover what might drive that person's current and future actions.

An interesting finding that has been replicated consistently is that infants are most likely to follow the gaze of others after mutual eye contact has been established (Farroni, Johnson, Brockbank, & Simion, 2000; Gredebäck, Örnkloo, & Von Hofsten, 2006; Hood, Willen, & Driver, 1998; Senju & Csibra, 2008). Because mutual gaze can be interpreted as a communicative or ostensive signal, some researchers take this finding to reflect infants' understanding of others' communicative intent and expectation of a more active communicative role from the information source (e.g., Csibra, 2010; Csibra & Gergely, 2009; Grossmann, Parise, & Friederici, 2010; Hoehl et al., 2009; Senju & Csibra, 2008; Shepherd, 2010). Within this perspective, it is suggested that in order to establish joint attention between an infant and an adult by means of gaze following, the infant is required to detect a communicative intent of the adult provided through eye contact (Bruinsma, Koegel, & Koegel, 2004; Farroni et al., 2002; Mundy & Newell, 2007; Senju & Csibra, 2008). Subsequent behavior of the adult will then be interpreted as communicative, as in joint attention. In other words, it is the appreciation of communicative intent by which infants modulate their interpretation for what they see next.

The current study questioned this interpretation of the role of mutual eye contact in gaze following and investigated whether an attention modulation mechanism is sufficient to explain infant gaze following. First, we hypothesized that once an infant's attention has been drawn toward a model's eyes, the infant is more likely to follow subsequent gaze redirections than when attention has not been drawn toward the eyes. This demonstrates that the basic result of gaze-following research is replicated and, by that, emphasizes the importance of attention toward the eye region (e.g., Farroni et al., 2000; Farroni, Mansfield, Lai, & Johnson, 2003; Senju & Hasegawa, 2006). Second, we hypothesized that this effect would be present even without establishing actual eye contact between the infant and the model. This means that eye contact does not need to be established as a prerequisite for the infant to follow subsequent gaze redirection of the model. Such a result will weaken any account of gaze following that makes reference to some sort of mental interpretation of eye contact on the part of the infant as a necessity for gaze following to occur. No additional mentalistic reference or interpretation by the infant is needed as a result of the eye contact in order to follow the gaze subsequently.

In the remainder of this Introduction, we review studies that show under which conditions infants are likely to follow gaze. Specifically, the study by Senju and Csibra (2008) is reviewed, whereby the attention modulation and interpretation modulation accounts are contrasted. Finally, the current study is introduced and its hypotheses are formulated.

Conditions for gaze following in young infants

Infant gaze following has been studied extensively in 4-month-olds by Farroni et al. (2000, 2003). They focused on the basic sufficient conditions for infant gaze following to occur. They found two such conditions using spatial cueing paradigms in which a sequence of three pictures was shown: one face frontally presented to the infant, another face turned away laterally from the infant either left or right, and finally a stimulus at either the left or right visual field. The first condition concerns frontal face presentation. Infant gaze following was most efficient when the perceived face was presented in an upright orientation with frontal gaze before the averted gazing face was shown (Farroni et al., 2003; Senju & Johnson, 2009). The infant's preference for faces presented in an upright and frontal