

Preschool development of the concept of line-of-sight as evidence for developmentally distinct systems of gaze processing

Infants follow others' gaze direction from at least the second year of life yet three-year-olds cannot judge where someone else is looking (Doherty et al., 2009). A potential explanation for this disjoint is that gaze following and gaze judgement depend on developmentally distinct psychological systems (Doherty 2011). One orients the child's attention to objects others attend to, may be evolutionarily old, and hypothetically only outputs the object of attention to the general cognitive system. The other is about the relation between the agent and the object as such. It forms an important part of thinking about others' mental states and hypothetically develops as part of general theory of mind development.

Distinguishing gaze following from gaze judgement poses methodological challenges. Seeing eyes directed towards a target automatically cues attention to the target, which is then more likely to be chosen regardless of whether a participant can judge the gaze relation. As an alternative we use the concept of line-of-sight. This is the understanding that there must be a straight uninterrupted line between an agent and an object for the agent to see that object. This is a fact about the gaze relation; understanding this fact indicates the ability to think about this relation.

This talk will present data on the development of this concept. We will briefly review two studies (total N = 200) examining children's judgement of line-of-sight. We showed children small scale models in which a target was occluded by either a curved or a sharp corner. Young preschoolers judged another could see the target. Three-year-olds continued to do so even after looking themselves from the other's vantage point. Effects were greater for curved corners, possibly indicating they had learned about sharp corners from experience. Performance was significantly associated with the ability to judge eye direction.

This supports the claim that a concept of line-of-sight develops between 3- to 4-years. A strong *prima facie* objection to this conclusion is children's facility with other perspective taking tasks. Even 2-year-olds can hide objects by placing them behind occluding objects, or in other words by placing them where there is no line-of-sight.

However, they are unable to hide objects by placing occluders in front of them, suggesting their success is not via manipulating line-of-sight (Flavell et al., 1978).

Instead we argue that early success is via general sensitivity to what others are likely to engage with (e.g., things in front of you, with no occluding barriers). Engagement persists once established, and placing small occluders does not subsequently affect it. We briefly review two further studies looking at children's hiding ability (total N = 144). Manipulating whether engagement has been established by blindfolding the agent before introduction of the target object improves ability to interpose occluding objects. This supports the claim that younger children approach the task by judging general involvement rather than visual perspective. Performance on the original 'move-screen' task associates cross-sectionally with gaze judgement and theory of mind tasks. Additionally there is modest evidence of longitudinal links between early gaze judgement and later theory of mind performance, providing limited support for gaze understanding as an early manifestation of theory of mind abilities.

Overall we consider there is a good empirical case that line-of-sight understanding develops in the preschool period. It is a clear conceptual consequence of understanding the gaze relation between agents and objects. This supports the claim that gaze processing is based on distinct systems, one early but limited, and one developing in preschool. Potential links to theory of mind development suggest that the later gaze processing system and theory of mind are developmentally related. The causal nature of this development is the focus of ongoing work.

References

Doherty, M.J. (2011). A two-systems theory of social cognition. *Perception, causation, and objectivity*, 305-323.

Doherty, M. J., Anderson, J. R., & Howieson, L. (2009). The rapid development of explicit gaze judgment ability at 3 years. *Journal of Experimental Child Psychology*, 104(3), 296-312. <https://doi.org/10.1016/j.jecp.2009.06.004>

Flavell, J. H., Shipstead, S. G., & Croft, K. (1978). Young children's knowledge about visual perception: Hiding objects from others. *Child Development*, 49(4), 1208-1211
<https://doi.org/10.2307/1128761>