Infancy, *13*(3), 275–278, 2008

ISSN: 1525-0008 print / 1532-7078 online
DOI: 10.1080/15250000802004130

Psychology Press
Taylor & Francis Group

Headed in the Right Direction: A Commentary on Yoshida and Smith

Richard N. Aslin
Department of Brain and Cognitive Sciences
University of Rochester

In 1984, I was jogging through the streets of Bloomington, Indiana, and came to an intersection just as a car approached on the cross street. The car slowed down for the stop sign, the driver looked in my direction, and I proceeded to jog in front of its path, confident that the driver was aware of my presence and would certainly not run the stop sign. I was wrong. After tumbling over the hood of the car, which hit me at perhaps 10 miles per hour, I ended up on the ground, with the panicked driver standing over me asking if I was okay (I was bruised but not broken). The point of this anecdote is that everyone takes for granted the inference that where someone looks, which is often based solely on head direction, is coincident with where that person is attending. The hard lesson I learned by that accident is that looking is not the same as seeing.

Experimental psychologists have known for nearly a century that an excellent measure of visual attention is the direction of gaze (Buswell, 1922). Head direction provides a less accurate measure because the eyes can move within a 90° horizontal extent even when the head is stationary. A variety of methods were developed to measure gaze direction with exquisite detail, and some of these methods eventually migrated to the study of infants (see Aslin & McMurray, 2004). Unfortunately, the most precise methods were impractical, requiring fairly rigid head stabilization (Haith, 1969). When more flexible methods became available, most notably head-mounted eye trackers, they opened up a new perspective on how adults view their visual world under less restrained conditions. The head was now free to move, and in some cases the entire apparatus could be mounted on the person as he

Correspondence should be sent to Richard N. Aslin, Department of Brain and Cognitive Sciences, University of Rochester, Meliora Hall, River Campus, Rochester, NY 14627. E-mail: aslin@cvs. rochester.edu

or she walked or drove a vehicle (Hayhoe & Ballard, 2005). These devices provided an unprecedented window on the so-called first-person view of the visual world as adults performed a variety of visually guided motor tasks.

Yoshida and Smith (this issue) provide one of the first attempts to overcome the most serious impediment to the use of head-mounted eye trackers with infants: Except in rare cases (Corbetta, Williams, & Snapp-Childs, 2007) they are not light enough to be worn on an infant's head, or the infant does not tolerate looking through a half-silvered mirror that is hanging on a rigid stalk directly in front of their eye. Despite the possible dissociation between head direction and gaze direction, it has been known for many years (in part because of nonhuman species that have a small range of eye movements) that head direction is, on average, coincident with gaze direction. This is because maintaining eccentric gaze is difficult. Thus, the initial advantage of using eye movements to direct attention away from a central gaze position—they can be implemented more rapidly than head movements because of the much smaller mass of the eyeball—is offset by the extra effort of maintaining eccentric gaze. As a result, head movements tend to return gaze to a central (default) position after every eye movement beyond the central ± 10°.

Armed with this knowledge, Yoshida and Smith reasoned that head direction could serve as a useful, if not definitive, proxy for gaze direction. They first verified that head direction is largely consistent with gaze direction by obtaining an observer-based (not an eye tracker) measure of gaze direction. They then reported how infants direct their head to one of three locations on a table where a parent placed objects and provided visual and vocal cues to those locations. The measure of head direction came from a small head-mounted video camera positioned in the middle of the infant's forehead, thereby providing a first-person view of what the infant was most likely attending to.

The most surprising finding of Yoshida and Smith is that 18- to 24-month-old infants spend very little time (6%) looking in the direction of their parent's face. In the specific behavioral context used in their study, infants looked almost exclusively to their own hands (51%) or their parent's hands (31%) when they were grasping an object. This confirms the tight coupling between visual attention and action, especially when that action is under the infant's control.

Such a view of perception and action is precisely how Thelen (2000) thought about the development of the mind, as illustrated in the following quotation about the use of a visual mobile to study infant learning via foot-kicking responses:

> The radical idea here is that the sophisticated skills shown by infants in the mobile task are created by the performance and not just reflected in the performance. I am suggesting that cognition is literally acquired from the outside in and depends on the strength and nature of the perceptual-motor pathways that access higher functions. The consequences are that, at least initially, cognitive skills are tightly linked with these modalities such that we cannot really assess the pure contents of mind. Nor can

> we say that infants can discriminate or categorize or remember abstracted from the way that they demonstrate these skills to us. Each time we ask infants to demonstrate what they "really know," we must also confront the real-time dynamics of the specific task, which include perceiving and moving limbs, head, and eyes. (p. 17)

Although Yoshida and Smith describe a number of new insights about how infants direct their attention in naturalistic contexts where they are free to make head and hand movements, and demonstrate the utility of a head-mounted camera in providing a first-person's view of the infant's visual world, a number of follow-up questions immediately come to mind. First, are the distributions of looking to people, hands, and objects relatively consistent across task and age or do they vary systematically? Recent evidence from my lab (Fiser, Aslin, Lathrop, Rothkopf, & Markant, 2006) suggests that task has a substantial effect on the proportion of time that 4- and 8-month-old infants attend to people, hands, and objects. The effect of age (at least between 4 and 8 months) was relatively minor, and comparison data from adults suggested very few differences throughout development. Second, can the head-mounted camera technique provide sufficient spatial resolution to investigate research questions without contriving the behavioral context by limiting the number and separation of critical regions of interest? Yoshida and Smith used three locations on a nearby table to maximize the ease of scoring the head-camera images. Given the more subtle shifts in gaze required to identify regions of interest in natural contexts, it may not be feasible to rely solely on head direction without the additional precision provided by an eye tracker.

In sum, Yoshida and Smith have certainly headed the field of infant development in the right direction by their clever use of a forehead-mounted camera. Not only have they confirmed the validity of the technique, but they have revealed how 18- to 24-month-olds deploy their visual attention to people and objects in a seminatural behavioral context. As Thelen (2000) emphasized in her dynamic systems perspective:

> The critical implication of this dynamic conceptualization is that nervous system, body, and environment are always embedded and coupled dynamic systems. They start out that way, and there is no point in development and no context when they are not embedded and coupled. What can change is the nature of the coupling. In skilled behavior, the coupling is highly flexible and is dynamically responsive to the task. (p. 7)

This increasing skill implies that with development infants gain greater control over their own perceptual input. The work of Yoshida and Smith highlights how this growing control influences measures of visual attention from the infant's first-person perspective in domains as diverse as language, theory of mind, social referencing, and observational learning. Research in these domains will certainly

be enriched by this proof-of-concept, and we anxiously await the application of similar techniques in the near future.

ACKNOWLEDGMENTS

Preparation of this commentary was supported by grants from the National Institutes of Health (HD-37082) and the McDonnell Foundation (220020096).

REFERENCES

Aslin, R. N., and McMurray, B. (2004). Automated corneal-reflection eye-tracking in infancy: Methodological developments and applications to cognition. *Infancy, 6,* 155–163.

Buswell, G. T. (1922). *Fundamental reading habits: A study of their development.* Chicago: University of Chicago Press.

Corbetta, D., Williams, J., & Snapp-Childs, W. (2007, March). *Object scanning and its impact on reaching in 6- to 10-month-old infants.* Paper presented at the annual meeting of the Society for Research in Child Development, Boston.

Fiser, J., Aslin, R. N., Lathrop, A., Rothkopf, C., & Markant, J. (2006, June). *An infants' eye view of the world: Implications for learning in natural contexts.* Presentation at the biennial meeting of the International Society on Infant Studies, Kyoto, Japan.

Haith, M. M. (1969). Infrared television recording and measurement of ocular behavior in the human infant. *American Psychologist, 24,* 279–283.

Hayhoe, M., & Ballard, D. (2005). Eye movements in natural behavior. *Trends in Cognitive Sciences, 9,* 188–193.

Thelen, E. (2000). Grounded in the world: Developmental origins of the embodied mind. *Infancy, 1,* 3–28.