Chapter 14
Eye-Tracking Technology:
A Closer Look at Eye-Tracking Paradigms with High-Risk Populations

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ABSTRACT

Eye movements and gaze direction have been utilized to make inferences about perception and cognition since the 1800s. The driving factor behind recording overt eye movements stem from the fundamental idea that one's gaze provides tremendous insight into the information processing that takes place early on during development. One of the key deficits seen in individuals diagnosed with Autism Spectrum Disorders (ASD) involves eye gaze and social attention processing. The current chapter focuses on the use of eye-tracking technology with high-risk infants who are siblings of children diagnosed with ASD in order to highlight potential bio-behavioral markers that can inform the ascertainment of red flags and atypical behaviors associated with ASD within the first few years of development.

INTRODUCTION

The potential to investigate underlying visual and cognitive processes becomes likely through innovative eye-tracking tools that have relatively high spatial and temporal advantages over traditional methods. More specifically, eye-tracking paradigms that explore visual social attention allow researchers to target young children's spontaneous as well as task-specific processing of relevant information. Using subtle phenotypic behaviors such as eye movements in combination with precise analytic tools of eye-tracking technology with a primarily non-verbal infant population will increasingly inform and improve research designs in the field. Advances in neuropsychological techniques such as eye-tracking have allowed researchers to match children's eye gaze patterns to the dynamic processes of their social experiences, which can further serve to inform our understanding of the continuities and discontinuities that exist during the first few years of life. Implications from eye-tracking paradigms and the early identification of red flags may improve the efficiency of intervention practices that can provide repeated learning opportunities and facilitate more typical developmental trajectories.

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The overall purpose of this chapter is to examine the current practices of eye-tracking technology used with an infant and toddler population that is considered to be high-risk. More specifically, the chapter focuses on the ways in which eye-tracking technology is being used with young infants and toddlers who are considered high-risk due to their older siblings being diagnosed with autism or autism spectrum disorders (ASD). First, the chapter provides a brief overview of the methodological aspects of eye-tracking technology (e.g. eye-tracking software, data analysis, calibration, setting, stimuli, etc.). Second, the chapter focuses on ways eye-tracking technology is being used with a specific population of young children (i.e., high-risk infant siblings of children with autism). Finally, the chapter ends with a brief description of the future directions and conclusions for the application of this innovative technology. The chapter also aims to be of interest to an interdisciplinary audience of researchers, clinicians, developmental psychologists, early intervention providers, teachers, and parents seeking to understand the impact of social attention and targeted behavioral interventions that will have a life-long impact on young children and families.

BACKGROUND

The motivation behind recording one's eye movements stem from the fact that one's gaze provides a tremendous insight into the visualization patterns and informational processing that goes above and beyond basic behavioral observations (Aslin & McMurray, 2004; Duchowski, 2007). Due to the fact that eye movements are a bidirectional influence of cognitive and perceptual processes, tools that allow for tracking of multiple simultaneous psychological processes can be powerful in understanding phenotypic behaviors and their associated underlying mechanisms (Boraston & Blakemore, 2007; Mele & Federici, 2012). More specifically, the process of observational learning and interpreting relevant information from social environments requires not only the physical eye movements that constitute looking (Jones, Carr, & Klin, 2008), but it also involves coordinating attention and other neural structures involved in prioritizing incoming social cues (von Hofsten, Dahlström, & Fredriksson, 2005). The simultaneous development of the eye movement systems and the general arousal system results in a synchrony that allows for specified attention and subsequent eye movement control (Richards & Holley, 1999). For example, from early on, the direction of an individual's eye gaze provides indication of not only what the individual is focusing on, but also the subtle shifts in gaze direction indicate a change in this attention, allowing eye-gaze to serve as a fundamental ostensive cue in social referencing (Happé & Frith, 2014; Senju & Csibra, 2008).

Traditionally since the 1800s, eye movements and gaze direction have been utilized to make inferences about perception and cognition in humans (Kowler, 2011; Haith, Bergman, & Moore, 1977). Previous research has analyzed gaze following and eye gaze in infants using only the infants' first head turn (Flom, Deák, Phill, & Pick, 2004; von Hofsten & Rosander, 1997), imposing analysis of only the macrostructures of eye gaze, which can result in a loss of more subtle cues and gaze behaviors (Aslin, 2007; Aslin & McMurray, 2004). Although, several promising techniques were traditionally used for recording eye movements and gaze behaviors (e.g., the use of electrodes, electrooculography), the most common technique for understanding one's point of regard in a visual scene were video-based corneal reflection (CR) techniques (Duchowski, 2007; Gredebäck, Johnson, & von Hofsten, 2009). Currently, automated CR eye-tracking techniques capture and record the location of near infrared light in order to create reflection patterns called Purkinje reflections on the cornea and pupil of the eyes of the par-

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