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Research in Autism Spectrum Disorders

journal homepage: <http://ees.elsevier.com/RASD/default.asp>

Brief report

Difficulties predicting time-to-arrival in individuals with autism spectrum disorders



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ARTICLE INFO

Article history:

Received 22 December 2015

Received in revised form 19 April 2016

Accepted 4 May 2016

Available online 20 May 2016

Keywords:

Autism spectrum disorders

Driving

Motion

Prediction impairment

Time-to-arrival

ABSTRACT

Background: Previous research suggests people with ASD may have various difficulties in processing and interacting with motion in the environment. We investigated whether individuals with ASD have difficulty judging the location of moving objects in a driving context using a time-to-arrival task.

Methods: Participants with and without ASD viewed scenes that simulated self-motion towards a junction, while another car approached on a side road. Scenes terminated prior to either car reaching the junction and participants were required to decide which car would reach the junction first.

Results: Participants with ASD made fewer correct responses although this was only true when self-motion was on a straight road.

Conclusions: This difficulty in judging the location of moving objects could contribute to difficulties people with ASD experience in learning to drive.

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1. Introduction

Research suggests that individuals with Autism Spectrum Disorders (ASD) have difficulties processing moving objects (e.g. Koldewyn, Weigelt, Kanwisher, & Jiang, 2013). These issues may manifest in a range of contexts such as playground games (Robison, 2006), sports (Morin & Reid, 1985), and road environments. For instance, it has been reported that many individuals with ASD are unable to drive (Feeley, 2010), although further data is needed on this matter. Additionally, those with ASD face significant challenges in attaining a driver's license, as well as in driving after obtaining a license (Cox, Reeve, Cox, & Cox, 2012; Daly, Nicholls, Patrick, Brinckman, & Schultheis, 2014). While survey studies suggest these challenges are likely to be manifold, some of the difficulties reported are at least consistent with a difficulty in judging trajectories of other road users (Daly et al., 2014). For instance, in Daly et al. (2014), survey respondents with ASD were more likely than comparison participants to report being in accidents where they hit someone or something.

Various areas of previous research support the notion that people with ASD may have difficulties judging the movement of objects (see Simmons et al., 2009; for a review). Several studies have reported elevated motion coherence thresholds in ASD (e.g. Milne et al., 2002; Pellicano, Gibson, Maybery, Durkin, & Badcock, 2005), although some have not (e.g. Del Viva, Iglizzi, Tancredi, & Brizzolara, 2006). There is also evidence for atypical responses to optic flow in individuals with ASD (Gepner, Mestre, Masson, & de Schonen, 1996; Price, Shiffrar, & Kerns, 2012), and some suggestion of abnormalities in speed perception, although this may be an enhancement rather than a deficit (Chen et al., 2012). Alternatively, difficulties with prediction could result in problems processing moving objects. Sinha et al. (2014) argue that people with ASD may have a

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general impairment in predictive abilities which may give rise to problems with anticipating an object's future position based on current perceptual information.

The ability to predict the location of objects has been investigated in individuals of typical development using time-to-arrival tasks (e.g. Berthelon & Mestre, 1990). These tasks typically involve presenting participants with scenes where an object is moving at a constant speed towards a specified location. The scenes are occluded prior to the object reaching the location and viewers are required to predict when the object would have reached it. Accuracy of time-to-arrival judgments is influenced by various factors including the angle of approach of the object (e.g. Schiff and Oldak, 1990), and self-motion (Van Loon, Khashawi, & Underwood, 2010). Moreover, judgments are improved by the presence of a static reference point close to the moving object (Berthelon & Mestre, 1990), perhaps because participants use the relative optical velocity between reference point and approaching object as a guide in their judgments (Berthelon & Mestre, 1993). Perceptual style affects participants' use of the reference point. Berthelon, Mestre, Pottier, and Pons (1998) found that individuals who are Field-Independent, who have a tendency to process local details without contextual information, responded faster in the presence of the local reference point than Field-Dependent participants, who tend to process stimuli in a more holistic fashion taking the context into account.

Given the difficulties those with ASD experience in driving, the current research used a time-to-arrival judgment task to explore whether individuals with ASD are impaired in judging the movement of objects within a driving context. Participants with and without ASD viewed short computer-generated sequences which simulated self-movement towards a road junction and the movement of another car towards the same junction along a side road. The sequences terminated before either car reached the intersection, and participants judged whether the other car would have arrived at the junction before or after them. On some trials, small posts were positioned along the road of the approaching vehicle leading up to the junction, to act as a local reference point. It was predicted that participants with ASD would be less accurate than comparison participants at judging which car would arrive at the junction first. As it has previously been suggested that individuals with ASD have a local processing style, similar to Field-Independence (Happé & Frith, 2006), it was also predicted that they would be more influenced by the presence of a reference point, that the difference between the groups would decrease in the presence of road posts.

2. Methods

2.1. Participants

Twenty-three males with ASD were recruited from colleges in the West Midlands and South of England. They had all received a formal diagnosis of autism ($N = 7$) or Asperger Syndrome ($N = 16$) by a mental health professional (a psychiatrist or clinical psychologist employed by the National Health Service, using DSM-IV, American Psychiatric Association, 1994). The Wechsler Abbreviated Scale of Intelligence (WASI) was carried out with all participants to establish levels of verbal and non-verbal ability.

A comparison group of 21 males was recruited from colleges of Further Education in the Nottinghamshire area. Details of the groups are provided in Table 1. The groups were matched on chronological age, verbal, performance and full-scale IQ (all $p > 0.25$), and were enrolled in a range of academic or vocational courses.

Table 1

Participant details (ASD = Autism Spectrum Disorders; CA = chronological age; VIQ = verbal IQ; PIQ = performance IQ; FSIQ = full scale IQ; AQ = Autism Spectrum Quotient score).

	ASD ($N = 23$)	Comparison ($N = 21$)
CA (years) mean	18.55	18.83
sd	1.79	2.25
range	16.25–22.00	16.92–23.25
VIQ mean	99.00	99.48
sd	12.15	15.48
range	79–122	74–131
PIQ mean	100.09	103.48
sd	11.38	7.61
range	75–124	89–120
FSIQ mean	99.52	101.76
sd	11.01	10.98
range	86–124	80–122
AQ mean	25.26	14.95
sd	7.93	5.21
range	8–38	7–25

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