INVESTIGATING A RESPONSIVE INTERACTION TECHNIQUE FOR JOINT ATTENTION IN CHILDREN (8-12) WITH AUTISM SPECTRUM DISORDER: A PILOT EYE-TRACKING STUDY

by

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DEDICATION

To my parents, who taught me how to do hard work, and to my wife and children, who supported me while I worked hard on this project.

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ABSTRACT

Children with autism spectrum disorder (ASD) demonstrate difficulty with joint attention (JA). A scoping review showed that methods of cueing for and measuring JA used in research influence JA, with methodologies emphasizing one of ecological validity or gaze measurement accuracy while compromising the other. No investigations have paired mobile eye tracking with face-to-face interactions to examine JA in children with ASD. A case study using mobile eye tracking to explore differences in JA and gaze use by a child with ASD when interacting with two occupational therapists, one using the responsive interaction style and the other naïve to it, was performed. Interaction style did not impact JA but seemed to influence the child's gaze use. With the responsive therapist, the child looked more at the therapist's face, and less at non-therapist, non-task targets. While findings are not generalizable beyond the case study, they can instruct the design of future studies.

LIST OF ABBREVIATIONS USED

ASD	Autism Spectrum Disorder
JA	Joint Attention
IJA	Initiated Joint Attention
RJA	Responded Joint Attention
PEO	Person Environment Occupation
P	Person
E	Environment
O	Occupation
TD	Typical Development
CA	Chronological Age
IQ	Intelligence Quotient
SO	Social Orienting
ESCS	Early Social and Communication Skills
PTZ	Pan-Tilt-Zoom
Movement ABC-2	Movement Assessment Battery for Children, Second Edition
AOI	Area of Interest
MFG	Mutual Facial Gaze

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CHAPTER 1 INTRODUCTION

1.1 Autism Spectrum Disorder (ASD) and Occupational Therapy

ASD is characterized by difficulties with social communication and the presence of restricted or repetitive behaviours, together creating persistent social or occupational impairment (American Psychiatric Association, 2013). Occupational therapists commonly provide services to children with ASD (American Occupational Therapy Association, 2015). The American Centres for Disease Control currently reports the prevalence of ASD is 1 in 59 (Baio et al., 2018). There is a large and growing population of individuals diagnosed with ASD who seek occupational therapy services.

When enabling occupational performance with children with ASD, occupational therapists employ a variety of service delivery models and diverse intervention techniques (American Occupational Therapy Association, 2015; Canadian Association of Occupational Therapists, 2015). A recent scoping review found current methods of joint attention (JA) intervention for children with ASD align with client-centred occupational therapy practice (Eschenfelder and Gavalas, 2017), and that JA skills support the occupational performance of children with ASD, primarily through their impact on children's co-occupation with their parents (Eschenfelder and Gavalas, 2017).

1.2 ASD and Joint Attention

A deficit in JA has long been considered one of ASD's core features (Landa, Gross, Stuart & Faherty, 2013; Mundy, Sigman, Ungerer & Sherman, 1986). JA involves sharing attention between two people and an external referent (Mundy 2018). There are two types of JA: initiated joint attention (IJA), the intentional attempt by one person to coordinate attention with another person and an external referent; and responded joint attention (RJA), the responding to attentional bids that a communication partner has initiated. Looking at a partner's face is a precursor to JA (Mundy 2018). Both IJA and RJA are commonly expressed through gaze use (Mundy, 2018), as gaze is a signal of visual attention (Ho, Foulsham & Kingstone, 2015). IJA is also expressed with behaviors like pointing, showing and vocalizations designed to direct a partner's attention (Gulsrud, Hellemann, Freeman & Kasari, 2014). RJA is also expressed through behaviors like verbal acknowledgement or taking a contextually appropriate action implied by the partner's IJA (Bean and Eigsti, 2012). Children with ASD look at their social partner's face less than typically developing children (Falck-Ytter, Bolte & Gredenback, 2013; Guillon et al., 2014; Hanley et al., 2014; Noris, Nadel, Barker, Hadjikhani & Billard, 2012). JA is regarded as a pivotal behaviour, supporting the acquisition of other developmental skills (e.g., Casenhiser, Shanker & Stieben, 2011). Because of its critical contribution in childhood development, building JA skills is a frequent goal for professionals, including occupational therapists, when working with children with ASD (Eschenfelder and Gavalas, 2017).

From the occupational therapy perspective, JA is considered a skill or capacity that falls under the conceptualization of the person within many theories of occupational performance, such as the Person Environment Occupation model (Law et al., 1996). By strengthening social engagements with others, improving JA skills in children with ASD facilitates improved occupational performance (Eschenfelder and Gavalas, 2017).

1.3 ASD and Responsive Interaction Interventions

One group of promising interventions commonly used to help children with ASD build JA skills focuses on the use of a responsive interaction style. The responsive interaction style a complex set of interrelated behaviours (Ruble, McDuffie, King & Lorenz, 2008), guided by the principles of contingency, reciprocity, positive affect and non-directiveness when engaging with children (Mahoney & Solomon, 2016). There are several independently-developed intervention programs that employ professional and/or caregiver use of the responsive interaction style with children with ASD. In the literature, these programs have been grouped together under several labels, among them Developmental Social Pragmatic (Casenhiser et al., 2011; Pajareya & Nopmaneejumruslers, 2011) Developmental / Relationship-based (Kossyvaki, Jones & Guldberg, 2014) and Responsive Interaction Intervention (Kong & Carta, 2013), none of which have come into common use.

When adults consistently use a responsive interaction style, positive developmental outcomes in typically-developing children (Warren & Brady, 2007), children with a range of developmental diagnoses (Mahoney & Solomon, 2016), and ASD (Siller, Hutman & Sigman, 2013) are observed. When considering children with ASD and the impact of adult responsive interaction style use, most studies have reported on parent-mediated interventions, in which parents, with input from professionals, routinely use a responsive interaction style in daily life. In this service delivery model, interventions consistently increase parent responsivity (Aldred, Green & Adams, 2004; Casenhiser et al., 2011; Green et al., 2010; Mahoney & Solomon, 2016; Pickles et al., 2015; Siller et al., 2013). These and other studies have also demonstrated improvements in child outcomes: joint attention (Casenhiser et al., 2011; Green et al., 2010; Oono, Honey & McConachie, 2013), dyadic communication (Aldred et al., 2004; Green et al., 2010; Pickles et al., 2015; Oono et al., 2013) expressive language (Aldred et al., 2004; Siller et al., 2013; Oono et al., 2013), and severity of ASD symptoms (Aldred et al., 2004; Mahoney & Solomon, 2016; Oono et al., 2013; Pajareya & Nopmaneejumruslers, 2011). In one randomized control trial, parent use of responsive interactions is associated with significant improvements in child joint attention and initiations, independent of group assignment to the group receiving coaching in that style (Karaaslan, Diken & Mahoney, 2011). Interventions featuring the responsive interaction style promote faster acquisition of developmental skills in preschoolers compared to treatment as usual (Landa, Holman, O'Neill & Stuart, 2011; Pajareya & Nopmaneejumruslers, 2011). Analyses of treatment mediators have found parent responsiveness a mediator in these outcomes (Aldred et al., 2012; Kim & Mahoney, 2005; Mahoney & Solomon, 2016; Pickles et al., 2015).

The existing research shows that when adults use a responsive interaction style with children with ASD, positive results follow. My clinical experience providing service to children with ASD matched what the research showed. After consistently incorporating the responsive interaction style into my practice, I noticed children seemed to be obtaining parent-prioritized goals faster, children seemed to be having more fun in occupational therapy appointments, parents seemed happier with the service, and I was enjoying myself more. I also noticed that I was alone in my community in my use of the responsive interaction style. Entry to practice occupational therapy students who participated in fieldwork in my practice were unfamiliar with the theoretical background, research base and practical use of the responsive interaction style. Other professionals with whom I collaborated did not seem interested in it, or believe that it was a well-researched intervention strategy. The disconnect between my experience how the responsive interaction style was perceived in my local community was the initial seed of this thesis project.

1.4 Measuring JA in ASD

The studies supplying evidence for the positive impact of the responsive interaction style on JA in ASD (e.g., Karaaslan et al., 2011; Casenhiser et al., 2013; Green et al., 2010) primarily use behavioural observation of video recorded interactions to collect data collection. Even when maintaining methodological rigor, determining JA from video review can be inaccurate (Guillon et al., 2014). As children with ASD sometimes use atypical gaze patterns, determining the precise target of gaze, and thus JA, can be challenging (Guillon et al., 2014).

Computerized eye tracking is a tool that more accurately measures the target of an individual's gaze (Falck-Ytter et al., 2013; Guillon at al., 2014). Corneal reflection is a widely-used eye tracking technology in which near-source infrared light is aimed at the eyes, and video cameras capture images of the eyes, and of the reflections of the infrared light off the corneas and pupils. Computer algorithms calculate gaze position based on the images of the pupils and the reflections (Falck-Ytter et al., 2013). As gaze location is used to infer the target of visual attention (Falck-Ytter et al., 2013), more accurately measuring gaze during JA with eye tracking can lead to more accurate determinations of the target of visual attention.

Most studies measuring JA in ASD with eye tracking have used screen-based eye tracking. In these studies participants view pre-recorded or algorithmic stimuli presenting simulated social exchanges on a screen while the eye tracker measures their gaze responses. Reviews of these investigations (Falck-Ytter et al., 2013; Guillon et al., 2014) question their ecological validity, as they present simulated and not actual social interaction. Engaging with a cue presented on a screen is very different than engaging with a cue in a dyadic exchange. In the real world, gaze has the dual functions of conveying visual information and signaling attention (Risko, Richardson & Kingstone, 2016). In unmonitored situations gaze use might be very different from situations where its use is monitored (Wu, Bischof & Kingstone, 2013).

Mobile eye tracking is a tool that permits accurate measurement of gaze in real world social interactions. Using mobile eye tracking during dyadic interaction allows accurate measurement of gaze use in JA within the context of a face-to-face interaction. The few studies that have used mobile eye tracking with children with ASD (Hanley et al., 2014; Noris et al., 2012) have found that children with ASD look at their social partner's face less than typically developing children during social interaction. These studies did not examine the impact of adult interaction style on child gaze use, and did not report on child JA. As eye tracking can reveal fine-grained temporal information about gaze use (Falck-Ytter et al., 2013), using it in an ecologically valid investigation of JA can potentially add information of value to the field.

1.5 Thesis Overview

This thesis is organized as follows: Chapter 2 is a scoping review that describes the influences of JA cueing and measurement methods on JA performance using the Person Environment Occupation model of occupational performance (Law et al., 1996). Chapter 3 describes the methodology of a planned pilot study to use mobile tracking to measure the impact of occupational therapist interaction style on gaze use and JA in children with ASD, and its transformation into a descriptive case study. Chapter 4 presents the results of the descriptive case study. Chapter 5 outlines the ways these findings might inform occupational therapy practice, education and research.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

As a profession concerned with enabling occupation to promote health and well-being, occupational therapists commonly provide services to children with autism spectrum disorder (ASD). The American Occupational Therapy Association reports that occupational therapy is the second-most frequently provided service for individuals with ASD in the United States, second to speech therapy (American Occupational Therapy Association, 2015). Using a variety of treatment methods, occupational therapists work to enable the performance of children with ASD in various occupations (American Occupational Therapy Association, 2015; Canadian Association of Occupational Therapists, 2015). As the American Centres for Disease Control currently estimate the prevalence of ASD at 1 in 59 (Baio et al., 2018), there is a large population of individuals with ASD that could access occupational therapy service.

Reduced quality and quantity of joint attention (JA) is consistently seen in children with ASD (Landa, Gross, Stuart & Faherty, 2013). JA is the sharing of attention between two people with a third element external to the dyad (Mundy 2018). JA is divided into two types: initiated joint attention (IJA), the intentional attempt to direct a partner's attention to an external element; and responded joint attention (RJA), responding to attentional bids toward an external element. The primary purpose of JA is to share an experience with another person (Mundy 2018). JA is considered a pivotal behaviour which supports ongoing human social cognition (Mundy 2018) and the acquisition of other developmental skills such as language use (e.g., Casenhiser, Shanker & Stieben, 2011).

Because of the key role of JA in facilitating childhood development, it is a frequent target for intervention among professionals providing services to children with ASD, including occupational therapists. A recent scoping review examining the impact of teaching JA strategies on engagement in occupation and co-occupation for children and families with ASD (Eschenfelder and Gavalas, 2017) concluded teaching JA strategies supports engagement in occupations, and in co-occupations with parents. Using the American Occupational Therapy Association's Occupational Therapy Framework: Domain and Process (2014a) and Scope of Practice (2014b), that recent review (Eschenfelder and Gavalas, 2017) also positions JA teaching strategies as consistent with contemporary occupational therapy practice. That recent scoping review (Eschenfelder and Gavalas, 2017) did not use models of occupational performance to link JA research to occupational therapy scholarship or practice.

Current literature measuring JA in children with ASD does so in two broad ways. One method elicits JA through in-person, play- or conversation-based interactions between research participants and examiners. This method extracts data from reviewing videos of these interactions (e.g. Karaaslan, Diken & Mahoney, 2011). The other method elicits JA through presentation of video stimuli on electronic screens. It extracts data by measuring gaze use with eye trackers (e.g., Swanson & Siller, 2013). In the literature, there is currently no analysis of the impact these differing cueing and measurement methods have on the JA demonstrated by participants in the research.

The Person Environment Occupation (PEO) model of occupational performance (Law et al., 1996) a useful analytical lens for understanding how different JA cueing and measurement methods influence JA performance. The PEO model conceptualizes occupational performance as the result of transactions between three components: person (P), environment (E), occupation (O). This model's three components are considered interdependent. A change in one of P, E or O results in a change in the others, and ultimately in occupational performance. Inside the PEO model, JA can be considered a part of the P component. It is an individual competency that influences how a child interacts with others, and through that, how a child engages with occupations in multiple environments. Children use JA skills when interacting with parents, siblings, friends, teachers and others to participate in occupations like play, group work in school and when learning new skills from another.

The purpose of this review is to analyse the transactions between JA cueing, the skills children need to use to engage with presented cueing, and demonstrations of JA occurring in the protocols of research studies examining JA in children age 6 – 12 with ASD to understand their influence on JA performance.

2.2 Method

As scoping reviews are used to map the range and extent of a research activity (Arksey and O'Malley, 2005) and to clarify a complex concept (Levac et al., 2010), the scoping review was selected as an appropriate methodology for this review. The Arksey and O'Malley (2005) five-step method of scoping reviews, with the recommendations made by Levac, Colquhoun, O'Brien and Kelly (2010) and by Colquhoun et al. (2014) guided the process used in this paper. The five steps of scoping review were followed: identifying the research question; identifying the relevant literature; study selection; charting the data; and collating, summarizing and reporting the results (Levac et al., 2010). The optional sixth step of stakeholder consultation recommended by Levac et al. (2010) was not used.

Step 1: Identifying the research question

A scoping review was used to examine the research question "How do the PEO transactions occurring in the protocols of research studies examining JA in children age 6 – 12 with ASD influence the children with ASD's JA performance?"

Step 2: Identifying relevant literature

Three electronic databases (CINAHL, PsycINFO and PubMed) were first searched for terms related to individual concepts, and then searched by combining the results of these concept searches to produce more refined results. The two concepts guiding this search were ASD, and JA. Search terms for ASD included: Autistic Disorder OR autis* AND ASD OR Child Development Disorders, Pervasive. Search terms for JA included: joint atten*. Headings, thesaurus terms and MeSH terms were used, when available, in each of the respective databases.

Step 3: Study selection

Inclusion criteria for study selection were: English language, publication in a peer-reviewed journal between 2008 – June 2018, JA performance as an outcome of the study, JA performance of ASD group compared to a typically developing (TD) group, mean age of groups between 6 and 12 years. Records that did not meet all inclusion criteria were excluded, as were reviews. Initial searches produced a total of 225 records, reduced to 144 following removal of duplicates. Abstracts of the remaining records were screened, and the inclusion / exclusion criteria applied, excluding an additional 119 records. Full text assessment of the remaining 25 records excluded an additional 19 (5 because they lacked a TD control group, 9 because the mean age of the groups was outside of the 6 – 12 age range, 4 because they did not use JA as an outcome measure, and 1 because it was not published in a peer-reviewed journal). The remaining 6 records that met the criteria were retained and included in this review. This process is graphically depicted in Figure 2.1.

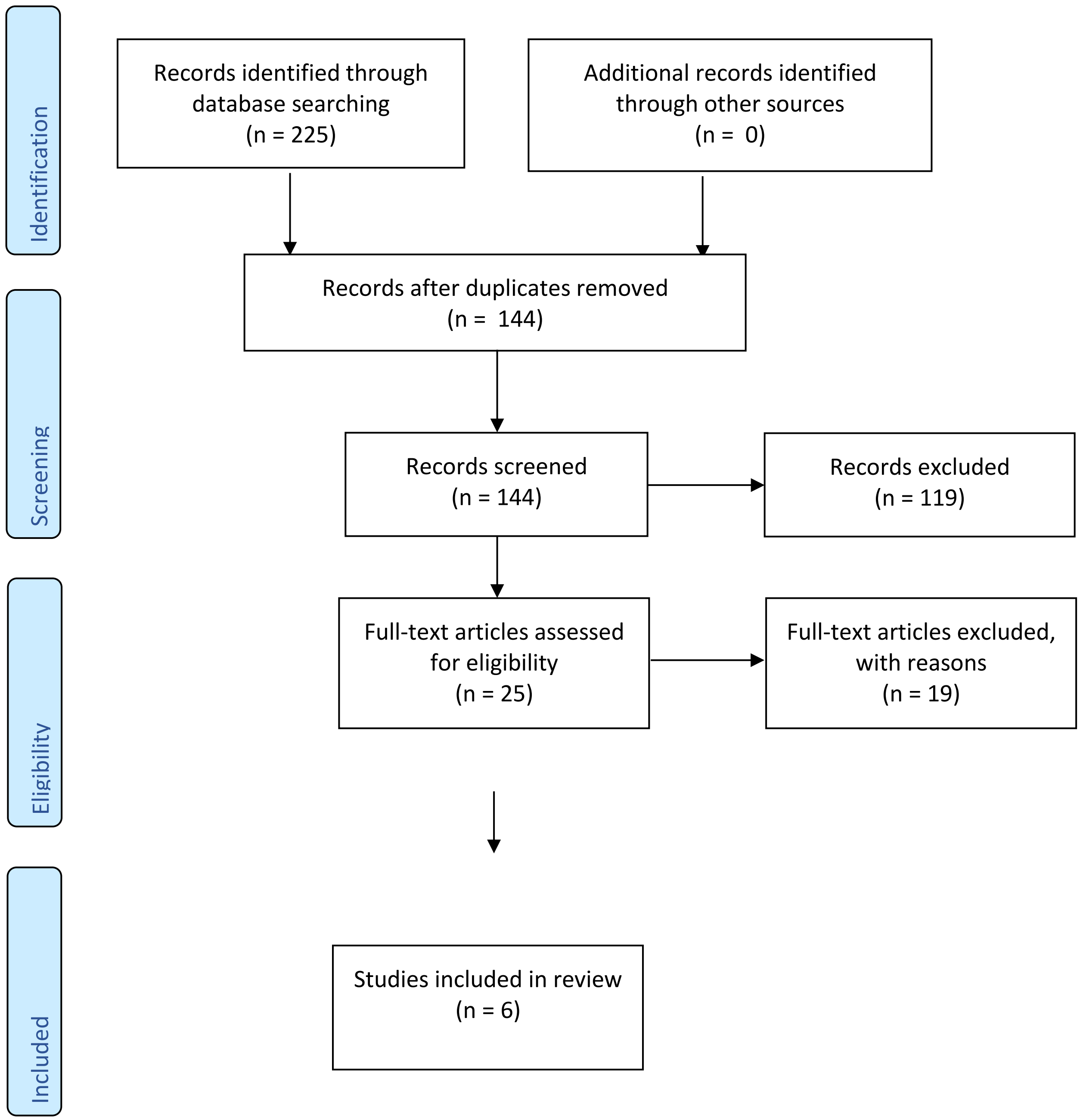


Figure 2.1 Literature search strategy

Step 4: Charting the data

The 6 studies retained were reviewed and their data extracted into three tables. Table 2.1 documents each study's author, year of publication, study purpose, study design, population and instrumentation.

Table 2.1 Descriptive summary of retained records

Author	Design and Purpose	Sample	Instrumentation
Anzalone et al. (2014)	Cross section between groups comparison To compute a robotic platform able to elicit JA; to compare JA between TD and ASD groups; to compare 4D exploration of environment between groups	X+ n=16; children with ASD CA mean 9.25 years. X- n=16 children with TD CA mean 8.06 years. Matched by developmental age and gender.	Experiment in a small room, with posters on the walls to the right and left of child's partner to act as referents. Child interacts first with experimenter in a play based-exchange, then with robot, in the same sequence of RJA tasks. Interaction is recorded, and JA behaviours are analysed from recorded data.
Bean & Eigsti (2012)	Cross section between groups comparison To index a JA measure's sensitivity	X+ n=18 children with ASD CA mean 12.8 years X- n=24; children with TD CA mean 13.0 years. Matched by age, receptive vocabulary and IQ.	Child seated across table from examiner. Six naturalistic RJA prompts presented between other formal tests. Interaction is recorded, and JA behaviours are coded from video review.
Gulsrud et al. (2014)	Randomized control trial. Follow-up at 6 months, 12 months and 5 years following intervention To examine the growth trajectories of JA and expressive language skills over 6 years period by initial group allotment, and by diagnostic	X+ n=27 children with higher functioning ASD on 5-year follow-up CA on 5-year follow-up 8.94 years X+ n=5 children with lower functioning ASD on 5-year follow-up CA on 5-year follow-up 8.53 years	Participants seated across a table from examiner; age appropriate toys provide affordances for IJA in a play-based context. Interaction is recorded, and JA behaviours are coded from video review.

Author	Design and Purpose	Sample	Instrumentation
	outcomes; To examine causal relationships between trajectories of JA skills and expressive language use	X- n=8 children no longer meeting diagnostic criteria on 5-year follow-up; CA on 5-year follow-up 8.72 years	
Johnson et al. (2012)	Cross section correlational study To use eye tacking and: replicate findings of a relationship between JA and social orienting; investigate the relationship between JA and imitation; and between social orienting and imitation.	X+ n=14 children with ASD, mean CA 88.8 months X- n=8 children with TD, mean CA 52.6 months	Participant is seated in an adjustable motorized chair, across a table from examiner. Research assistant familiar to the child is seated to the right of the participant. Examiner delivers scripted, standardized cues. Tobii x50 eye tracker on the table between participant and examiner. Eye tracker records gaze response at a sample rate of 50 Hz. Gaze responses are later analysed using eye tracker's software package.
Mundy et al. (2016)	Cross section between groups comparison To examine the information processing effects of JA in higher functioning children and adolescents with ASD.	X+ n=32 children with high functioning ASD mean CA 11.4 years X- n=27 children with ADHD symptoms mean CA 12.2 years; matched with ASD group on age, memory and attention. X- n=23 children with TD mean CA 11.8 years. Matched with ASD group on age.	Child wearing mono-head mounted virtual reality display system, 40-degree field of view on 0.59 diagonal inch display. Infrared eye tracker sampling at 60 Hz tracked right eye movements relative to stimuli. Gaze responses recorded and later analysed.
Thorup et al. (2017)	Cross section between groups comparison	X+ n=23 children with ASD, 16 of which provided	Child seated at a table, 60 cm from a 17-inch monitor with Tobii T120 eye tracker.

Author	Design and Purpose	Sample	Instrumentation
	To replicate findings of decreased differentiation between attended and unattended objects in ASD To determine if objects corresponding to common circumscribed interests improve sensitivity to contextual gaze cues in ASD.	usable data. Mean CA 81.56 months X- n=25 children with TD, 17 of which provided usable data. Mean CA 74.12 months. Matched on age, gender and nonverbal IQ.	Eye tracker, sampling at 120 Hz, records gaze response to video stimuli. Gaze responses later analysed using eye tracker's software package.

X+ - experimental group; X- - control group; JA – joint attention; RJA – responded joint attention; IJA – initiated joint attention; TD – typical development; ASD – autism spectrum disorder; CA – chronological age; IQ – intelligence quotient.

Table 2.2 maps the transacting components within each retained record's methodology and documents the main JA findings of the record..

Table 2.2 Mapping transacting components of each retained record's methodology.

Author	Task Demand How the Participant Engaged with the JA Cues	Research Context How the JA Cues are Delivered to the Participant	JA Feature How the Participant Demonstrated JA	JA Findings
Anzalone et al. (2014)	Play and conversation with examiner; monitor and respond to robot.	Sequence of progressively direct RJA cues: gaze; gaze plus gesture; gaze plus gesture plus vocalization. First delivered by examiner in a play session, then repeated more formally by robot.	RJA: Gaze moves to referenced object, measured from review of video.	No group differences in RJA with human partner. ASD lower RJA performance than TD with robot partner ($p = 0.001$).
Bean & Eigsti (2012)	Play and conversation with examiner.	Examiner embeds RJA cues between formal testing items. Cues	RJA: Points for each of these behaviours, higher	RJA: Significant group

Author	**Task Demand** **How the Participant Engaged with the JA Cues**	**Research Context** **How the JA Cues are Delivered to the Participant**	**JA Feature** **How the Participant Demonstrated JA**	**JA Findings**
		delivered when participant is not visually engaged with examiner. Cue types are grouped by verbal or nonverbal, and number of gaze shifts required by participant (single or dual). Some cues based on ESCS.	scores indicate more social behaviour: triadic attention; look to examiner's face; look at examiner's eyes; offer appropriate vocalization. Scored in vivo by observer, confirmed by video review.	differences with total score ($p < 0.001$), and with all subscales ($p < 0.001$ – $p < 0.01$)
Gulsrud et al. (2014)	Play and conversation with examiner	Cues delivered in semi-structured play-based tasks with examiner. Cues based on ESCS.	IJA: Alternating gaze between object and partner; showing object to partner; pointing to object	IJA: The group that no longer had autism or ASD diagnosis at 5-year follow-up showed higher frequency of JA skill use compared to autism ($p < 0.01$) and ASD diagnostic groups ($p < 0.01$ – $p < 0.03$)
Johnson et al. (2012)	Monitor and respond to standardized interactions delivered by examiner, supported by research assistant	Cues delivered in standardized manner by examiner: examiner states, "Watch me," and pauses for 3 seconds, then demonstrates facial expression or action with a toy. Participant	RJA: gaze shift to examiner's face or body in response to research assistant's point toward examiner, when necessary to support attention.	ASD and TD group share correlations: RJA (body) with SO (body); RJA (body) with RJA (face); RJA (face) with SO (face);

Author	Task Demand How the Participant Engaged with the JA Cues	Research Context How the JA Cues are Delivered to the Participant	JA Feature How the Participant Demonstrated JA	JA Findings
	familiar with participant.	has 8 seconds to attempt a response. Research assistant role limited to pointing to examiner to elicit RJA.	IJA: gaze shift to examiner's eyes or face when trying to imitate the demonstrated action with a toy.	IJA (face) with SO (face). ASD group unique correlations: IJA (face) with SO (body); RJA (face) with IJA (face) TD group unique correlations: RJA (body) with SO (face)
Mundy et al. (2016)	Interacting with a programmed virtual reality avatar.	RJA: avatar waited for eye contact of at least 300 ms; then shifted gaze to the referent for 1000 ms, after which time the referent disappeared. Avatar maintained gaze shift for an additional 400 ms after participant returned gaze to midline. IJA: avatar waited for eye contact. Participant instructed to select a target to the left or right of avatar. After 300 ms of participant gaze on target, avatar followed participant's gaze, and referent appeared, which	RJA: Participant followed avatar's gaze to a picture, maintained gaze on the picture for 1000 ms IJA: Participant looked from avatar's eyes to a target area, maintained gaze on the target area for 1000 ms.	RJA: no group differences in gaze following, fixation durations IJA: no group differences in gaze leading, fixation durations

Author	Task Demand How the Participant Engaged with the JA Cues	Research Context How the JA Cues are Delivered to the Participant	JA Feature How the Participant Demonstrated JA	JA Findings
		remained for 1000 ms. Avatar maintained gaze shift for an additional 400 ms after participant returned gaze to midline.		
Thorup et al. (2017)	Watching a series of 10-second videos	A series of 10 second videos, where the model first looked at the camera (1.5 s), then directed head and eyes to one of four objects arrayed on a table in front of her (0.5 s). Model maintained gaze on referent (5.0 s), returned gaze to midline (0.5 s) and looked directly at camera (2.5 s)	RJA: Gaze moves to the area of the screen depicting the referent.	RJA: No group differences in accuracy.

JA – joint attention; RJA – responded joint attention; IJA – initiated joint attention; TD – typical development; ASD – autism spectrum disorder; SO – social orienting; ESCS – Early Social and Communication Skills.

Transactions between the Task Demand, Research Context and JA Feature were identified and presented in Table 3. Task Demand – Research Context transactions focused on the degree to which the way the participant engaged with cues changed how cues were delivered. Task Demand – JA Feature transactions focused on the degree to which the method of engagement with the cues changed how JA was successfully demonstrated. Research Context – JA Feature transactions focused on the degree to which how cues were delivered changed JA performance.

Table 2.3 Task demand, research context and JA feature transactions.

Author	**Task Demand – Research Context Transactions:** **How method used by participant to engage with cues change how cues were delivered**	**Task Demand – JA Feature Transactions:** **How method used by participant to engage with cues changed JA performance**	**Research Context – JA Feature Transactions:** **How JA cue delivery changed participant JA performance**
Anzalone et al. (2014)	With robot: interactive, cues delivered by script, with no change based on participant engagement. Participant monitors and responds. With human: interactive. Cues delivered within play, able to change based on participant engagement. Participant actively involved in creation of social exchange that delivers cues.	Participant must direct gaze to target. How participant directs gaze does not matter to performance.	All participants showed better performance when playfully interacting with a responsive examiner compared to reacting to scripted cues delivered by the robot; responsiveness of environment supports JA performance.
Bean & Eigsti (2012)	Interactive with examiner, cues delivered between more formal items of other tests, able to change based on participant engagement. Participant actively involved in creation of social exchange that delivers cues.	Participant must direct gaze between examiner and target, and/or offer contextually appropriate vocalizations, with more complex social behaviour acknowledged by higher scores. How participant directs gaze does not matter to performance. Vocal responses scored on thematic content, not specific words.	Examiner adapts communication surrounding cues to support participant's performance.
Gulsrud et al. (2014)	Interactive with examiner, cues delivered within play, able to change based on participant engagement. Participant actively involved in	Three ways to show JA: alternating gaze between object and partner; showing partner an interesting object or action; and pointing to an	Examiner adapts communication surrounding cues to support participant's performance.

Author	Task Demand – Research Context Transactions: How method used by participant to engage with cues change how cues were delivered	Task Demand – JA Feature Transactions: How method used by participant to engage with cues changed JA performance	Research Context – JA Feature Transactions: How JA cue delivery changed participant JA performance
	creation of social exchange that delivers cues.	interesting object or action. How participant directs gaze or shows objects does not matter to performance.	
Johnson et al. (2012)	Interactive with examiner, cues delivered in scripted, formal testing exchanges supported by a research assistant. Cues follow timing algorithm regardless of participant engagement. Participant monitors and responds.	Participant must direct gaze, as detected by eye tracker, at the examiner's body, face or eyes at specific times within the cueing sequence. How participant directs gaze does not matter to performance.	Once started, cueing does not change regardless of participant performance.
Mundy et al. (2016)	Interactive with avatar, once triggered, cueing does not change regardless of participant engagement. Participant monitors and responds.	Participant must fix gaze on on-screen targets, and shift gaze in response to the cues. Gaze shifts produced by isolated eye movements.	Avatar adapts start time of cues to deliver them when participant is ready, supporting participant's performance. Once started, cueing does not change regardless of participant performance.
Thorup et al. (2017)	Interactive with video. Cueing does change regardless of participant engagement. Participant monitors and responds.	Participant must fix gaze on on-screen targets, and shift gaze in response to cues. How participant directs gaze does not matter to performance.	Once started, cueing does not change regardless of participant performance.

JA – Joint Attention

Step 5: Collating, summarizing and reporting the results

2.3 Results

Transacting Components

The first step in this review's analysis was to map the transacting components onto the protocols of each of the six retained records.

In this analysis, the Task Demand component was identified as how research participants were asked to engage with JA cueing. Of the six retained records, four asked research participants to engage with JA cueing through real world interaction with either people (Anzalone et al., 2014 human condition; Bean & Eigsti, 2012; Gulsrud, Hellemann, Freeman & Kasari, 2014; Johnson, Gillis & Romanczyk, 2012) or with a robot (Anzalone et al., 2014 robot condition). Two asked research participants to engage with JA cueing by viewing screen-based stimuli (Mundy, Kim, McIntyre, Lerro & Jarrold, 2016; Thorup, Kelberg & Falck-Ytter 2017).

The Research Context component was identified as the method used to deliver JA cueing in each of the retained records. Three of the retained records delivered cues to the research participants using play- and conversation based interactions with the examiners (Anzalone et al., 2014 human condition; Bean & Eigsti, 2012; Gulsrud et al., 2014). These interactions were semi-structured. While playing or talking with the research participants, examiners sought to deliver all required cues, but were afforded a degree of flexibility in their wording and actions when doing so, both in the play and in the cueing. JA cueing in the four of the retained records (Anzalone et al., 2014 robot condition; Johnson et al., 2012; Mundy et al., 2016; Thorup et al., 2017) was delivered to participants using scripted or algorithmic standardized stimuli. These JA cues consisted of video clips (Thorup et al., 2017) with no capacity to change, or directed by cueing scripts (Johnson et al., 2012) or algorithms (Mundy et al., 2016) with limited capacity to change.

The JA Feature component was identified as the way research participants successfully demonstrated JA. In three of the retained records, participants demonstrated successful JA through whole-body, socially-directed behaviour including gaze shift between the referent and the partner (Anzalone et al., 2014; Bean & Eigsti, 2012; Gulsrud et al., 2014), contextually appropriate vocalizations (Bean & Eigsti, 2012, Gulsrud et al., 2014) and showing and pointing with the partner (Gulsrud et al., 2014). In the remaining retained records (Johnson et al., 2012; Mundy et al., 2016; Thorup et al., 2017) participants successfully demonstrated JA through isolated eye movements in response to the stimuli.

Task Demand, Research Context, JA Feature Transactions

The second step in this review's analysis was to identify the transactions occurring within the protocols of each of the six retained records.

Task Demand – Research Context transactions identified to what degree the way research participants were asked to engage JA cueing changed how the cues were delivered. Three of the retained records (Anzalone et al., 2014 human condition; Bean & Eigsti, 2012; Gulsrud et al., 2014) asked research participants to engage with JA cues through play- or conversation based dynamic social engagement. In these retained records, research participants actively co-constructed, with examiners, the social engagements that delivered JA cueing. As each social engagement between research participant and examiner was unique, this permitted examiners to alter cues to match the context of the engagement. Four of the retained records (Anzalone et al., 2014 robot condition; Johnson et al., 2012; Mundy et al., 2016; Thorup et al., 2017) asked research participants to engage with JA cues through standardized cueing. In each of the retained records, JA cueing did not vary between research participants. Research participants were asked to monitor the stimuli and then respond when appropriate. Research participants did not actively co-construct social exchanges.

Task Demand – JA Feature transactions identified to what degree the way research participants were asked to engage JA cueing changed how JA was demonstrated. In two retained records (Bean & Eigsti, 2012; Gulsrud et al., 2014) research participants were able to use several behaviours to demonstrate JA while actively co-constructing the social exchanges that delivered JA cues. For example, both of these retained records accepted gaze shift as a successful indicator of JA. But, it did not matter if the gaze shift was achieved using isolated eye movement, head movement, physical repositioning, ambulation or some combination of any or all of these responses. Other behaviours, like showing, pointing and contextually appropriate vocalizations were also considered successful demonstrations of JA. The play- and conversation based presentation of JA cueing created the context that permitted JA to be demonstrated using many different behaviours. Three of the retained records (Johnson et al., 2012; Mundy et al., 2016; Thorup et al., 2017) saw participants engage with cueing by monitoring the cue source and responding, and accepted only gaze positioning as measured by screen-based or table top eye tracking as successful demonstrations of JA. One retained record (Anzalone et al., 2014) reports on two JA cueing conditions. In both conditions, whether JA cues were delivered in a play-based engagement with a human examiner or during a standardized interaction with a robot, the research participants could only use gaze shift to successfully demonstrate JA. But, in both human examiner and robot conditions, gaze shift could be expressed using any combination of eye, head or body movement. The human examiner condition delivered cues in play- based exchanges, similar to those in Bean & Eigsti (2012) and Gulsrud et al. (2014). The robot interaction condition featured participant engagement with the cuing through monitoring and responding, similar to the engagement seen Johnson et al. (2012), Mundy et al. (2016) and Thorup et al. (2017).

Research Context – JA Feature transactions identified to what extent the way JA cues were delivered changed how JA was demonstrated. Two retained records (Bean & Eigsti, 2012; Gulsrud et al., 2014) delivered JA cueing in the context of dynamic social engagement and accepted a wider array of social behaviours as indications of successful JA demonstrations. Flexibility in cue delivery permitted flexibility in JA demonstration. The variety of potential JA responses then influenced the following social exchanges. Three of the retained records (Johnson et al., 2012; Mundy et al., 2016; Thorup et al., 2017) presented JA cues in a scripted, standardized manner, and accepted only gaze positioning as measured by screen-based or table top eye tracking as successful demonstrations of JA. These routine and socially simpler elements constrain the range of stimuli and responses participants experience in the testing scenarios. One retained study (Anzalone et al., 2014) presents two conditions. Both conditions use an acceptable response that is flexible compared to some other retained studies (Johnson et al., 2012; Mundy et al., 2016; Thorup et al., 2017), but not as broad as others (Bean & Eigsti, 2012; Gulsrud et al., 2014). The human interaction condition pairs this demonstration of JA with a dynamic play-based presentation of JA cues. The robot interaction condition pairs this demonstration of JA with scripted presentation of cues.

The analysis of the transactions in this paper produces two clusters of retained records. One is labelled the dynamic transactions cluster. In the retained records in this cluster (Bean & Eigsti, 2012; Gulsrud et al., 2014) research participants actively co-construct, with examiners, the play- and conversation based exchanges that deliver JA cueing. There is flexibility in JA cueing to adapt to research participant performance. A range of possible demonstrations of JA are considered successful. In this cluster of retained records, the transacting components fluidly transact, exerting dynamic mutual influences on each other. The second cluster is labelled the constrained transactions cluster. In the retained records in this cluster (Johnson et al., 2012; Mundy et al., 2016; Thorup et al., 2017) research participants engage with JA cues by monitoring them and responding to them. The JA cues are standardized and scripted. Successful demonstrations of JA are limited to gaze shift measured by eye tracker. In this cluster of retained records, the transacting components have little ability to transact; a change in one has little impact on the others.

One retained record (Anzalone et al., 2014) has some features of both clusters. In this retained record, there is one JA Feature condition, where participants demonstrate JA through gaze shift, and gaze shift can occur in any combination of eye and body movement. There are two Research Context conditions. The dyadic exchanges between participants and human examiners are play- and conversation based, featuring social complexity and the capacity of the environment to adapt to child performance, as is seen in the dynamic transactions cluster. The exchanges between participants and the robot are scripted with less capacity to adapt to child performance, as is seen in the constrained transactions cluster.

JA Results

Five of the retained records examined RJA as an outcome (Anzalone et al., 2014; Bean & Eigsti, 2012; Johnson et al., 2012; Mundy et al., 2016; Thorup et al., 2017) while three examined IJA (Gulsrud et al., 2014; Johnson et al., 2012; Mundy et al., 2016). In retained records examining RJA, two showed group differences between the ASD and TD groups, with the ASD group showing lower performance (Anzalone et al., 2014 robot condition; Bean & Eigsti, 2012) and three showed no group differences (Anzalone et al., 2014 human condition; Mundy et al., 2016; Johnson et al., 2012). In retained records examining IJA as an outcome, one showed group differences between the ASD and TD groups, with the ASD group showing lower performance (Gulsrud et al., 2014) and one showed no group difference (Mundy et al., 2016). Johnson et al. (2012) presented results as correlations between measured skills. As the ASD group demonstrated correlations between other skills and both RJA and IJA that the TD group did not demonstrate, a degree of group difference can be reasonably inferred, although the significance of that difference cannot.

The dynamic and constrained transactions clusters of retained records tend to demonstrate different JA results. Studies in the dynamic transactions cluster (Bean & Eigsti, 2012; Gulsrud et al., 2014) both show significant difference between the ASD and TD groups, with the ASD group showing less proficient performance of JA skills. In contrast, two of the studies in the constrained transactions cluster (Mundy et al., 2016; Thorup et al., 2017) show no significant differences in JA performance between the ASD and TD groups.

2.4 Discussion and Implications

The seven methods of delivering JA cues described in the six studies included in this review represent a range of methods used to cueing for and measure JA. Analysing this variability through a transactional analysis helps develop an occupational therapy perspective on this body of research.

Across transactions, the retained records in this review form two clusters. The dynamic transactions cluster (Bean & Eigsti, 2012; Gulsrud et al., 2014) features fluid transactions between the components. Recalling that in the PEO Model, occupational performance is determined by the degree of overlap between the person, environment and occupation elements

(Law et al., 1996), protocols in the retained records forming this cluster maintain the ability to adjust the overlap during participation, ultimately supporting occupational performance. The constrained transactions cluster (Johnson et al., 2012; Mundy et al., 2016; Thorup et al., 2017) features limited transactions between the components. If there is little overlap between the components, the protocols in the retained records forming this cluster have limited ability to adjust, or to support occupational performance. The two conditions in Anzalone et al. (2014) fall somewhere in the middle of these two clusters, with the human interaction condition closer to the dynamic transactions cluster, and the robot interaction condition closer to the constrained transactions cluster.

Analyzing the transactions between these clusters demonstrates research participants would have had very different experiences between them. Experiences in the dynamic transactions cluster would have been closer to what research participants experienced in their daily interactions with skilled adults. Social interactions were freely co-created between the research participant and the examiner. The timing of the examiner's verbal and non-verbal cues, and the exact wording of verbal cues would have varied between research participants, if even slightly. The social exchanges in the retained records included in this cluster would have been more complex, as research participants' experiences in this cluster would have been less routine and less predictable compared to the constrained transactions cluster (Rosenthal et al., 2013).

We can be confident examiners in the retained records of the dynamic transactions cluster (Bean & Eigsti, 2012; Gulsrud et al., 2014) would have made these dynamic adjustments when presenting JA cues as the cues were derived in whole or in part from the Early Social Communication Scales (ESCS) (Mundy et al., 2013). The ESCS is a play-based observational assessment of early communication skills. The ESCS is widely used in research into JA and other communication skills with younger children with ASD (Bean & Eigsti, 2012). The ESCS require examiners to responsively adapt their interactions and testing sequence to the child's demonstrated skill (Mundy et al., 2013). In both retained records in this cluster, JA cues were modified from their original to more age-appropriate forms.

Research participants' experience with the tasks in the constrained transactions cluster (Johnson et al., 2012; Mundy et al., 2016; Thorup et al., 2017) would have been more routine, repetitive and predictable. As JA cueing was scripted, research participants could learn to anticipate the rhythm of cue-then-respond pattern. This predictability could have been comfortable for research participants with ASD (Rosenthal et al., 2013). However, if research participants were not able to learn the pattern, the transactions in this cluster had no ability to adapt to or facilitate their performance. The responsibility for adapting to the cueing rested solely with the research participant. The one study in this cluster that delivered cues via face to face interaction (Johnson et al., 2012) produced exchanges less like those encountered in daily life; the studies that presented cues through a screen (Mundy et al., 2016; Thorup et al., 2017) simulated social interactions rather than creating them.

This difference in JA results between the dynamic and constrained transactions clusters illustrates the impact of research methods on JA performance for children with ASD. In the constrained transactions cluster research participants demonstrated more JA proficiency. The simplification of each of the three transacting components produced more skilled occupational performance. However, recalling that the purpose of JA is to share an experience with another person (Mundy, 2018), it is questionable whether the tasks in this the retained records forming the constrained transactions cluster truly require JA. This critique of the ecological validity of screen-based eye tracking has been raised elsewhere (Flack-Ytter et al., 2013; Guillon at al., 2014).

In contrast, in the dynamic transactions cluster of retained records research participants with ASD demonstrated less proficient JA performance compared to their TD peers. In the dynamic transactions cluster, each transacting component is more complex than those in the constrained transaction cluster. Social exchanges in the dynamic transactions cluster are more representative of social exchanges encountered in daily life, as they are actively co-created by the research participant and the examiner. In the dynamic transactions cluster, the more complex transactions produced less proficient occupational performance. Ecological validity was maintained, as JA occurred within a social engagement between research participants and examiners, permitting true sharing of experiences between two people (Mundy, 2018). However, measuring JA from video review of in-person exchanges, as the retained records in the dynamic transactions cluster do, has received critique. As children with ASD demonstrate atypical gaze patterns, inference from video review does not necessarily accurately measure gaze location, making ascertaining JA challenging. One of the retained records in this review articulates this critique (Johnson et al., 2012).

The two conditions in Anzalone et al. (2014) represent points in the middle of the continuum and permit additional analysis of transactions and their impact on JA performance. There were no differences between the ASD and TD groups with the human partner, and significant group differences with the robotic partner, with the ASD group demonstrating less proficiency. The results in Anzalone et al. (2014) appear at odds with those seen in the dynamic and constrained transactions clusters, as in this study, the more complex environment produced better results for children with ASD. There are a number of possible explanations for this result, and the authors of the study list some potential interpretations. Of interest to this review is a transaction analysis: responsiveness in the more complex environment with the human partner and the relatively simplified behaviour required to demonstrate JA support a higher degree of task performance. Removing the responsiveness by replacing the skilled human with a robot removes the facilitating influence of responsiveness that even the simplified environment cannot overcome to support the same degree of performance in the ASD group.

There are a number of professional coached and parent-mediated ASD interventions that focus on improving parent responsiveness as method of improving the child's pivotal social and communication skills, among them JA (e.g., Casenhiser et al., 2011). Analyses of effect mediators have consistently identified parent responsiveness as a key mediating factor in these outcomes (e.g., Pickles et al., 2015). In the context of this paper, it seems examiner responsiveness represents the environment's capacity to adapt to individual participant needs. Examiner responsiveness is an important factor in Task Demand – Research Context and Research Context – JA Feature transactions that retained records that maintain ecological validity. As examiners in the dynamic transactions cluster are able to make adjustments within the social exchanges with research participants to best match the individual research participant's idiosyncratic presentation, examiner responsiveness prevents the environment from becoming too complex as to inhibit engagement, or too simplified as to lose its social character.

None of the retained records used mobile eye tracking to measure eye gaze when studying JA. Mobile eye tracking is a tool that preserves the measurement accuracy of eye tracking while simultaneously permitting live, face-to-face dyadic interaction to maintain ecological validity. As gaze location indicates the focus of visual attention (Falck-Ytter et al., 2013) its accurate measurement is an important issue in studies examining JA. Using mobile eye tracking during dyadic interaction, in an environment that maintains a responsive capacity to adapt to child performance, would permit accurate measurement of gaze when studying JA within ecologically valid supportive transactions. To the authors' knowledge no studies have yet used mobile eye tracking to do so.

This analysis has features that limit the extent to which its findings are generalizable. Inclusion criteria sought a specific range of records. Changing the inclusion criteria to include a wider range of records could potentially reveal additional methods of cueing for and measuring JA, which could change the analysis. Only one of the retained records (Gulsrud et al., 2014) was an evaluation of an intervention for JA. The other retained records were point in time cross sectional group comparisons. This analysis focuses only on the transactions occurring in the retained records. It does not attempt to address the transactions occurring within the intervention examined in Gulsrud et al. (2014). Although definition of the Task Demand, Research Context and JA Feature was guided by feedback from the author's thesis committee, only the author identified the transacting components in each of the retained records.

2.5 Conclusion

After retaining six records following a literature search and application of inclusion / exclusion criteria, transacting components were mapped onto each retained records. A relationship between the transactions in the retained studies and research participant JA performance emerges. Constrained transactions can support the JA performance of research participants with ASD, but oversimplification to the point of removing the social character of the environment might not actually target JA. Dynamic transactions present JA cues that preserve ecological validity and are more complex for research participants with ASD. This complexity can be mitigated by maintaining responsiveness to the research participant's performance in the environment.

CHAPTER 3 METHODOLOGY

3.1 Rationale

The scoping review analysing the transactions occurring in the protocols of research studies examining joint attention (JA) in children age 6 – 12 with autism spectrum disorder (ASD) revealed a gap in the literature. None of the retained records paired the measurement accuracy of eye tracking with the ecological validity of the dynamic transactions found in face-to-face interaction with a responsive examiner.

Mobile eye tracking is a tool that accurately measures a user's gaze location in real time as the user interacts with the environment (SensoMotoric Instruments, 2016a). Since gaze location is an indicator of overt visual attention (Falck-Ytter, Bolte & Gredeback, 2013) its accurate measurement is an important consideration when investigating JA. Applied to the study of JA in children with ASD, using mobile eye tracking will improve accuracy when determining gaze use patterns and when ascertaining initiated joint attention (IJA) and responded joint attention (RJA) within ecologically valid contexts.

The responsive interaction style is a specific set of adult behaviours used as part of some ASD interventions (Ingersoll, 2010). Consistent use of a responsive interaction style over time is associated with improved developmental outcomes for children with ASD (Siller, Hutman & Sigman, 2013), including JA (Casenhiser, Shanker & Stieben, 2011; Green et al., 2010; Oono, Honey & McConachie, 2013). To date, there have been no investigations examining the impact of a responsive interaction style on gaze use patterns and JA in children with ASD using eye tracking to accurately measure gaze location.

A pilot study was planned for children 8 – 12 with ASD incorporating mobile eye tracking while being guided through two developmentally-appropriate tabletop activities by two different occupational therapists, one purposefully using the responsive interaction style and the other naïve to it. The goal was to gather preliminary data on the impact of the occupational therapist's interaction style on participant gaze use and JA during the activity.

3.2 Research Questions

The in PICO format, the research questions for the pilot study were:

P: Older elementary aged children (8-12 years old) with ASD

I: Occupational therapist using responsive interaction style to guide the child through a developmentally appropriate tabletop activity

C: Same group of children with ASD guided through a different developmentally appropriate activity by an occupational therapist not explicitly using a responsive style

O: As measured by eye tracking and information gathered by scene video:

- Frequency of IJA by occupational therapist and by child
- Frequency of RJA by occupational therapist and by child to IJA attempts by partner
- Fixations by occupational therapist and child on task and non-task objects during the task
- Total occupational therapist cues (verbal, block building, block passing) during the interaction

Null hypotheses for collected outcomes:

- There will be no condition differences in the frequency of occupational therapist and child IJA.

- There will be no condition differences in the frequency occupational therapist and child RJA to partner's IJA attempts.
- There will be no condition differences in child and occupational therapist gaze use during the tasks
- There will be no condition differences in the total cues used by the occupational therapist during the interaction
- There will be no condition differences in the distribution of cue types used by the occupational therapists during the interaction.

3.3 Participants

The originally planned study seeking up to 12 participants received approval from Dalhousie University's Health Sciences Research Ethics Board on January 5, 2018 (file 2017-4343).

Criteria for inclusion were: age 8 – 12; parent/guardian report of ASD diagnosis; spoken English as primary communication method; and attend school in a mainstream classroom. Parent/guardian report of ASD diagnosis is required as children with ASD is the population of interest. Independent confirmation of ASD diagnosis is outside the scope and resources of this project. Spoken English as primary communication method is included as the lead investigator delivered instructions for using eye trackers and conducted the interaction during the experimental task in English. It also indicates a relatively high level of function on the autism spectrum. School attendance in a mainstream classroom, one that is designed for a general population of students and not specifically for students with unique learning or behavioural needs, targets students with ASD who can manage classroom expectations integrated with their typically developing peers, indicating a relatively high level of function on the autism spectrum.

Potential participants were excluded from the study if they were outside of the targeted age range or did not meet the study's inclusion criteria. Additionally, participants were excluded from participation by a parent/guardian report of Down syndrome, intellectual disability, developmental delay, cognitive delay, anxiety, tics, Tourette's, depression, cerebral palsy, muscular dystrophy, ataxia, schizophrenia, bipolar disorder, seizures, tremors, or heart or lung conditions. This last criterion limited participation to children whose occupational performance was impacted by only ASD, and not by other conditions.

3.4 Ethics and Recruitment

The lead investigator partnered with Autism Nova Scotia, through their Community Outreach Coordinator, to recruit potential participants. The Community Outreach Coordinator distributed a recruitment email (refer to Appendix A) to Autism Nova Scotia's members inviting participants to the study and to display recruitment posters (refer to Appendix B) at their facility or events. Both the participant information email and the poster contained a snowball sampling request.

As a secondary recruitment strategy, the lead investigator initiated snowball sampling requests of other members of his research group: other MSc OT Post-Professional candidates with clinical experience working with children with ASD, and members of their supervisory committees with connections in the local community. These research group members were asked to purposively share the Pilot Study Participation Information Letter (refer to Appendix C) with families of potential participants.

As recruitment strategies yielded only one eligible consenting participant the project was reconceived as a descriptive case study. Data collection proceeded as planned. As a single participant does not permit group comparisons or statistical analysis, the plans for data analysis reporting were revised, focusing on descriptions of gaze use and the sentinel events of mutual facial gaze and initiating joint attention. An amendment outlining the revised plan for data analysis and reporting was approved by Dalhousie University's Health Sciences Research Ethics Board on February 15, 2019. The revised plan is detailed in the following sections of this chapter.

3.5 Informed Consent

The parent of the single participant initiated contact with the lead researcher via email. Following completion of the self-screen, the lead researcher emailed the parent the consent form, and invited the parent to initiate telephone or email contact with any concerns or comments. When the parent indicated a willingness to provide informed consent, an appointment for research participation was scheduled. At the scheduled appointment, consent was reviewed, and the paper consent form was signed (refer to Appendix D). Additional consent to the change in data analysis and reporting plans was obtained via email exchange with the participant's parent (refer to Appendix E). At the time of data collection, participant assent was obtained (refer to Appendix F).

3.6 Risk and Benefit Analysis

The consent form (refer to Appendix D) outlined anticipated risks to the participant from participation in this study. Risks associated with participation in the study, becoming mildly frustrated, uncertain, bored, or fatigued, were considered to be minimal and to be no greater than risks for participation in similar situations encountered in daily life.

The participant was expected to derive direct benefit from participation in the study. It is possible that the participant or their parents may appreciate knowing their participation contributes to the broader knowledge base on the topic.

3.7 Compensation Privacy and Confidentiality

Participants are not provided with any compensation for their participation in the study. This inquiry collected private information.

Confidentiality in this study will be maintained through the mechanisms required by the second edition of the Tri-Council Policy Statement for Ethical Conduct for Research Involving Humans (2014) and Dalhousie University (2012). Information security steps were taken to maintain confidentiality.

The home simulation suite is a locked unit, accessible by reservation only. Access is controlled through the main office of the School of Occupational Therapy. While the participant and guardian may be seen entering the building/suite, they cannot be viewed by others during study participation. The suite has recording capacity from multiple pan-tilt-zoom (PTZ) cameras in each dedicated home space. The recordings from the PTZ cameras are stored on a password protected recorder encased in a locked cabinet within the suite. Recordings were removed from the simulation suite recorder following completion of the experiment.

After completing the consent form the single participant was referred to as the participant in all research team communications. The participant's name is known only to the lead researcher. Signed consent forms are securely stored in a locked filing cabinet in thesis supervisor's office at Dalhousie University. Participants' digitally recorded data, from the eye trackers and from the scene camera, are encrypted and securely stored in the lead researcher's computer while the research is active. When the research is complete, all digital files will be securely transferred to Dalhousie University's servers, and deleted from the lead researcher's computer. The connection during file transfers will be secured by Dalhousie University's virtual private network.

All data will be retained for five years following participation in the study. Paper records will be destroyed using Dalhousie University's confidential shredding service. Digital records will be permanently deleted from Dalhousie's servers.

All reporting of study findings will be done maintaining privacy and confidentiality. The participants will not be identified by name or indirectly. No quotes from participants will be shared or reported.

Participants' guardians are asked to opt in to results sharing at the time of initial consent. Findings will be summarized in a brief (no more than one page) letter, and emailed to guardians who elected to receive the information. Individual results of study participation will not be shared.

3.8 Instrumentation

Movement Assessment Battery for Children, Second Edition

The Movement Assessment Battery for Children, Second Edition (Movement ABC-2) is a standardized test that requires children to perform a series of movements in a specified manner. Research, both for describing study populations and for measuring longitudinal change, is identified as an intended purpose of The Movement ABC-2, building on the first edition's established use as such (Henderson, Sugden & Barnett, 2007).

The Movement ABC-2 is composed of 8 tasks, grouped into three components: Manual Dexterity, Aiming and Catching, and Balance. Age-adjusted standard scores and percentile scores are provided for each component, and the total test. The Movement ABC-2 is divided into three age bands: age band 1, 3 – 6 years; age band 2, 7 – 10 years; age band 3, 11 – 16 years.

This study used the three Manual Dexterity tasks to describe the participant's fine motor skill, as the tabletop tasks comprising the experimental task required consistent application of fine motor skill. The Aiming and Catching and Balance components were not be administered.

SMI ETG 2w Mobile Eye Tracking Glasses and BeGaze Software

The SMI ETG 2w mobile eye tracking glasses were used to measure gaze position during the experimental task. The SMI ETG 2w are a binocular mobile eye-tracker that use corneal reflection to estimate gaze location, sampling eye position at a rate of 120 Hz. An integrated scene camera records the user's field of view and audio of the scene. High definition video is recorded at 1920 by 960 pixels, 24 frames per second. The eye tracker's algorithms calculate gaze position and overlay a cursor on the gaze target within the scene in real time. The algorithm's accuracy is reported as 0.5 degrees over all distances, with parallax compensation. The eye tracker's range is 80 degrees horizontal and 60 degrees vertical. Each eye tracker is connected by a cord to a tablet that stores the video and audio recordings, including the gaze cursor overlay. Each eye tracker's recording is mirrored on a dedicated laptop computer connected to the same closed, secured wireless network as the tablets. The laptops are monitored by a research assistant familiar with the eye tracker's operation. The occupational therapist and the participant both wore these eye trackers during the experimental task.

The eye tracker's accompanying BeGaze software was used to algorithmically identify visual events captured in the eye trackers' recordings. The software defines events as saccades, fixations and blinks. The software's default settings for low speed event detection dispersion based algorithm were used in this analysis. This algorithm defined fixation as the primary event, and identifies saccades and blinks with reference to fixations. Fixations have a minimum duration of 80 ms and a maximum dispersion of 100 pixels. Blinks have a minimum duration of

70 ms with no eye data, and no maximum duration. Saccades are defined as events between fixations or blinks.

The BeGaze low speed event detection algorithm identifies fixations as groups of consecutive points within a particular dispersion, or maximum separation (100 pixels). It uses a moving window that spans consecutive data points checking for potential fixations. The moving window begins when the algorithm detects a minimum duration fixation (80 ms) within the 100 pixel maximum dispersion. The algorithm continues checking data points, determining if gaze location remains within the 100 pixel maximum dispersion; all subsequent data points falling within the maximum dispersion are considered part of the fixation; the fixation end time is identified as the last data point that falls within the dispersion.

BeGaze software was used for semantic gaze mapping. In this process, the lead researcher manually coded each algorithmically identified fixation onto reference pictures that outlined specific areas of interest (AOI). Each perspective assigned AOIs to their partner's head, body and hands. All perspectives included AOIs for the build, the blocks in reserve, and the instruction book. An additional "white space" AOI was used for each perspective, into which gaze fixations falling outside of all other AOIs were assigned. Once each gaze fixation was mapped into the AOIs, the software calculated summary measures of fixation duration in each AOI.

Figure 3.1 shows the AOIs, from the participant's perspective, drawn onto a reference image. A similar reference picture depicting AOIs from the OTs perspective was also used.

Figure 3.1 AOIs used when mapping participant's gaze

3.9 Experimental Set Up

The experiment took place in the School of Occupational Therapy home simulation suite. The selected space within the suite had no visual distractions on the walls so to minimize attentional detractors. The participant's parent remained in the suite, but outside of the patrician used for the experimental task. A table was arranged within the partitioned space to permit a clear view along its length by the two PTZ cameras. The participant and the OTs sat facing each other.

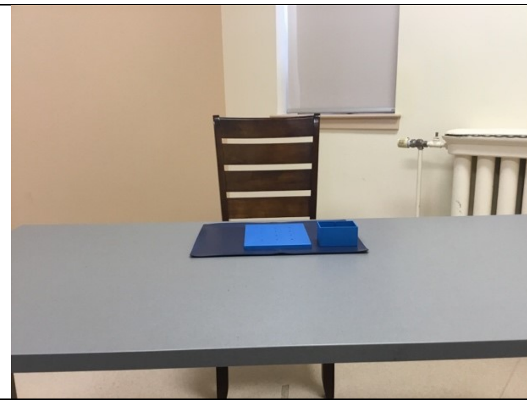
The experimental task, a construction of an animal using Kapla® blocks (kalpaus.com), was selected for degree of interest, degree of difficulty and relative novelty. Two variants, a dinosaur and a spider, were selected, and step by step pictorial instructions were generated. Each variant used a similar number of blocks (dinosaur 66, spider 63). During informal trials by the lead investigator in a clinical setting prior to the experiment, clients matching the study's inclusion criteria found the tasks engaging but challenging. During that informal testing, the tasks were noted to afford joint attention opportunities.

The lead investigator, who functioned as the therapist with experience using a responsive interaction style (OT1), obtained a temporary licence to practice occupational therapy in Nova Scotia from the College of Occupational Therapists of Nova Scotia (registration number 1067), active during the time the investigator was present at Dalhousie university conducting the experiment. At the time of the study, the other participating occupational therapist, who functioned as the therapist who did not explicitly use a responsive interaction style (OT2), had 12 years of experience working with children with ASD, and worked as an occupational therapist in a pediatric / developmental program. The lead investigator and the participant did not know each other; the other occupational therapist and the participant have worked together in the past, but were not engaged in a clinical relationship at the time of the study.

The day prior to data collection, the lead researcher met with OT2 and introduced the experimental tasks. OT2 independently followed picture instructions to build each variant. OT2 had the opportunity to ask questions about the instructions or the task; no questions were asked. The lead researcher did not provide any directions to OT2 during this time.

After the participant arrived at the home simulation suite and exchanged introductions with the lead investigator and others present, the lead investigator confirmed consent for study participation from the participant's parent, and assent from the participant. The remaining sequence of events is described in Table 3.1. At the beginning of the OT2-child engagement the lead researcher directed OT2 and the child to work together to build the animal shown in the instructions. As the lead researcher acted as OT1, he provided these directions to the child at the beginning of the OT1-child engagement.

Table 3.1 Experimental procedure

Timeline	Task	Description	Picture
~ 10 minutes	Part I Completion of Movement ABC-2 Manual Dexterity component	The participant was ergonomically seated at a table. The three items of the Manual Dexterity component of the Movement ABC-2 were completed.	
3 – 5 minutes	Part II Donning and Calibration of Eye tracker	The lead investigator helped the participant don the eye tracker, and the research assistant led the one-point calibration.	
~ 10 minutes	Part III Experimental Task One. (dinosaur) with OT1 (RII). 66 blocks in construction.	The participant was ergonomically seated at a table across from the lead investigator with the task materials between them. Random task selection yielded dinosaur construction. Together, they completed the task.	
5 minutes	Break		
3 – 5 minutes	Part IV Re-calibration of Eye tracker	The research assistant led the one-point re-calibration.	

Timeline	Task	Description	Picture
~ 10 minutes	Part V Experimental Task Two (spider) with OT2 (non-RII). 63 blocks in construction	The participant was ergonomically seated at a table across from the other occupational therapist with the task materials between them. Together, they completed the task.	
~ 10 minutes	Remove eye tracker, participant questions and thank you		

3.10 Video Analysis

Each experimental task generated three videos: the participant's perspective, the occupational therapist's perspective and an external scene video from the Home Simulation Suite's PTZ camera covering the experiment. The perspective videos captured by the eye trackers included audio recordings; the video captured by the home simulation suite's PTZ cameras did not. The videos recorded by the eye tracker had a running display of elapsed time to the millisecond. All times were synchronized between videos with reference to a synchronizing event. The individual perspective recordings were viewed in iMovie, and start / stop times for verbal utterances were coded with the aid of the magnified audio wave form display. To accurately determine the other events' start and stop times, the three individual videos of the experimental task were combined in to one video, synchronized at the synchronizing event, then exported using software found in the Apple App Store (Movie Edit – Video Editor Video). The resulting video simultaneously displayed all three recordings of the experimental task. The lead experimenter conduced multi-pass frame-by-frame analysis of these videos, coding the start and stop times of selected interactive behaviours; one behaviour per pass. Interactive behaviours identified and included for analysis from the occupational therapist's perspective are: verbal utterances, passing a block, building the structure and initiating joint attention. Interactive behaviours identified and included for analysis from the participant's perspective are: verbal utterances, building the structure, initiating joint attention and mutual facial gaze. Operational definitions of these behaviours are summarized in Table 3.2 and Table 3.3:

Table 3.2 Operational definitions of interactive behaviours coded from occupational therapist perspective

Interactive Behavior	**Casual Definition**	**Operationalized definition used when coding video**
Verbal	When the OT uses words or prosody	Guided by audiotrack visualization magnified 400%. Start – uptick in audiotrack accompanied by start of voice sound Stop – downtick in audiotrack accompanied by end of voice sound End of vocalization coded when contextual (as when partner issued verbal, nonverbal response; when there is long pause between same speaker's vocalizations and partner's actions do not constitute a response)
Block Passing	When the OT passes blocks to the participant	OT touches block with hand AND OT gestures toward participant with block AND block not yet part of structure Start – when OT starts gesture toward participant Stop – when participant holds block, moves it within OT's hand
Block Building	When the OT actively helps in building the emerging structure	OT touches block with hand AND block is part of structure OR block becomes part of the structure Start – when OT touches block Stop – when OT releases block
Initiating Joint Attention	When the OT initiates joint attention with the participant	OT gazes at participant's head AND OT moves gaze to external referent AND OT's gaze returns to participant's head AND gaze shift not accompanied by physical manipulation of referent Start – gaze cursor leaves participant's head Stop – gaze cursor returns to participant's head OR participant takes physical action on referent

Interactive Behavior	Casual Definition	Operationalized definition used when coding video
Participant Response to OT IJA Attempts	When the participant follows the OT's gaze to the referent	Following OT IJA, participant's gaze moves to the referent indicated by OT AND participant does not perform any additional actions between start of OT IJA and participant gaze moving to referent. Start –OT's gaze cursor leaves participant's head Stop – participant's gaze cursor enters referent (participant responded to IJA, making this a successful IJA attempt) OR participant takes action unrelated to IJA attempt (participant did not respond to IJA, making it an unsuccessful IJA attempt)

Table 3.3 Operational definitions of interactive behaviours coded from participant perspective.

Variable	Casual Definition	Operationalized definition used when coding video
Verbal	When the participant used words or prosody	Guided by audiotrack visualization magnified 400%. Start – uptick in audiotrack accompanied by start of voice sound Stop – downtick in audiotrack accompanied by end of voice sound End of vocalization coded when contextual (as when partner issued verbal, nonverbal response; when there is long pause between same speaker's vocalizations and partner's actions do not constitute a response)
Block Building	When the participant actively helps in building the emerging structure	Participant touches block with hand AND block is part of structure OR block becomes part of the structure Start – when participant touches block Stop – when participant releases block
Initiating Joint Attention	When the participant initiates joint attention with the participant	Participant gazes at OT's head AND participant moves gaze to external referent AND participant's gaze returns to OT's head AND gaze shift not accompanied by physical manipulation of referent Start – gaze cursor leaves OT's head Stop – gaze cursor returns to OT's head OR OT takes physical action on referent
Mutual Facial Gaze	OT and participant are looking at	Start – when OT and participant's gazes are on each other's heads Stop – when one of OT or participant moves gaze away from the other's heads

Variable	Casual Definition	Operationalized definition used when coding video
	each other's heads	
OT Response to Participant IJA Attempts	When the OT follows the participant's gaze to the referent	Following participant IJA, OT's gaze moves to the referent indicated by participant AND OT does not perform any additional actions between start of participant IJA and OT gaze moving to referent. Start – participant's gaze cursor leaves OT's head Stop – OT's gaze cursor enters referent (OT responded to IJA, making this a successful IJA attempt) OR OT takes action unrelated to IJA attempt (OT did not respond to IJA, making it an unsuccessful IJA attempt)

Mutual facial gaze occurs when the OT and the child are simultaneously looking at each other's head AOI. Mutual facial gaze is not necessarily a prerequisite for an IJA as defined in this study. While IJA requires the initiator to move gaze from partner head to referent to partner head, the partner's gaze need not be at the initiator's head during the IJA attempt.

When the start and stop frames of an interactive behavior were identified, the displayed running time from the user's perspective video was entered into a spreadsheet. The spreadsheet then calculated a synchronized time by subtracting the time between the start of video recording and the synchronizing event. Synchronized times were used in all further analysis. By identifying the start and stop times of each interactive behavior this way, the frequency of the behavior could be calculated, along with the mean and standard deviation of its duration. The spreadsheet could also create a Gantt chart for repeated tasks to graphically display the occurrence of the interactive behavior on a timeline.

3.11 Roles and Duties of the Research Team

The lead researcher proposed the original research concept, and was responsible for study design, participant recruitment, data collection and data analysis. The lead researcher also functioned as the occupational therapist with experience using a responsive interaction style. Dr.

Diane MacKenzie is the student supervisor with research interest in in the areas of eye tracking and neurorehabilitation. Dr. Joan Versnel is a student committee member with research interests in child and adolescent transitions. Dr. Parisa Ghanouni is a student committee member with research interests in technology and children with ASD. Dr. Heather Neyedli is a student committee member with research interest in decision making and human computer interaction. Drs. MacKenzie, Versnel and Ghanouni are faculty members at the School of Occupational Therapy at Dalhousie University. Dr. Heyedli is a faculty member at the School of Health and Human Performance at Dalhousie University. Drs. MacKenzie, Versnel and Neyedli provided feedback on study design, data collection and data analysis. Dr. Ghanouni provided feedback on data analysis. All committee members provided feedback on manuscript drafts.

3.12 Recruitment Difficulties

This project encountered recruitment difficulties. These difficulties seemed, in part, due to the available data collection window. When the lead researcher was able to travel to Halifax, NS to access the inter-professional Center for Attention in Real Environment's eye tracking equipment at Dalhousie University from his home community of Saskatoon, SK for data collection, local schools around Halifax were on spring break. Additionally, there were winter storms during the data collection window. A third possible contributing factor was the stringent eligibility criteria. Eligibility criteria were created to target higher functioning children, to minimize the potential distraction posed by the eye tracking equipment. They may have also restricted the pool of potential participants.

As a result, a single eligible participant was recruited. This necessitated a change to the planned study's data analysis and reporting plans, away from a pilot to look for trends in group differences, and to a single subject case study to test the methodology.

CHAPTER 4 CASE STUDY

4.1 Introduction

Autism Spectrum Disorder (ASD) and Joint Attention (JA)

ASD is characterized by deficits in social communication and restricted or repetitive behaviours, leading to persistent social or occupational impairment (American Psychiatric Association, 2013). As a profession concerned with enabling occupation to promote health and well-being, occupational therapy is the second-most frequently provided service for individuals with ASD in the United States, after speech therapy (American Occupational Therapy Association, 2015). As current estimates place the prevalence of ASD at 1 in 59 (Baio et al., 2018), there is a large population of individuals with ASD that could, and seemingly do, access occupational therapy services.

JA is the coordination of attention between two people and a third external element (Mundy 2018). Children with ASD commonly show reduced quality and quantity of JA (Landa, Gross & Stuart, 2013). JA has two types: initiated joint attention (IJA), the intentional attempt to focus a partner's attention on an external element; and responded joint attention (RJA), the placing of attention on an external element in response to a partner's attentional bid. Behaviorally, both IJA and RJA are expressed through gaze shift, moving the eyes to look at the external element. (Mundy, 2018). For example, when playing together, one child may attempt to draw another child's attention to an interesting toy by looking toward it, and then back to the other child. IJA is also expressed through contextually appropriate vocalization, pointing or showing (Gulsrud, Hellemann, Freeman & Kasari, 2014). RJA is also expressed through contextually appropriate vocalization, or by taking the action implied by the IJA attempt (Bean and Eigsti, 2012).

JA is a pivotal behaviour, supporting the development of human social cognition (Mundy 2018) and the acquisition of other developmental skills, like language (e.g., Casenhiser, Shanker & Stieben, 2011). Because of its key role in facilitating childhood development, JA is a frequent target for intervention (Eschenfelder and Gavalas, 2017). Looking at a communication partner's face is a precursor to IJA (Mundy 2018). Children with ASD look at a partner's face less than typically-developing children (Falck-Ytter et al., 2013; Hanley et al., 2014).

ASD and Responsive Interaction Interventions

Practitioners, including occupational therapists, can select from many intervention methods to help children with ASD build JA skills (Muzra, Schwartz, Hahs-Vaughn & Nye 2016). One set of interventions commonly used to help children with ASD build JA skills asserts that the style of interaction between a caregiver and a child influences child development (Mahoney & Perales, 2005). More specifically, these interventions argue that a responsive parent interaction style has a differential positive impact on development of pivotal behaviours (Karaaslan, Diken & Mahoney, 2011; Shire, Gulsrud & Kasari, 2016) like joint attention.

The responsive interaction style is a complex set of skills (Ruble, McDuffie, King & Lorenz, 2008), summarized as adults consistently using contingency, reciprocity, positive affect and non-directiveness when engaging with children (Mahoney & Solomon, 2016). When adults use a responsive interaction style, they respond sensitively and contingently to the child at a level appropriate for the child's level of development (Ingersoll, 2010). Adults will also minimize communications that explicitly direct the child (Aldred, Green & Adams, 2004) or the child's attention (Shire et al., 2016), and instead prioritize following the child's focus of attention more often during a task (Girolametto, Sussman & Weitzman, 2007). Additionally, adults will allow for longer times for a child to respond, and use more gestures, facial expressions and other non-verbal communications (Kossyvaki, Jones & Guldberg, 2014). Adults will also structure the physical and social environment to promote child initiations (Gulsrud, Hellemann, Shire & Kasari 2016) then elongate resulting synchronous interactions (Kong & Carta, 2013), and emphasize co-regulation, emotional expression and affect sharing (Casenhiser et al., 2011).

Consistent adult use of a responsive interaction style is associated with positive developmental outcomes in children with ASD. Various interventions featuring adult use of a responsive interaction style have demonstrated significant improvements in joint attention (Casenhiser et al., 2011; Green et al., 2010; Oono, Honey & McConachie, 2013) amoung other positive developmental outcomes. Analyses of treatment mediators have consistently identified parent responsiveness as a key factor in these outcomes (Aldred et al., 2012; Kim & Mahoney, 2005; Mahoney & Solomon, 2016; Pickles et al., 2015).

Measuring JA in ASD

As JA is expressed through gaze use (Mundy 2018), and as gaze is measured to infer the target of visual attention (Ho, Foulsham & Kingstone, 2015), accurately measuring gaze location in studies of JA is a critical methodological issue. So far, the evidence supporting use of a responsive interaction style's benefit in building JA skills in children with ASD has used only behavioural observation of video recorded interactions (e.g., Karaaslan et al., 2011; Casenhiser et al., 2013; Green et al., 2010). While these studies maintain methodological rigor, observational measurement of JA can be inaccurate, as some children with ASD may demonstrate atypical gaze patterns, making ascertaining gaze position and thus JA from video review challenging (Guillon, Hadjikhani, Baduel & Roge, 2014).

Computerized eye tracking is presented in the literature as a tool that more accurately measures the target of an individual's gaze than observational measurement (Falck-Ytter et al., 2013; Guillon at al., 2014). Corneal reflection is a commonly used eye tracking technology (Falck-Ytter et al., 2013). In this technology, a near-source infrared light is aimed at the eye, and video cameras record the eye's position, and the infrared reflections off the pupil and cornea. The eye tracker's algorithms use these images to calculate the target of gaze within one visual degree (Falck-Ytter et al., 2013).

The bulk of eye tracking research examining JA in children with ASD has been conducted using tabletop, screen-based eye trackers. Authors summarizing these investigations (Falck-Ytter et al., 2013; Guillon et al., 2014) conclude that the ecological validity of these investigations is questionable, as they do not use real-world social interactions, only screen-based simulations.

Mobile eye tracking is a tool that preserves the measurement accuracy of eye tracking while simultaneously permitting live, face-to-face dyadic interaction to maintain ecological validity. Using mobile eye tracking during dyadic interaction would permit accurate measurement of gaze within real-world environments. Some studies (Hanley et al., 2014; Noris, Nadel, Barker, Hadjikhani & Billard, 2012) used a mobile eye tracker to investigate gaze in children with ASD during a face to face interaction. These studies showed children with ASD look at their partner's face less than typically developing children. But, they did not investigate JA or the impact of the responsive interaction style on gaze use.

There seems to be a gap in the literature. There is a group of ecologically valid studies employing less accurate measurement of gaze to study JA that shows the responsive interaction style helps children with ASD build JA skills. There is another group of studies that measure gaze more accurately, but that has low ecological validity for the study of JA. There is a tool that potentially marries the ecological validity of the first group of studies with the measurement accuracy of the second. To the authors' knowledge no studies have yet used mobile eye tracking to investigate JA, or the impact of the responsive interaction style in children with ASD within a real-world interaction. This case study is an initial attempt to address this identified gap in the literature.

The purpose of this case study is to explore differences in gaze use and joint attention associated with the responsive interaction style using mobile eye tracking. The procedure is designed to detect gaze use and joint attention differences between occupational therapists when they do or do not use a responsive interaction style, and in a child with ASD when being guided by occupational therapists using or not using the responsive interaction style.

4.2 Method

Participants

This case study received approval from Dalhousie University's Health Sciences Research Ethics Board (REB file 2017-4343). It involved one child with ASD and two occupational therapists (OT1, OT2). The child was a high functioning 9-year old boy with a parent report of an ASD diagnosis. He used spoken English as his primary communication method, and by parent report, he attended school in a mainstream classroom. By parent report, he did not have any comorbid developmental, psychiatric or medical diagnoses in addition to ASD.

The lead researcher functioned as the occupational therapist with experience using a responsive interaction style (OT1). OT1 had 14.5 years of experience working with children with ASD, and 9 years using a responsive interaction style with children with ASD. OT1 had no previous relationship with the child. As the lead researcher, OT1 was not blinded to the case study's hypotheses.

OT2 was the occupational therapist with no specific training using a responsive interaction style. OT2 had 12 years of experience working with children with ASD. To permit exploration into the differences in the child's gaze use between the occupational therapists, OT2 received no information or instruction about the responsive interaction style during participation in this study. OT2 remained blind to the case study's hypotheses.

OT1 developed and refined the tasks and produced the step-by-step pictorial instructions. OT2 practiced building the constructions with OT1 one day prior to the experiment. During this practice period OT2 received no additional instruction prior to data collection. While OT2 had the opportunity to ask questions about the experimental task during the practice period, none were posed. The child with ASD had no previous experience with these tasks.

Equipment and Task

The experiment was conducted in Dalhousie University's Home Simulation Suite, located in the School of Occupational Therapy. The apartment-like simulation suite is equipped with multi- pan-tilt-zoom (PTZ) cameras, which provided an external scene video recording of the experimental task.

OT1 developed the experimental task in a clinical setting. The experimental task was a block construction designed to resemble an animal. The task was created for this experiment. The experimental task was developmentally-appropriate, designed to be engaging for children 8 – 12 with ASD, while remaining challenging enough to afford opportunities for JA. To minimize the learning effect, two variants of the experimental task**,** a dinosaur (66 blocks) and a spider (63 blocks), were created. At the beginning of each variant of the experimental task the OT and the child with ASD were seated at a table facing each other. The unassembled blocks were arranged to the child's right, and the pictorial instruction book was placed to the child's left. The child with ASD performed each variant of the experimental task once, first completing the dinosaur with OT1 and then the spider with OT2. The lead researcher directed OT2 and the child with ASD to work together to build the animal shown in the instructions. As the lead researcher functioned as OT1, the lead researcher provided these directions to the child at the beginning of their engagement.

The Movement Assessment Battery for Children, Second Edition (Movement ABC-2) is a standardized test of children's movement abilities (Henderson, Sugden & Barnett, 2007). The Manual Dexterity component of the Movement ABC-2 was administered to the child with ASD to describe the child's fine motor skill, as the experimental task required block construction. As the experimental task did not require dynamic balance or aiming and catching, the Balance and Aiming and Catching components of the Movement ABC-2 were not administered.

The SensoMotoric Instruments (SMI) ETG 2w mobile eye tracking glasses were used to measure gaze position during the experimental task. The SMI ETG 2w are a binocular mobile eye-tracker that sample eye position at a rate of 120 Hz, and use corneal reflection to estimate gaze location (SMI, 2016a). An integrated scene camera records the user's field of view and audio of the scene. The eye tracker's algorithms calculate gaze position and overlay a cursor on the gaze target within the scene video in real time. The scene and gaze cursor are displayed on a dedicated laptop connected to the eye tracker via closed, secure wireless network. OT1, OT2 and the child with ASD all wore these eye trackers during the experimental task. In this study, each time OT1, OT2 or the child with ASD donned the eye tracker, the eye tracker was calibrated prior to recording the experimental task. This study used the eye tracker's one-point calibration method, in which users are asked to hold their gaze on an object about 1.5 meters away, positioned so that it is in the middle of the scene, while a research assistant monitors the dedicated laptop, and confirms the gaze cursor on the display is aligned with the gaze target. One point calibration is fast, convenient, and provides the same measurement accuracy as 3-point calibration (SMI, 2016a).

The eye tracker's accompanying analysis software, BeGaze v 3.7 (SMI, 2016b) was used in the analysis of eye tracking data. This experiment used BeGaze's default settings for the low speed event detection dispersion-based algorithm to identify gaze fixations. This algorithm identifies fixation as having a minimum duration of 80 ms and a maximum dispersion of 100 pixels.

BeGaze permits users to define specific areas of interest (AOI) on a static reference picture. In a process called semantic gaze mapping (SMI, 2016b), BeGaze permits each algorithmically-detected fixation within a perspective video to be mapped onto a reference picture, to determine if the fixation falls within any AOI. Each user has their own reference picture for gaze mapping. In this study, each reference picture assigned AOIs to their partner's head, body and hands. All perspectives included AOIs for the build, the blocks in reserve, the instruction book and "white space." The White Space AOI comprised all areas of the scene not attributed to another AOI. In this case study, the White Space AOI represents the non-task, non-partner elements of the visual scene. To illustrate, when mapping OT1's fixations from the interaction with the child, the AOIs of Child Head, Child Body, Child Hands, Blocks in Reserve, Build, Instructions and White Space were used. When mapping the child's fixations from that same interaction with OT1, the AOIs of OT1 Head, OT1 Body, OT1 Hands, Blocks in Reserve, Build, Instructions and White Space were used. The same process for gaze mapping was used for the OT2/child interaction.

Figure 4.1 AOIs used for mapping child's gaze.

This experiment involved two experimental task variants: OT1 and the child building the dinosaur together, and then OT2 and the child building the spider together. Each experimental task variant generated three video recordings: the child with ASD's perspective, the occupational therapist's perspective and an external scene video from the Home Simulation Suite's PTZ camera. The video recordings captured by the eye trackers included audio recordings; the video recording captured by the PTZ camera did not. In digital playback, videos recorded by the eye trackers displayed the elapsed time to the millisecond and a cursor showing the user's gaze location. The three video recordings from each engagement were synchronized and combined into a single video file. The resulting single video file displayed synchronized views of all three perspectives of the engagement between the OT and child when performing one variant of the experimental task. Once such video file was created for the child's interaction with OT1, and another for the child's interaction with OT2.

4.3 Data Collection

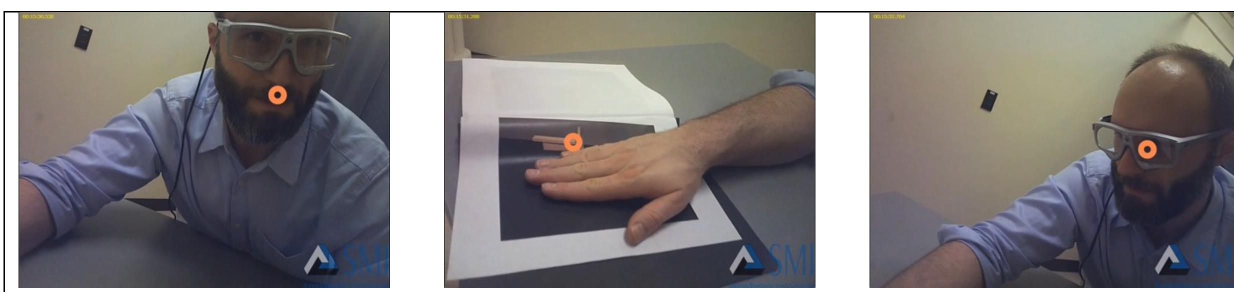
After informed consent was confirmed by the child's parent and the child's assent was obtained the experiment began. First, OT1 administered the Movement ABC-2's Manual Dexterity component. To extend the rapport established during the Movement ABC-2, OT1 was purposively selected to guide the child with ASD through the first variant of the block construction. The child and OT1 each donned a pair of eye tracking glasses, and then individually participated in one-point calibration. The variant of the block construction task completed by OT1 and the child, the dinosaur, was randomly selected. Following completion of the dinosaur block construction, the child continued wearing the eye tracker while taking a break. During the child's break OT1 doffed the eye tracker, reset the blocks into their starting configuration and removed the dinosaur pictorial instruction book, replacing it with the spider pictorial instruction book. OT2 then donned the eye tracker and participated in one-point calibration. The child participated in recalibrating the eye tracker, and then with OT2 completed the second variant of the experimental task, the spider block construction.

4.4 Data Analysis

During semantic gaze mapping, fixations from each perspective (OT1, Child with OT1, OT2, Child with OT2) falling within the head, body, hands, build, blocks in reserve and instructions AOIs were so assigned. Fixations falling outside of all other AOIs were assigned to the white space AOI. Once each fixation in each perspective was mapped, the BeGaze calculated fixation duration in each AOI for each perspective.

Using the video files that showed synchronized views of all three recordings created during each experimental task variant, multi-pass frame-by-frame analysis was conducted. Each pass through the video file focused on identifying exact start and stop times for one specific interactive behaviour, from only one perspective. The interactive behaviours considered for analysis from all perspectives include verbal, building blocks, and IJA. The interactive behaviour considered from only the OT's perspectives is passing blocks. The interactive behaviour considered from only the child's perspectives is mutual facial gaze (MFG).

IJA was operationally defined as a gaze sequence that started at the partner's Head AOI, moved to a referent, and then returned to the partner's Head AOI, consistent with the definition used by Mundy (2018). The initiator's gaze was required to fixate on the referent before the responder's gaze. Additionally, to be considered IJA, the gaze shift sequence had to clearly attempt to direct the partner's attention to the referent within context of the interaction.



Child looks at OT1's Head	Child moves gaze to Instructions	Child returns gaze to OT1's Head

Figure 4.2 Example of child initiating joint attention with OT1

MFG is, to our knowledge, a unique measure of social interaction, made possible by both partners wearing eye trackers during the interactions. MFG is operationally defined as the times when the OT and child gaze cursors are simultaneously in the other's Head AOI. In this case study's definitions, MFG is not necessarily a prerequisite of IJA. Although IJA requires the initiator's gaze cursor to start in the partner's Head AOI, the partner need not hold their gaze cursor in the initiator's Head AOI for the initiator to complete an IJA attempt. While other studies have used eye trackers on dyadic partners (e.g., Ho, Foulsham & Kingstone, 2015; Schwarzkopf, Buchner, Holscher & Konieczny, 2017) none have identified MFG as a variable of interest. As children with ASD tend to look less at faces (Falck-Ytter et al., 2013; Guillon et al., 2014; Hanley et al., 2014; Noris et al., 2012) identifying MFG provides an opportunity to examine joint, simultaneous face looking.

Figure 4.3 Example of mutual facial gaze between OT1 and child

All interactive behaviours considered for analysis are described in Table 4.1. Operational definitions for each interactive behaviour are available in Chapter 3 of this thesis.

Table 4.1 Interactive behaviours identified for analysis

Interactive Behavior	**Brief Definition**	**Rationale**
Verbal	First person perspective uses words or prosodic vocalizations.	Words and prosodic vocalizations are used to communicate about the task, and about non-task topics.
Block Building	First person perspective actively arranges blocks to help produce the emerging structure.	Block construction was the experimental task.
Initiating Joint Attention	First person perspective is looking at partner's face, then moves gaze to an external referent, and then back to partner's face.	The face-referent-face pattern of gaze use is an accepted behavioural definition of IJA (e.g., Mundy 2018) that has been used in other eye tracking studies of JA (e.g., Johnson et al., 2012).

Interactive Behavior	Brief Definition	Rationale
Block Passing	When the OT passes blocks to the child. Not coded from child perspective, as the child did not pass a block to the OT during either variant.	Passing the block is part of the experimental task.
Mutual Facial Gaze	When OT and child gaze cursors simultaneously fall in each perspective's Head AOI.	Looking at partner's face is a common measure in eye tracking studies of children with ASD. (e.g., Noris et al., 2012). It is a precursor to IJA (Mundy 2018). As this study used two eye trackers, identifying MFG was an opportunity to examine interactive gaze at a partner's face.
Partner Response to IJA Attempt	When the partner follows first person perspective's IJA attempt, moving gaze to referent indicated during IJA attempt.	This records the success of IJA attempts. IJA attempts are successful if the partner moves gaze onto the referent. They are unsuccessful if the partner takes actions other than moving gaze to the referent.

4.5 Results

After reporting of the child's performance on the Manual Dexterity component of the Movement ABC-2, analysis of data proceeded in two steps. The first step examined aggregate measures of gaze use and interactive behaviours to provide a description of gaze and behaviour used by the OTs and the child with ASD when completing the experimental task. The second step examined the relationships between gaze and interactive behaviours surrounding the sentinel events of IJA and MFG.

Movement ABC-2

Using the Movement ABC-2's scoring guidelines (Henderson et al., 2007), the child's standard score on the Manual Dexterity component was 6, placing his performance in the 9th

percentile. The Movement ABC-2's interpretation guidelines consider this "at risk of having a movement difficulty" (Henderson et al., 2007, p.96).

Aggregate Results

After semantic gaze mapping, BeGaze collated the total time each member of the dyad fixated gaze within each AOI. As the duration of the engagements differed between the dyads (11:32 with OT1 and 9:39 with OT2) this data is presented in as percentage of total fixation time. These percentages do not sum to 100 as they include only fixation time, and not other ocular events like saccades, pursuits or blinks. Interactive behaviours coded from video analysis are presented as frequency counts per minute. Table 4.2 presents the gaze and interactive behaviour data collected across the two engagements.

Table 4.2: Gaze and interactive behaviour. OT (Child with OT)

	OT1 (Child)	**OT2 (Child)**
Fixation Time per AOI as a percent of total engagement time		
Head	8.5 (5.4)	4.7 (0.9)
Body	8.5 (0.7)	2.8 (0.4)
Hands	17.3 (4.5)	15.8 (2.5)
Build	23.3 (51.0)	35.8 (47.9)
Instructions	10.6 (18.5)	20.2 (16.0)
Blocks in Reserve	6.2 (1.1)	1.0 (0.9)
White Space	5.9 (6.3)	6.7 (17.6)
Interactive Behavior as frequency per minute		
Verbal	6.6 (6.8)	10.3 (6.8)
Pass Blocks	1.4 (-)	0.7 (-)

	OT1 (Child)	OT2 (Child)
Build Blocks	0.6 (2.3)	2.4 (2.2)
IJA	1.7 (0.3)	0.8 (0.3)
Mutual Facial Gaze	3.9	1.5
Partner Response to IJA attempts as success / IJA		
Frequency	0.7 (0.8)	1.0 (0.8)
Notes: As the child did not pass blocks to the OT in either engagement, there is no child data for that interactive behaviour. MFG involves both the OT and the child, producing only one frequency measure for each engagement. Partner response to IJA attempts records the frequency of successful IJA attempts.		

Sentinel Events

This step of the analysis focused on understanding the relationships between IJA, MFG and the experimental task in each dyad. It is conducted using Figures 4.4 and 4.5 which place each of these interactive behaviours in each OT-child interaction on a timeline, and with contextual information extracted from video review.

In Figures 4.4 and 4.5, the horizontal axis represents time, expressed in minutes and seconds. The interactive behaviours are arrayed vertically. Each repetition of each interactive behaviour is illustrated with a horizontal bar, positioned to represent its precise start and stop times. Each horizontal bar depicts when the interactive behaviour started and stopped, and when in the OT – child interaction it occurred.

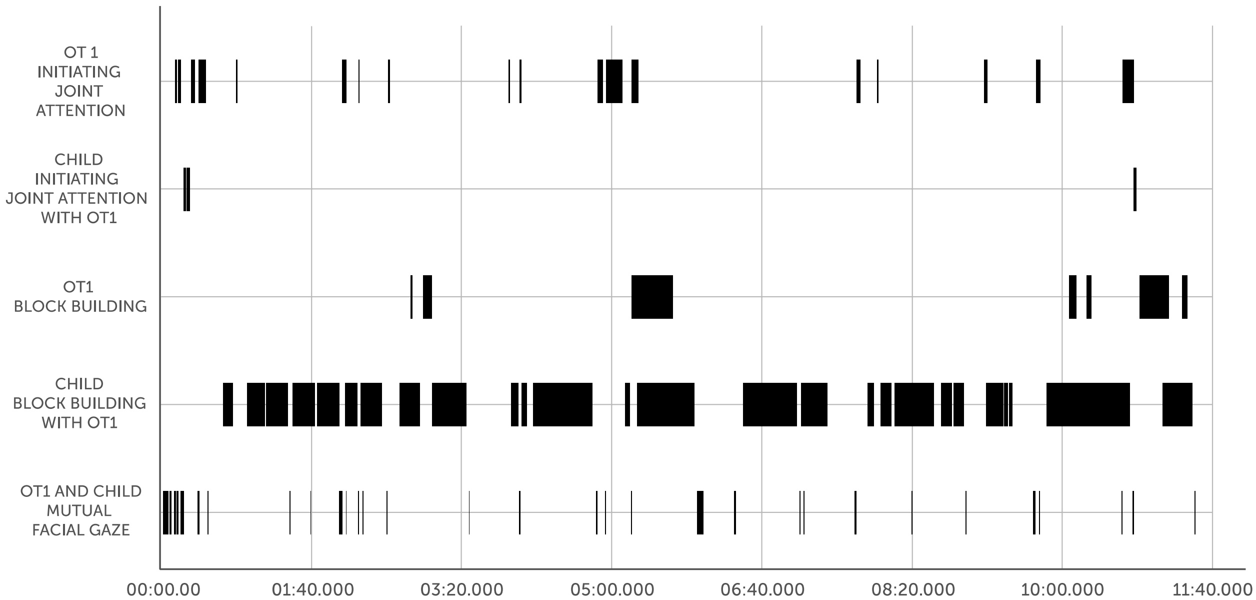


Figure 4.4: Interactive behaviours in the OT1-child interaction

OT1 and Child IJA.

OT1 demonstrated IJA 19 times. Of these 19 attempts, 12 were immediately preceded by MFG. The Instructions AOI was the most common referent of OT1's IJA (14 times). Other referents were the Blocks in Reserve AOI (three times) and the Build AOI (two times). The child accurately responded to OT1's IJA 14 times. All of the unsuccessful IJA attempts used the Instructions AOI as the referent, with the exception of one that used the Blocks in Reserve AOI as the referent. During successful IJA, the child's gaze entered an average of 3.3 AOIs between its location at the beginning of OT1's IJA and its end point on the referent. These AOIs were uniformly along the scan path between the child's gaze location at the start of OT1's IJA and the referent, suggesting the child moved gaze directly to the referent.

When working with OT1 the child demonstrated IJA three times. Of these three attempts, one was immediately preceded MFG. All of the child's IJA used the Instructions AOI as the referent. OT1 accurately responded to two the child's IJA. When responding to the child's IJA, OT1's gaze moved through an average of 3.0 AOIs between its location at the beginning of the child's IJA and its end point on the referent. These AOIs were uniformly along the scan path between the OT1's gaze location at the start of the child's IJA and the referent, suggesting OT1 moved gaze directly to the referent.

When considering the context of the child's IJA, they occurred around challenging aspects of the task. The first repetitions occurred when OT1 introduced the experimental task variant, as the child was checking to see if he was permitted to begin. The last repetition occurred during a particularly challenging aspect of the construction, when the child checked his understanding of the pictorial instruction. Periods of MFG are closely related to the child's IJA attempts with OT1. The first two of the child's IJA attempts follow a relatively stable period of MFG, interrupted only by OT1's gaze flickering away from the child head AOI; the child maintained relatively steady gaze at OT1's head. The child's final IJA attempt is the action that ends the period of MFG.

OT1 and Child MFG

The child and OT1 demonstrated MFG 45 times during the interaction. OT1 initiated MFG 17 times and the child initiated MFG 28 times. OT1 ended MFG 29 times, the child ended MFG 15 times and OT1 and the child simultaneously ended MFG one time.

Of the 17 times OT1 initiated MFG, 13 times were contextually linked to the child's actions; as the child completed one step depicted in the pictorial instructions and before turning the page to view the next step (11 times); in the interval mid-construction when OT1 held the blocks the child needed (one time); or after the child viewed the pictorial instruction book (one time).

When the child initiated MFG, 17 times happened after a moment of thought, for example, just after referencing the pictorial instructions (two times), or while directions are being discussed (three times), after an OT1 IJA attempt (four times), after an accident that knocked over part of the build (two times), or as a check after completing part of the construction, including the final step (four times).

When the child ended MFG, four times were through head movement (three nods, one blink). The child ended one MFG with an IJA attempt, and seven MFG by moving gaze onto to the next appropriate step in a sequence.

Overall, OT1 and the child seem to have a "do then check" pattern; after the child performs a "do" (e.g., completing a portion of the construction, referencing the printed instructions, accidentally knocking over a part of the construction, following OT1's IJA) there is a "check" MFG, showing that both partners routinely make themselves socially available in rhythm with the task.

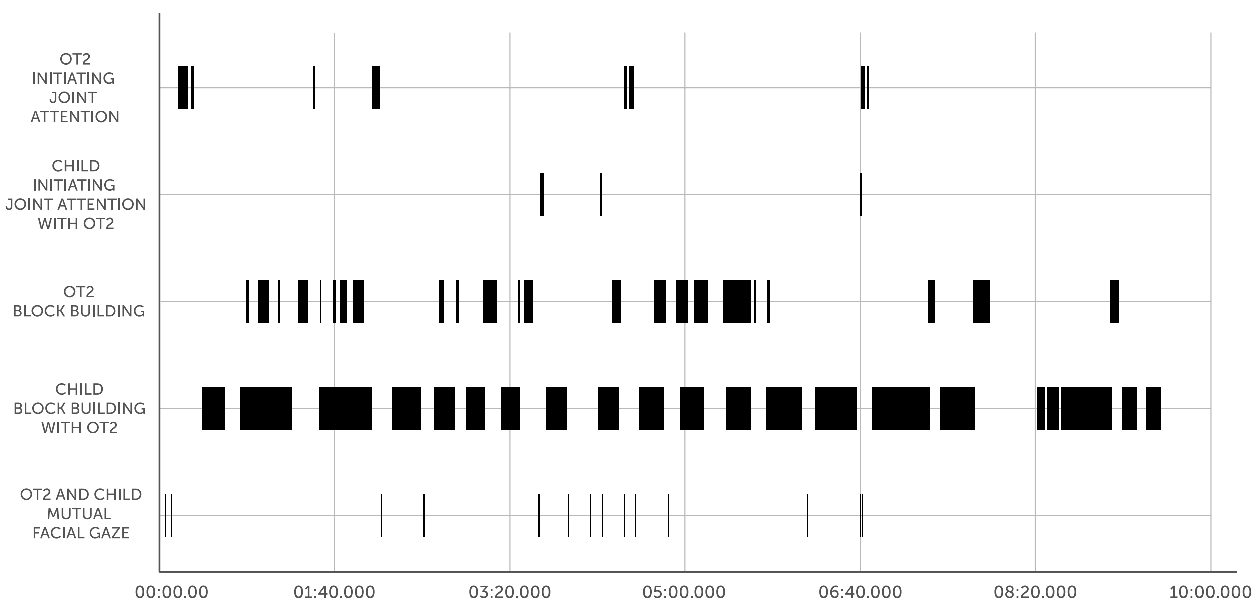


Figure 4.5: Interactive behaviours in the OT2-child interaction

Child and OT2 IJA.

OT2 demonstrated IJA eight times. Of these eight attempts, two were immediately preceded by MFG. All eight of OT2's IJA used the Instructions AOI as the referent. The child accurately responded to OT2's IJA four times. During successful IJA, the child's gaze entered an average of 2.8 AOIs between its location at the beginning of OT2's IJA and its end point on the referent. These AOIs were uniformly along the scan path between the child's gaze location at the start of OT2's IJA and the referent, suggesting the child moved gaze directly to the referent.

When working with OT2 the child demonstrated IJA three times. Of these three attempts, two were immediately preceded MFG. All of the child's IJA used the Instructions AOI as the referent. OT2 accurately responded to all of the child's IJA. When responding to the child's IJA, OT2's gaze moved through an average of 3.0 AOIs between its location at the beginning of the child's IJA and its end point on the referent. These AOIs were uniformly along the scan path between the OT2's gaze location at the start of the child's IJA and the referent, suggesting OT2 moved gaze directly to the referent.

When considering the context of the child's IJA, they occurred around situations similar to how the child used IJA with OT1. One use of IJA sought permission to resume the task following OT2's request for a high-five. One use of IJA referenced the pictorial instructions that depicted a change in the block construction pattern that had been previously established.

Child and OT2 Mutual Facial Gaze.

The child and OT2 demonstrated MFG 15 times during the interaction. OT2 initiated MFG eight times and the child initiated MFG seven times. OT2 ended MFG three times, the child ended MFG 12 times.

Of the seven times OT2 initiated MFG, five times were contextually linked to the child's actions; after the child viewed the pictorial instruction book (four times), after completing a step in the construction (one time). Two were unrelated to the construction task. Of the three times OT2 ended MFG, two times immediately preceded IJA.

Of the eight times the child initiated MFG, the child seemed to initiate them after a moment of thought, for example, just after referencing the pictorial instructions (three times), or as a check after he completed part of the construction (two times).

When the child ended MFG, all 12 times seemed related to the task; two proceeded directly into IJA. There were eight MFG ended by the child as gaze moved to the Instructions AOI, three as gaze moved to the Blocks in Reserve AOI, and one as gaze moved to the Build AOI.

Overall, OT2 and the child seemed to have a "view and check" pattern; seven periods of MFG followed inspection of the instruction book; only three followed the act of building.

4.6 Discussion

The purpose of this case study is to pilot a method to explore differences in gaze use and joint attention associated with the responsive interaction style using mobile eye tracking. The collected data detected gaze use and joint attention differences between two occupational therapists, and in the child with ASD when being guided by the two occupational therapists.

The Method

This case study introduces a unique method that maintains both high measurement accuracy and ecological validity when examining JA in a single child with ASD. Measurement accuracy is maintained through the use of mobile eye tracking glasses, worn by both members of each dyad in the case study. The table top task creates a natural physical boundary to the task, limiting the variability of the visual scene. This permits a single, static two dimensional reference picture to map all gaze fixations from a user's perspective, which is dynamic and three dimensional. Semantic gaze mapping provides aggregate gaze use data of fixation time per AOI for each member in each dyad permitting comparisons of gaze use between dyads.

The use of a mobile eye tracker on each dyadic member operational definitions of interactive behavior based on gaze position. This study defined IJA in part, and RJA and MFG in whole, by gaze cursor location, adding a degree of accuracy to the measurement of these interactive behaviors while maintaining ecological validity.

The Occupational Therapists

As adults use a responsive interaction style with children, their behaviours are guided by the principles of contingency, reciprocity, positive affect and non-directiveness (Mahoney & Solomon, 2016). The collected aggregate measures and sentinel event results, when taken together, support the assertion that OT1 was using a responsive interaction style while OT2 was not. This is expected as OT1 purposively used a responsive interaction style, and OT2 was purposively naïve to it.

The total duration of the interaction with the child is longer for OT1 by nearly two minutes. The aggregate measures of fixation time show OT1 looked more at the Child Head, Child Body and at the Blocks in Reserve AOIs, and less at the Build AOI. In this case study, the OTs and the child began seated facing each other, with the animal being constructed on the table between them. In this physical arrangement of participants and materials, the Child's Body AOI is along the scan path between the Build AOI and the Child's Head AOI. OT1 looking more at the Child Body AOI might be a consequence of more frequent gaze shifts between the Build AOI and the Child Head AOI. More time looking at the Child Head AOI, and less time looking at the Build

AOI is consistent with the responsive interaction style behaviour of reciprocity (Ingersoll, 2010) and the emphasis on co-regulation, affect sharing and emotional expression (Casenhiser et al., 2011).

OT1 generated IJA attempts at more than double the rate of OT2. In addition to generating more IJA attempts, OT1 used IJA differently than OT2. For OT1, IJA was more often preceded by mutual facial gaze, consistent with the continuous social monitoring required by responsive interaction style's principles of reciprocity and following the child's attentional focus (Ingersoll, 2010). While both OTs used the instruction book as the most frequent referent in IJA attempts, it was the only referent in all of OT2s attempts. OT1 also targeted other materials in the environment, consistent with the idea of arranging the environment to support synchronous interactions (Kong & Carta, 2013).

OT1 looked more at the blocks in reserve than did OT2 or the child in either interaction. This could be an indication of OT1 purposively arranging and adjusting the environment as the construction sequence unfolded to continually promote synchronous interactions, an interpretation supported by the higher frequency of block passing OT1 demonstrated.

OT2 looked more at the build and instructions than OT1. This might reflect OT2's relative inexperience with the construction task compared to OT1. It might also reflect prioritization of task completion over reciprocity in the interaction, which might be expected when a responsive interaction style is not explicitly used.

The Child

The child generated an equal number of IJA attempts between the OTs, and all attempts used the Instructions AOI as the referent. Child IJA was distributed differently in the interactions. With OT1, the child's IJA was near the beginning and the end of the interaction. With OT2, the child's IJA grouped more in the middle of the interaction. The child seemed to use IJA in similar ways between the OTs; to direct attention to the instruction book, checking for understanding of the depicted steps, and seeking permission to start the task. Although OT1 used IJA at nearly double the rate of OT2, the child successfully used RJA at the same rate between the OTs.

Screen based eye tracking studies (Falck-Ytter et al., 2013; Guillon et al., 2014) and mobile eye tracking studies (Hanley et al., 2014; Noris et al., 2012) have shown children with ASD spend less time looking at a partner's face. The aggregate measures of fixation time in this case study show the child looked at the OT1 Head AOI much more than at the OT2 Head AOI. This finding is potentially consequential, as it suggests some difference between the OTs influenced how the child looked at their heads. It is important to note that neither OT directly requested the child to look at their face or eyes during the interactions.

In this case study, both partners wore eye trackers during the interactions. This permits the identification of MFG, which to our knowledge, is a unique measure of interactive behaviour. It describes the times each partner was looking at each other's face. This is important, as IJA is preceded by looking at a partner's face (Mundy 2018), and the responding partner must see the initiation in order to respond to it. Together, OT1 and the child looked more at each other than did OT2 and the child, generating more frequent periods of MFG. Periods of MFG are more evenly distributed across the child's interaction with OT1 than they are in the child's interaction with OT2, where they cease approximately two-thirds of the way through.

The child looked more at the White Space AOI with OT2 than with OT1. Recalling the White Space AOI is defined as that parts of the scene not included in other AOIs, fixations in it represent those times the child was looking at something other than the OT and the task materials. Both OTs looked at the White Space AOI for approximately equal proportions of time.

The child's proportion of aggregate fixation time in the White Space AOI was similar to that of the OTs when in the engagement with OT1, and seemingly much higher when in the engagement with OT2.

Hanley et al. (2014) included "non-partner" AOIs in their face-to-face eye tracking study of gaze use of children with ASD. This non-partner AOI seems similar to this case study's White Space AOI. In Hanley et al. (2014), children with ASD are found to fixate more on the non-partner AOI more than all other AOIs in their engagement. The authors propose this finding could reflect children with ASD's gaze aversion in social engagements, where children look away to manage physiological arousal associated with social gaze. Hanley et al. (2014) also propose distraction or lack of interest as possible explanations for the high dwell time in their non-partner AOI. While this case study does not replicate Hanley et al. (2014)'s findings, the difference in the child's proportional dwell time in the White Space AOI between OTs is potentially consequential. It suggests than in individual with ASD can look at non-task, non-social targets at varying frequencies, dependent on context.

As the data in this case study show differences in OT1 and OT2's gaze use and interactive behaviours, and as OT1's gaze use and interactive behaviours are consistent with a responsive interaction style, the data also then suggest that differences in the child's gaze use and interactive behaviour might be in part because of the differences in the OT's behaviour. This case study did not find any adult interaction style related differences in child IJA or RJA. It does suggest that OT use of a responsive interaction style during interactions increases the frequency with which the child looked at his partner's face, and reduced the frequency of non-task, non-social looks.

4.7 Limitations

Caution is needed when interpreting this paper's findings, as they represent observations collected in the interactions that formed this case study and cannot be generalized beyond it. While efforts were made to control for confounding variables, there are factors other than OT interaction style that might have influenced the child's gaze use and interactive behaviours. The differences in the task variants, the OTs' familiarity with the task variants and the OTs' previous relationship with the child might all have influenced how the child performed. This case study did not use an independent measure of occupational therapist responsiveness, or an independent confirmation of the child's ASD diagnosis. It cannot claim with certainty any differences in responsiveness between the OTs, or that the child has ASD.

Additionally, the multiple roles performed by the lead researcher introduce to potential for bias. The lead researcher designed the study and the experimental tasks. The lead researcher independently conducted semantic gaze mapping and video analysis, and acted as OT1 in the case study. As the lead researcher was not blind to study hypotheses while OT2 was, the possibility of bias has not been eliminated.

When implementing a larger scale study, these limitations will need to be addressed. A design that recruits a larger sample of children with ASD will permit randomization into two groups; one that interacts with the responsive occupational therapist and one that interacts with the occupational therapist naïve to the responsive interaction style. This will then permit use of a single experimental task. Independent confirmation of ASD diagnosis for each participant will create stricter inclusion criteria. Adding a measure of responsiveness of the occupational therapists will better describe the differences in responsiveness between them. Separation of roles, so that the individuals gaze mapping and video coding are blind to the study hypothesis and interaction condition will reduce the potential for bias, as will adding an interrater reliability check to gaze mapping and video coding. Blinding the occupational therapists interacting with the children to the study hypotheses will further reduce the potential for bias.

4.8 Conclusion

This case study documents a unique method of measuring gaze use in the context of face to face interaction. The method used in this study can be used with a larger sample and with greater control of potential sources of bias to examine the impact of occupational therapist interaction style on gaze use and JA in children with ASD, and with other related research questions.

The case study demonstrates differences in gaze use and interactive behaviour between two OTs, one using a responsive interaction style and the other naïve to it. It also demonstrates differences in gaze use and interactive behaviours in a single child when engaging with these two OTs around similar tabletop block building tasks.

CHAPTER 5 CONCLUSION

This thesis comprises a scoping review that identifies a gap in the literature and case study that pilots a methodology aimed at addressing that gap. The scoping review shows that the methods used to cue for and measure joint attention (JA) when investigating JA in children with autism spectrum disorder (ASD) influence how study participants demonstrate JA. Methods with high ecological validity have lower gaze measurement accuracy, and those with higher gaze measurement accuracy have lower ecological validity. The case study in this thesis pilots a methodology that maintains both ecological validity and gaze measurement accuracy when investigating JA in children with ASD. The outcome of this thesis concerning the use of mobile eye tracking to measure the impact of occupational therapist interaction style on gaze use and JA in a child with ASD has implications for occupational therapy education, practice and research.

5.1 Implications for Occupational Therapy Education

Entry-to-practice occupational therapy education includes content on typical development, ASD and its associated occupational performance concerns, and common practice models occupational therapists use to provide service to individuals with ASD. The lead researcher's personal experience, first as an entry-to-practice student and more recently as a fieldwork educator for entry-to-practice students, suggests occupational therapy students are not exposed to the theoretical background for interventions employing a responsive interaction style, the research supporting their use, or practical considerations in their use.

Interventions using the responsive interaction style are well-researched, and are documented to facilitate improvements in developmental outcomes, including JA (Oono, Honey & McConachie, 2013). The case study in this thesis adds to the evidence-base supporting the use of the responsive interaction style with children with ASD. Occupational therapy is a frequently sought service (American Occupational Therapy Association, 2015) for a growing population individuals with ASD (Baio et al., 2018). Therapists and consumers would benefit from integrating information on the theoretical background, research base and practical application of the responsive interaction style and its utility in building skills in individuals with ASD into entry to practice occupational therapy education.

5.2 Implications for Occupational Therapy Practice

The scoping review in this thesis initiates a rigorous transactional analysis of the experimental protocols of studies that examine JA in children with ASD. It demonstrates these transactions impact the JA performance of children with ASD. The method of analysing the transactions used in the scoping review serves as a guideline for individual occupational therapists when consuming research similar to the retained studies, and offers an additional lens when considering the applicability of a piece of research into their evidence-based practices.

The case study in this thesis documents that a single participant can demonstrate different gaze use and interactive behaviour patterns while completing developmentally appropriate tabletop tasks guided by two occupational therapists, each using a different interaction style. This finding can guide occupational therapists in their reflective practices, encouraging them to consider the interaction style used when working with clients with ASD, and ensuring the selected interaction style is the best fit to facilitate the client's individual goals.

5.3 Implications for Occupational Therapy Research

The scoping review in this thesis is, to the lead researcher's knowledge, the first effort to rigorously analyze the transactions occurring in research examining JA in children with ASD. The scoping review serves as a model when using its analysis with a broader range of research papers covering a wider range of child ages. Broadening the analysis to a include wider age range of children with ASD is necessary to develop a comprehensive understanding of the transactions occurring in protocols of studies measuring JA, and their impact on JA.

The case study in this thesis is, to the lead researcher's knowledge, the first effort of using mobile eye tracking to accurately measure gaze while maintaining ecological validity by examining JA during a face-to-face interaction. The experimental methods used to collect data in the case study, and the measurements of gaze use and interactive behaviour extracted from the eye tracker and video review can be used in three different directions of research.

Data collected in the case study suggests gaze use differed between occupational therapists. One direction of research could use mobile eye tracking with larger samples of occupational therapists or other professionals to determine if adult guides using the responsive interaction style, as a group, use gaze differently during interactions with children with ASD compared to adult guides not explicitly using the responsive interaction style.

Data collected in the case study also suggests the child with ASD used gaze and interactive behaviour differently between the two occupational therapists. The second direction of research suggested by these results could investigate group differences in gaze use and JA in a larger sample of children with ASD when randomized to interact with occupational therapists or other professionals either purposively using or naïve to the responsive interaction style.

To the lead researcher's knowledge, this case study is the first to use mutual facial gaze (MFG) as a measure of social interaction in children with ASD. As children with ASD look less at their partner's faces than typically developing children (Falck-Ytter, Bolte & Gredenback , 2013; Guillon et al., 2014; Hanley et al., 2014; Noris, Nadel, Barker, Hadjikhani & Billard, 2012), and as looking at a partner's face precedes IJA (Mundy, 2018), MFG seems important, as it provides an indicator of mutual gaze use within a dyad. Additional investigation on the utility of MFG as a measure of social interaction is the third direction of research suggested by this thesis.

The earliest idea for this thesis originated in clinical experiences. I was interested in learning more about the responsive interaction style and its use in helping children with ASD build skills. Through piloting a methodology that maintains both gaze measurement accuracy and ecological validity, the case study in this thesis contributes a methodology that can later add to the body of research on the responsive interaction style.

APPENDIX A RECRUITMENT EMAIL

DALHOUSIE UNIVERSITY 1818 2018

Vicki Harvey
Community Outreach Coordinator
Autism Nova Scotia

Subject: Request for assistance to recruit participants for a pilot study.

Dear Ms. Harvey:

My name is David Ambrose and I am an occupational therapist in Saskatoon, SK, in my 18th year of practice. I am also a student in the thesis stream of Dalhousie University's post-professional MSc OT program delivered by distance. This letter details the pilot project I have planned as part of the requirements for my Master's degree. I am contacting your organization for support in recruiting potential study participants from your membership. I am currently in the process of applying to the Dalhousie's Research Ethics Board for study approval.

Please see below for a few study details for your consideration:

Purpose: This pilot study will use real-time mobile eye tracking technology to investigate the impact of occupational therapist (OT) interaction styles on the joint attention (JA) demonstrated by children with autism spectrum disorder (ASD). Joint attention is when two people share their attention on a third thing, and they both understand that they are both interested in that same third thing. This pilot study will not tell us if therapist interaction style changes the way a child uses joint attention. Instead, it helps us know if the way we designed the study, and the way we plan to analyze the results, have the potential to help us learn something new. The information gained in this pilot research study will help us learn if a larger study, involving more children, is reasonable and realistic.

Participants: As this is a proof of concept study to gather pilot data and test the technology in an ecologically valid way, I am limiting the number of participants. I seek to recruit 12 children with ASD, aged 8 – 12 years old, who attend school in a mainstream classroom (a classroom that is designed for all students, and not just for students with unique learning or behaviour needs), with or without an individual education plan. Children must use English as their primary communication method. Children who have any other diagnoses like Down syndrome, intellectual disability, developmental delay, cognitive delay, anxiety, tics, Tourette's, depression, cerebral palsy, muscular dystrophy, ataxia, schizophrenia, bipolar disorder, seizures, tremors, and heart or lung conditions, cannot participate in this study.

Time Commitment: Each participant will be asked to complete a brief standardized test of fine motor skills, and then to perform two developmentally appropriate tabletop tasks; one with one occupational therapist and one with another occupational therapist. A tabletop task is one that is performed seated, like at a kitchen table, with small, light materials. Participants and occupational therapists will be wearing mobile eye tracking glasses, about the size of safety goggles, which video record what they see, and where their gaze in a scene falls. The entire experience for each participant will not exceed 60 minutes; the participant will need to wear the eye tracking glasses for about 25 minutes.

Research Team:

Lead researcher:
David Ambrose, B.M.R.(O.T.); O.T. Reg. (Sask)
Master of Science (Post Professional Occupational Therapy) Candidate
School of Occupational Therapy, Dalhousie University
Email: david.ambrose@dal.ca
Tel: (306) 221-3537 - If calling long distance, please call collect.

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Heather Neyedli, PhD, Assistant Professor
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Dalhousie University
E: hneyedli@dal.ca

Once I receive ethics approval, I will send a copy for your records. If permission to assist with recruitment is granted, I will also forward you a pilot study participant letter that can be sent to your organization's members. In addition to assistance in electronically communicating with members, I also request that a recruitment poster be displayed at your facility or events where it can be seen by members. An email granting or denying your permission to contact your organizations members can be sent to david.ambrose@dal.ca.

If you have any questions or comments, I am happy to discuss the project in more detail, at your convenience.

Sincerely,

David Ambrose, B.M.R.(O.T.); O.T. Reg. (Sask); SIPT, Occupational Therapist
MSc OT (Post Professional) Candidate

School of Occupational Therapy, Dalhousie University
p: 306 221 3537 e: david.ambrose@dal.ca

APPENDIX B RECRUITMENT POSTER

PARTICIPANTS WITH AUTISM *(AGE 8 - 12)* NEEDED
FOR RESEARCH IN *JOINT ATTENTION*

We are looking for child volunteers (age 8 - 12) with autism spectrum disorder to take part in a study to learn if an adult's interaction style changes a how a child uses joint attention. Joint attention is when two people share their attention on a third thing, and they both understand that they are both interested in that same third thing.

Your child would be asked to: *complete a brief fine motor test (the manual dexterity part of the Movement ABC-2) and then two tabletop activities (like make a sandwich or build a lego kit) with an experienced occupational therapist*

Your child's participation would involve one session to complete the tasks at Dalhousie University, lasting no more than an hour. In that hour, your child will need to wear eye tracking glasses for about 25 minutes.

This study is a pilot project, to help decide if more research about this question is needed. The lead researcher is a post-professional Masters student in occupational therapy at Dalhousie University.

If you know anyone who might be interested in this study, please tell them about it. For more information about this study, or to volunteer for this study,
please contact:

David Ambrose, Lead Researcher

Dalhousie University - School of Occupational Therapy

306-221-3537. If calling long distance, call collect
Email: david.ambrose@dal.ca

This study has been reviewed by, and has received ethics approval though the Health Sciences Research Ethics Board at Dalhousie University.

Call Collect
David Ambrose
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APPENDIX C PILOT STUDY PARTICIPATION INFORMATION LETTER

Project title: Investigating a responsive interaction technique for joint attention in children (8-12) with Autism Spectrum Disorder: a pilot eye-tracking study

Lead researcher:
David Ambrose, B.M.R.(O.T.); O.T. Reg. (Sask)
Master of Science (Post Professional Occupational Therapy) Candidate
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Other researchers:
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Heather Neyedli, PhD, Assistant Professor
School of Health and Human Performance,
Dalhousie University
E: hneyedli@dal.ca

Dear Pilot Study Participant Guardian:

My name is David Ambrose and I am an occupational therapist doing a research project as part of my Master of Science graduate program. My research project is a pilot study that will help me learn if the way an adult interacts with the child changes the way the child uses joint attention during tabletop activities. Joint attention is when two people share their attention on a third thing, and they both understand that they are both interested in that same third thing. It is a skill that can be slow or hard to develop in children with autism. It is an important skill because it shows how a child is learning to share attention with another person. A tabletop task is one that is performed seated, like at a kitchen table, with small, light materials.

In this study, I will ask the child to wear eye-tracking glasses that video record where their eyes are looking while they do the activity. The child will have to wear eye tracking glasses, about the size of safety glasses, for about 25 minutes. The therapist working with the child will also wear the eye-tracking glasses at the same time. The eye-trackers will provide real-time information on how the child and the therapist moved their eyes while they worked together.

The eye-trackers we will use in this study have some advantages over other studies that have used video review or screen-based eye-tracking trackers to look at how children move their eyes. The mobile eye tracking glasses allow for the child and therapist have and interaction, and to do a real job together while eye movements are collected and linked to where they looked.

This pilot study will not tell us if therapist interaction style changes the way a child uses joint attention. Instead, it helps us know if the way we designed the study, and the way we plan to analyze the results, have the potential to help us learn something new. The information gained in this pilot research study will help us learn if a larger study, involving more children, is reasonable and realistic.

I am looking for children participants with ASD, ages 8 – 12; who attend school in a mainstream classroom, (a classroom in a public or private school that is designed for all students, and not just for students with unique learning or behaviour needs) with or without an individual education plan. Children also need to use spoken English as their main way of communicating. If the child has any other diagnoses like Down syndrome, intellectual disability, developmental delay, cognitive delay, anxiety, tics, Tourette's, depression, cerebral palsy, muscular dystrophy, ataxia, schizophrenia, bipolar disorder, seizures, tremors, and heart or lung conditions, they cannot participate in this study.

Children who participate in this study will come to Dalhousie University and work with two occupational therapists. They will complete the Manual Dexterity part of the Movement-ABC 2 (a test of fine motor skills) and two age-appropriate tabletop activities. They will complete the tabletop activities with two different occupational therapists. During these activities, children and occupational therapists will wear mobile eye tracking glasses that video record where they are looking as they complete their task and audio record any sounds made. The interaction between therapist and child participant will also be recorded by a third camera. Participation in this study will take no longer than 60 minutes; children will need to wear the eye tracking glasses for about 25 minutes.

This study has been reviewed by the Health Sciences Research Ethics Board at Dalhousie University. There is no compensation provided to participants.

If you are interested in your child participating in this study, please contact David Ambrose by phone (306-221-3537) or by email (david.ambrose@dal.ca). If you are calling long distance, please call collect. If your child is eligible to be in the study, I will send you more information about the study and a participant consent form. If you know of other families who might be interested in their children participating in this study, please talk about it with them, share this letter with them, and ask them to contact me for more information.

Thank you,

David Ambrose, O.T. Reg. (Sask), Occupational Therapist
MSc OT (Post Professional) Candidate
School of Occupational Therapy, Dalhousie University
p: 306 221 3537 e: david.ambrose@dal.ca

APPENDIX D CONSENT FORM

DALHOUSIE UNIVERSITY 1818 2018

Project title: Investigating a responsive interaction technique for joint attention in children (8-12) with Autism Spectrum Disorder: a pilot eye-tracking study

Lead researcher:
David Ambrose, B.M.R.(O.T.); O.T. Reg. (Sask)
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Introduction
We invite your child to take part in a research study being conducted by David Ambrose, occupational therapist, a graduate student at Dalhousie, as part of his post-professional Master of Science degree. This research is supervised by Dr. Diane MacKenzie, an associate professor in the School of Occupational Therapy at Dalhousie University.

This letter provides you with information on the study and on any possible risks or benefits from participation in the study. Participation in this study is voluntary and whether your child will take part in this research is entirely your choice. If you chose to have your child participate, your child will also be asked if they are willing to work with the researchers on the day of the study. There will be no impact on you, your child, your family, or the services you access if you decide not to participate in the research, or if your child decides not to work with the researchers on the day of the study. The information in this letter tells you about what is involved in the research, what your child will be asked to do and about any benefit, risk, inconvenience or discomfort that your child might experience.

If you have any questions about this study, please contact David Ambrose at (306) 221-3537 or by email (david.ambrose@dal.ca). Please ask as many questions as you like. If you are calling long distance, please call collect.

Purpose and Outline of the Research Study

The purpose of this pilot study is to learn if the way an adult interacts with the child changes the way the child uses joint attention during tabletop activities. Joint attention is when two people share their attention on a third thing, and they both understand that they are both interested in that same third thing. It is a skill that can be slow or hard to develop in children with autism. It is an important skill because it shows how a child is learning to share attention with another person. A tabletop task is one that is performed seated, like at a kitchen table, with small, light materials. Some examples to tabletop tasks are making a sandwich, or building a small lego kit. This study will use eye tracking technology to measure joint attention in children with autism during tabletop task performance, to see if an adult's use of a responsive interaction style changes how a child uses joint attention when working together.

A responsive interaction style uses a slow, deliberate pace to give the child a chance to think about what has happened before needing to respond. When adults use a responsive interaction style, they allow for longer times for a child to respond; they use more gestures, facial expressions and other non-verbal communication; and they follow the child's lead more often during task completion.

Responsive interaction styles have been studied and have been shown to help improve joint attention. But, these studies have used video analysis to measure joint attention. Video analysis is pretty inaccurate when it comes to knowing exactly where and how long people are looking, two things important to know when studying joint attention. Eye tracking can be much more accurate when studying joint attention. There has been some eye tracking research looking at joint attention in children with ASD, but most of that research has used screen-based eye trackers, asking children to respond to videos, and none has used a responsive interaction style.

This is a pilot study and 12 children will participate. A pilot study will not tell us if a responsive interaction style changes the way a child uses joint attention. Instead, it helps us know if the way we designed the activities in the study, and the way we plan to analyze the results, have the potential to help us learn something new. The information gained in this pilot research study will help us learn if a larger study, involving more children, is reasonable and realistic.

Who Can Take Part in the Research Study

This study is for children aged 8 – 12, with an autism spectrum disorder diagnosis who attend a mainstream classroom (a classroom that is designed for all students, and not just for students with unique learning or behaviour needs), with or without an individual education plan, and who use spoken English as their main way of communicating with others. The child cannot have other diagnoses like Down syndrome, intellectual disability, developmental delay, cognitive delay, anxiety, tics, Tourette's, depression, cerebral palsy, muscular dystrophy, ataxia, schizophrenia, bipolar disorder, seizures, tremors, and heart or lung conditions.

What You Will Be Asked to Do

As the child's parent, you will be asked to: complete a self-screening questionnaire about your child to determine if your child can participate in the study; accompany your child to the study; and to observe your child's participation during the study.

Your child will be asked to give their assent to participate, meaning the will be asked if they are willing to work with the occupational therapists that day. They will be asked to complete a brief test of fine motor skills (the Manual Dexterity component of the Movement ABC-2). This information will help us describe the children who participate in the study. They will then be asked to wear a mobile eye tracker (roughly the size of safety glasses), and to perform a brief calibration task. While wearing the eye tracker, they will work with two different occupational therapists and do two different tabletop jobs. The occupational therapists will also be wearing eye trackers. The eye trackers will record what the wearer is seeing, and any sounds that are made during the jobs. A third video will also be made that shows the therapist and your child working together. This video will be made by a camera that is built into the room where the study will be performed.

Participation in this study will take no longer than 60 minutes. Your child will need to wear the eye tracking glasses for about 25 minutes.

Possible Benefits, Risks and Discomforts

The risks of participating in this study include being bored, fatigued, uncertain or frustrated. Children might become frustrated if they find the eye tracking glasses uncomfortable, or if they think the activity is too hard or too long. They might be uncertain about working with two new therapists, or working in a new environment.

To help mitigate these risks, we have tried to match the participation criteria for the study (that is, which children can and cannot participate in the study) with the tabletop tasks, so that the tasks are not too hard for the children. The research will happen in Dalhousie University's home simulation suite, a 1200 square foot apartment-like space in the School of Occupational Therapy, which is more comfortable than a laboratory or classroom. The occupational therapists working with the children have experience working with children with ASD, and their experience is expected to help children become comfortable with the glasses, with the environment, with the tasks, and with working with new therapists. You, the children's parent / guardian will be present, and available for comfort or encouragement, as required. Children will have the opportunity to take breaks as they request; occupational therapists or parents / guardians will also direct breaks as they are needed.

Your child may not benefit personally by participating in this study. However, the information gained may contribute to increased knowledge and understanding of the responsive interaction style and joint attention for children with autism.

Compensation / Reimbursement
There is no compensation or reimbursement offered for this study.

How your information will be protected:
This study takes your privacy and confidentiality seriously. These are the steps we will take to protect your private and confidential information:

After you complete the consent form your child will be assigned an identification number. A list of participants' names and assigned identification numbers will be known only to the lead researcher and his thesis supervisor, Dr. Diane MacKenzie. The master list will be stored on the lead researcher's computer and protected with encryption. Signed consent forms will be securely stored in a locked filing cabinet in Dr. MacKenzie's office at Dalhousie University. Participants' digitally recorded data, from the eye trackers and from the scene camera, will be encrypted and securely stored in Dalhousie University's file servers.

The videos, which include audio recordings the interactions, will be viewed by all members of the research team. We will use the videos to analyze how your child uses joint attention when working with the occupational therapists and how the occupational therapists interact with your child.

All data will be kept for five years following participation in the study. Paper records will be destroyed using Dalhousie University's confidential shredding service. Digital records will be permanently deleted from Dalhousie's server, and from the researcher's computer.

The information that you provide to us will be kept private. Only the research team working on this study will have access to that information; and only the lead researcher and his supervisor will have access to the information that can possibly identify your child. When we describe and share our findings in theses, presentations, public media, journal articles, etc., we will be very careful to only talk about group results so that no one will be identified. This means that ***you and your child will not be identified in any way in our reports***. The people who work with us have an obligation to keep all research information private. Also, we will use a participant number (not your name) in our written and computer records so that the information we have about you contains no names. All your identifying information will be securely stored.

We will not disclose any information about your child's participation in this research to anyone unless compelled to do so by law. In the event that we witness child abuse or neglect, or suspect them, we are required to contact authorities.

If You Decide to Stop Participating
Participation in the study is voluntary and you can choose to remove your child from the study at any time. If you decide to stop participating at any point in the study, you have two days (48 hours) to decide if we can use the data we collected, or if we should remove it from our analysis. After two days, the data we have collected will be grouped with the other data, and cannot be removed due to the analysis process.

How to Obtain Results
We will provide you with a short description of group results when the study is finished. No individual results will be provided. You can obtain these results by including your contact information at the end of the signature page.

Questions
We are happy to talk with you about any questions or concerns you may have about your participation in this research study. Please contact David Ambrose at (306) 221-3537 or david.ambrose@dal.ca at any time with questions, comments, or concerns about the research study. If you are calling long distance, please call collect. We will also tell you if any new information comes up that could affect your decision to participate.

This study has been reviewed by the Health Sciences Research Ethics Board at Dalhousie University. If you have any ethical concerns about your participation in this research, you may also contact Research Ethics, Dalhousie University at (902) 494-1462, or email: ethics@dal.ca

Signature Page

Project title: Investigating joint attention in children (8-12) with ASD with/without responsive interaction adult guiding: a pilot eye-tracking study

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I have read the explanation about this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction.

I understand that my child will be asked to complete the Manual Dexterity component of the Movement ABC-2, and then will wear an eye tracker to complete two different tabletop jobs with two different occupational therapists.

I understand that my child's eye tracker will video record the task area in front of them and where they looked in that area, and audio record the sounds they make and words they say. I understand the occupational therapist's eye tracker will video and audio record the same things from their perspective. I understand that the interaction of my child with the two therapists will be recorded by a third camera. I understand these three video recordings will also record the sounds my child and the occupational therapist make when working together. I understand these recordings will be used for analysis without identifying the child.

I agree for my child to take part in this study. My child's participation is voluntary and I understand that I am free to withdraw my child from the study at any time. If I withdraw my child's participation, I understand that I have two days (48 hours) to decide if the researchers can use the data they collected, or if they cannot use it in the study.

The following three statements require a response of "Yes" to participate in this study. If you answer "No" to any of the following three statements, your child cannot participate in this study.

I agree that my child will be video and audio recorded for this study.
☐ *Yes* ☐ *No*

I agree that my child's performance in the study will be used without any identifying features.

☐ *Yes* ☐ *No*

I consent to the use of my child's data in a presentation for educational or research purposes if they are not identified in any way.
☐ *Yes* ☐ *No*

The following statement's answer does not impact your child's ability to participate in the study:

I agree that researchers can contact me about related research projects in the future.
☐ *Yes* ☐ *No*

I agree that quotes collected during the interactions may be used when presenting the results, without identifying my child.
☐ *Yes* ☐ *No*

____
Child's Name

______________________ ___________________________ ___________
Parent's Name Signature Date

I would like to receive a summary of the results.
☐ Yes ☐ No

Email: ___________________________

APPENDIX E CONSENT FOR CHANGES TO DATA ANALYSIS AND REPORTING

Email exchange between the lead researcher and the participant's mother:

February 18, 2019

Dear David,

Thank you for the update. Sounds good to me. I am glad that XXX was able to support with your research study. Good luck with your all your future endeavours.

Take care... XXX

On Sat, Feb 16, 2019 at 11:45 AM David Ambrose <David.Ambrose@dal.ca> wrote:

Dear XXX,

Your child was a participant in a research study I conducted at Dalhousie University on March 15, 2018. As you may recall, your child worked with me and another occupational therapist while completing block puzzles and wearing eye-tracking glasses. I am reaching out today to let you about some changes to the analysis plan for the research study and what those changes mean for you and your child.

The study planned to recruit 12 participants and the analysis would allow for reporting of comparison group results with statistical methods. Given your child was the only participant we were able to recruit during the measurement period, this type of analysis will not be possible. The new reporting plan is to report the results as a case study. This plan will not use your child's name and it will not include any specific details about your child, you or your family, or any information that can be used to identify you. Instead, I will call your child "the participant." All I will say about your child is what you have already told me when you completed the self-screen for participation: your child has autism spectrum disorder, your child was between the ages of 8 and 12 and attended mainstream school at the time of participation in the study, your child uses spoken English as his primary communication method, and your child does not have any other diagnoses that impact functional performance. Again, there will be no identifying information when I describe how your child performed the table top task with myself or the other occupational therapist.

If you have any questions about the changes to how the data will be reported and what it means for your child's privacy and confidentiality, please let me know by February 23, 2019. You can reach me at david.ambrose@dal.caor by phone at (306) 221-3537. If you decide to call me, please call collect.

Sincerely,

David Ambrose

APPENDIX F ASSENT SCRIPT

Hi. My name is Dave. I am here today because I want to find out how kids use their eyes to look at different things when working with different occupational therapists.

Your Mom/Dad/Guardian has said it's OK you to work with me, and with my colleague (name of co-participating occupational therapist), to do two different activities. First, I will ask you to use your hands and move some small things. Then, we will put on our glasses. These glasses make a video of what we each see, and tell the computer where our eyes are looking. Once we have our glasses on, I will build one thing with blocks with you, and (name of co-participating occupational therapist) will build another thing with blocks with you.

You will work with both (name of co-participating occupational therapist) and me, one at a time, to do the activities together. You can take a break whenever you want.

You might find the activities that we do might be fun, a bit hard or even boring! It's OK to feel those ways, just please try your best. You don't have to finish everything. Just let me know if you want to take a break or stop.

Do you have any questions?

Are you ready to start?

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