Predicting Expressive Language in Children with Autism Spectrum Disorder

Joakim Rudebjer

Artikkelbasert masteroppgave i spesialpedagogikk

Institutt for spesialpedagogikk

Det utdanningsvitenskaplige fakultet

UNIVERSITETET I OSLO

VÅR 2019

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2019

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http://www.duo.uio.no

Trykk: Reprosentralen, Universitetet i Oslo

Abstract

Background: Deficits in expressive language abilities is evident in many children with autism spectrum disorders (ASD). Expressive language is central for expressing needs, opinion and participate in social interactions, and has been linked to outcome in children with ASD. To be able to understand language development in ASD and to identify possible targets for intervention, research on early predictors is essential. Thus, the current study aimed to investigate early predictors for expressive language abilities in late childhood with a focus on initiation and response to joint attention, joint engagement, fine motor abilities, and nonverbal cognition. **Aims:** 1) To assess how well social communication and interaction, fine motor and nonverbal cognition collectively explains the variance in later expressive language, after controlling for initial expressive language. 2) To investigate which of the individual potential predictors have the strongest relationship with later expressive language. **Method:** The study involved a sample of 89 children with ASD from Norway and US. In a descriptive longitudinal design, a hierarchical regression was used to examine how early social communication and interaction, fine motor skills and nonverbal cognition predicted expressive language in late childhood. **Results:** Although all potential predictors were significantly correlated with the outcome variable, only early joint engagement and fine motor predicted expressive language at late childhood in the hierarchical regression. Fine motor had the strongest impact of the predictors. Collectively, the predictors accounted for 60% of the variance in subsequent expressive language. Early social communication and interaction, fine motor and nonverbal cognition accounted for 10,8% of the variance, when the variance of initial expressive language was accounted for. **Conclusion:** The results implied that the study had successfully identified several important aspects of expressive language development. Further, it highlights the importance of early joint engagement and fine motor for later expressive language outcome. The study's longitudinal design, large sample size compared to similar studies, and the inclusion of a multitude of potential predictors provides an important contribution to the existing research on expressive language in children with ASD.

Preface

First and foremost, I would like to thank my advisor, Anett Kaale. Thank you for including me in your project, and for giving me a unique opportunity to travel to California to meet with the researchers at UCLA. It was exiting to collaborate with such skilled researchers in the process of obtaining the data from the JASPER study. Thank you for answering all my questions and sharing your wisdom and knowledge with me, even outside your regular work hours. Further, I will express my gratitude to Connie Kasari and Amanda Gulsrud for welcoming me at UCLA, for letting me use their data for this study, and for giving me so much help in digging up old data.

I will like to thank my fellow students for all the great coffee and lunch breaks. I will also direct my gratitude towards my mother and father, Marianne and Lars, for being supportive throughout this process and life in general. Thank you Linn, for your patience, love and support! Finally, I would like to thank Patricia and Knut Inge for helping me proofread the article.

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1 Introduction

The current study sought to investigate early predictors of expressive language in late childhood in children with autism spectrum disorder (ASD). Most individuals with ASD have deficits or challenges related to expressive language, although there is great variability within the group (Anderson et al., 2007; Kasari, Gulsrud, Freeman, Paparella, & Hellemann, 2012; Mundy, Sigman, & Kasari, 1990; Sigman & McGovern, 2005; Özçalışkan, Adamson, & Dimitrova, 2016). More knowledge of early predictors could aid in development of interventions to improve outcome for children with ASD. Based on longitudinal quantitative data from two studies (Kasari, Freeman, & Paparella, 2006; Kaale, Smith, & Sponheim, 2012), this study uses a longitudinal descriptive design to address how early social communication and interaction, fine motor, and nonverbal cognition relates to expressive language in late childhood. As the current thesis is article-based, it has two components: (a) an article (Appendix A) following the submission guidelines and citation style of *Journal of Autism and Developmental Disorders* (Appendix B), and (b) an extended essay elaborating on of theoretical and methodological considerations presented in the article.

The extended essay is mainly structured in the same form as the article, including background and method, but does not include chapters of results and discussion. In *background*, previous research and important terms are described in greater depth, compared to the article. Regarding *method,* additional sections are added to discuss *reliability*, *validity* and *ethics.* Although the main content of the essay is covered in the article, the aim is to provide more detailed discussions on theoretical background, methodological and ethical considerations, validity, and reliability. The discussion on reliability, validity and ethics only include the most central considerations, as discussion regarding these topics can be extensive. Still, the aim of the essay is to provide the reader with insight into the strengths and weaknesses of the study, to make the research process and results transparent. The reader is advised to read the article prior to the essay, as the essay elaborates on elements from the article.

2 Background

2.1 Autism Spectrum Disorder (ASD)

ASD is classified as a neurodevelopmental disorder (American Psychiatric Association [APA], 2013b; World Health Organization [WHO], 2018), characterized by (a) deficits in social communication and social interaction and (b) restricted, repetitive patterns of behavior, interests and activities. In addition, the symptoms must be present in the early developmental period and limit or impair everyday function. However, the symptoms may not be detectable until the environmental demands exceed the capacity of the individual. Further, the individual is placed on a continuum based on symptom severity and degree of support needs (APA, 2013b). In other words, the group of individuals with ASD is heterogeneous in terms of symptom traits in the two core domains, degree of functioning, and support needs (Keller & Ruta, 2010). As there are some distinctions between diagnostic manuals, it is useful to know how ASD is understood in the most commonly used diagnostic manuals in Norway and USA, as the current sample consist of participants from these two countries.

Currently, the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; APA, 2013a) is the most widely used diagnostic manual in USA, while Norway uses the tenth edition of the International Classification of Disorders (ICD-10; WHO, 2016). A draft of the upcoming version of the ICD (ICD-11) was released in June 2018, and implementation in Norway is soon to be planned (Direktoratet for e-helse, 2019, March 19). How ASD is defined in ICD-11 (WHO, 2018) is believed to be similar to the characterization in DSM-5. During the course of data collection for the data used in this study, DSM has shifted from its fourth to its fifth revision. In other words, the older version of the DSM (DSM-IV-TR; APA, 2000) was used in USA at first visit. In DSM-IV-TR and ICD-10, the autism spectrum diagnosis is divided into different sub-diagnosis (pervasive developmental disorders), including *Autistic Disorder/Childhood Autism, Pervasive Developmental Disorder-Not Otherwise Specified, Disintegrative Disorder* and *Asperger syndrome,* characterized by three core domains: (a) deficit in social interaction, (b) communication deficits and (c) patterns of restricted, stereotyped, repetitive behavior, activities and interests. In 2013, the DSM-5 replaced the previous version of the manual, and replaced the sub-diagnosis with a broader diagnostic term: ASD (Perry, Koudys, Dunlap, & Black, 2017), and moved from three to two core symptom domains.

ASD is a rather common disorder, estimated to occur in approximately 1% of the population (Baird et al., 2006; Perry et al., 2017), affecting more boys than girls, with a ratio of ~3–4:1 (Fombonne, 2009; Keller & Ruta, 2010; Perry et al., 2017; Yeargin-Allsopp et al., 2003). The etiological cause of ASD is still unclear, but is believed to be related to multiple factors (Newschaffer et al., 2007; Perry et al., 2017). Findings of some genetic markers (Newschaffer et al., 2007; Umbarger, 2017; Veatch, Veenstra-VanderWeele, Potter, Pericak-Vance, & Haines, 2014; Volkmar et al., 2014) and recurrence rates (Newschaffer et al., 2007; Volkmar et al., 2014) supports a genetic cause of autism. Moreover, ASD is associated with a high rate of comorbidity (Dykens & Lense, 2011; Gotham, Bishop, & Lord, 2011; Perry et al., 2017; Romero et al., 2016; Tidmarsh & Volkmar, 2003; Volkmar et al., 2014), and a co-occurring diagnosis of intellectual disability (ID) is common. However, the estimated proportion seems to vary greatly between studies (Baio et al., 2018; Dykens & Lense, 2011; Newschaffer et al., 2007).

2.2 Expressive Language

Expressive language is about the conveying of meaning or expressing one's needs, feelings, ideas, or intentions to others (Frazier, 2011; Morris, 2013). After the preverbal period, the emerge of first words typically begin at 12 months in typically developing (TD) children (Lust, 2006). From 18–24 months of age, the child typically has a vocabulary between three and fifty words (Lust, 2006), and by the time the child reaches 2 years it is able to produce two-word phrases (Lust, 2006; Percy, Machalek, Brown, Pasquali, & Fung, 2017). Deficits in communication skills is a common reason for referral when children are suspected of, and later diagnosed with ASD (Schaefer-Whitby, Lorah, Love, & Lawless, 2017; Tager-Flusberg, Paul, & Lord, 2005). Within the ASD group, individuals show a wide range of expressive language ability (WHO, 2018), from those with a high level to those remaining non-verbal throughout their lifespan (Bottema-Beutel, 2016; Schaefer-Whitby et al., 2017; Tager-Flusberg, Edelson, & Luyster, 2011; Thurm, Lord, Lee, & Newschaffer, 2007). Early expressive language is an important predictor of outcome, meaning a higher level of expressive language is associated with better adaptive behavior, social, communicative and vocational outcome (Billstedt, Gillberg, & Gillberg, 2005; Kirby, Baranek, & Fox, 2016; Szatmari, Bryson, Boyle, Streiner, & Duku, 2003; Venter, Lord, & Schopler, 1992).

In ASD, developmental trajectories of expressive language and early vocalization abilities deviate significantly compared to TD children (Chericoni et al., 2016; Tek, Mesite, Fein, &

Naigles, 2014). Moreover, approximately 25–50% of children with ASD experience regression (i.e., plateauing or loss of skills) when it comes to expressive language (Baird et al., 2008; Newschaffer et al., 2007). In other words, language development in ASD children is often atypical, and most individuals experience delays or deficits in expressive language skills (Anderson et al., 2007; Kasari et al., 2012; Mundy et al., 1990; Sigman & McGovern, 2005; Özçalışkan et al., 2016).

2.3 Joint Attention

Joint attention (JA) can be defined as the individual's capacity "to coordinate or share attention with a social partner regarding an object or event" (Mundy & Burnette, 2005, p. 653). Examples of JA skills include pointing, coordinated looks between object/event and social partner, showing and giving to share (Kasari et al., 2006; Mundy & Burnette, 2005). These skills have been linked to language development, since JA creates learning opportunities though social interaction (Adamson, Bakeman, Deckner, & Romski, 2009; Charman et al., 2003; Thurm et al., 2007). It is common to distinguish between different aspects of JA, such as response to joint attention (RJA) and initiation of joint attention (IJA; Bottema-Beutel, 2016; Edmunds, Ibañez, Warren, Messinger, & Stone, 2017; Luyster, Kadlec, Carter, & Tager-Flusberg, 2008; Sigman et al., 1999; Weismer & Kover, 2015; Yoder, Watson, & Lambert, 2015). RJA refers to the individual's ability to respond to others' social bids for JA, usually with eye gaze. IJA is the child's ability to initiate episodes of JA to share interest or affect regarding an object, activity or event (Bottema-Beutel, 2016). These initiations usually come in form of pointing, showing, spoken language, alternating gaze or giving to share. Both RJA and IJA skills are typically impaired in children with ASD, and restricted JA skills have been linked to deficits in language development (Bottema-Beutel, 2016). Further, IJA can be divided into higher (point, show, and give to share) and lower order (alternating gaze) skills (Kaale, 2014; Mundy, Sigman, & Kasari, 1994).

2.4 Joint Engagement

Where JA refers to abilities of the individual, *joint engagement* (JE) is a construct which involves an interaction between an adult caregiver and a child in a shared activity (Bottema-Beutel, 2016). Typically, we divide into two levels of JE: *Supported joint engagement* (SJE) and *coordinated joint engagement* (CJE; Bakeman & Adamson, 1984; Hahn, Brady, Fleming, & Warren, 2016). SJE is characterized as a state where the caregiver and child are actively engaged in the same activity, object or event, but the where child is not actively recognizing

the adult's participation (Adamson et al., 2009; Bottema-Beutel, 2016). In this state, the adult has the role of facilitator in creating opportunities for shared attention and language learning through scaffolding. A state of CJE, requires that the child is also actively acknowledging the adult's participation, for example with alternating gaze between the object, activity, or event and the adult (Bakeman & Adamson, 1984; Bottema-Beutel, 2016). Typically, CJE demand more of the individual's capacity of socially sharing attention (Adamson, Bakeman, & Deckner, 2004). Therefore, SJE usually precede CJE in the developmental period. Generally, children with ASD spend equal amount of time in SJE, but less time in CJE, compared to their TD peers (Adamson, Bakeman, Deckner, & Nelson, 2012; Adamson et al., 2009). According to Adamson et al. (2009), this could be due to failure to orient towards the adult, stereotyped or idiosyncratic interests (which may restrict opportunities for a finding shared topic), or the difficulty in processing the variety of social demands in a social interaction and producing an adequate response.

2.5 Nonverbal Cognition

The concept of nonverbal cognition generally involves spatial awareness or perception, nonverbal reasoning, visual organization and sequencing, problem-solving and fine motor coordination (Elliott, 1993; Kuschner, 2013; Mullen, 1995; The Psychological Corporation, 1999; Wasserman, 2003). Measures of nonverbal cognition can be derived from subscales such as the performance and eye and hand coordination scale in Griffiths Mental Development Scale (Griffiths, 1986), the performance scale in the Wechsler Abbreviated Scale of Intelligence (WASI; The Psychological Corporation, 1999) and the nonverbal cluster in the Differential Ability Scales (DAS; Elliott, 1993). The operationalization of the concept differs between tests, as different tests are based on different theories of intelligence (Wasserman, 2003). In Mullen Scales of Early Learning (MSEL; Mullen, 1995) *visual reception* taps into visual processing, visual discrimination, and visual memory (Bradley-Johnson, 1997; Dumont & Willis, 2007). Previous studies, especially those who investigate the relationship between motor skills and language, have used visual reception as a proxy for nonverbal cognition (Bedford, Pickles, & Lord, 2016; Chenausky, Norton, Tager-Flusberg, & Schlaug, 2018; Choi, Leech, Tager-Flusberg, & Nelson, 2018; LeBarton & Iverson, 2013; Luyster et al., 2008). Children with ASD often exhibit discrepancy in terms of verbal abilities and nonverbal cognition, where many typically score higher on the latter (Gotham et al., 2011; Kanai, Toth, Itahashi, Hashimoto, & Kato, 2016; Yu et al., 2018). According to Kanai et al. (2016), many individuals with ASD score higher on tasks that involves detail-oriented

cognitive processing (central coherence). Still, it should be noted that this does not apply to all individuals with ASD. Despite the discrepancy between verbal abilities and nonverbal cognition in some children with ASD, nonverbal cognition has been considered a robust predictor of language and speech attainment (Anderson et al., 2007; Thurm et al., 2007; Wodka, Mathy, & Kalb, 2013).

2.6 Fine Motor

Fine motor skills refer to the ability to perform small and precise motor movements using fingers and hands (Belva et al., 2016). Although not being a core feature in ASD, fine motor skills are sometimes delayed or impaired in these children (Gowen & Hamilton, 2013; Hilton, 2011; Landa, 2011; Smile & Kawamura, 2016). This may be associated with disruption in the sensory and motor systems (Landa, 2011). Such deficits could impair the child's ability to write, use scissors or grasp, and has been associated with expressive language development (Choi et al., 2018; Hilton, 2011; LeBarton & Iverson, 2013). The reason for this association is still somewhat unclear. Still, fine motor enables the child to explore, manipulate objects and engaging in play. Thus, enhanced fine motor abilities may facilitate language learning through meaning construction and increasing knowledge about object properties (Hellendoorn et al., 2015; LeBarton & Landa, 2019). Another explanation could be shared mechanisms involved in brain regions associated with some aspects of motor function and speech production (Groen & Buitelaar, 2011; Iverson & Thelen, 1999; LeBarton & Iverson, 2013).

2.7 Previous Research on Expressive Language

2.7.1 Expressive Language

Several previous studies have assessed how early expressive language impacts later expressive language and language development (Mundy et al., 1990; Sigman & McGovern, 2005; Sigman et al., 1999; Stone & Yoder, 2001; Weismer & Kover, 2015). In a sample of ~50 children with ASD, expressive language at early age was associated with expressive language at early adolescence (Sigman et al., 1999), and expressive language at these ages continued to predict expressive language in late adolescence and early adulthood (Sigman & McGovern, 2005). Similarly, expressive language at 2 years has been found to predict expressive language at 4 and 5½ (Stone & Yoder, 2001; Weismer & Kover, 2015). On the contrary, in a study by Mundy et al. (1990), language at age 4 was not associated with language one year later. However, this study did not distinguish between expressive and

receptive language, and only included a small sample of children with ASD (*n*=15). In other words, early expressive language seems to be a robust predictor of later expressive language.

2.7.2 Social Communication and Interaction

Several studies have investigated the association between social communication and interaction and expressive language in children with ASD (Anderson et al., 2007; Bottema-Beutel, Yoder, Hochman, & Watson, 2014; Charman et al., 2003; Edmunds et al., 2017; Gulsrud, Hellemann, Freeman, & Kasari, 2014; Kasari et al., 2012; Luyster et al., 2008; Mundy et al., 1990; Sigman & McGovern, 2005; Sigman et al., 1999; Stone & Yoder, 2001; Toth, Munson, N. Meltzoff, & Dawson, 2006; Weismer & Kover, 2015; Yoder et al., 2015; Özçalışkan et al., 2016). Anderson et al. (2007) found that JA (i.e., IJA and RJA) at 2 years predicted growth in language between 2–9 years. The study included a large sample of children with ASD (*N*=206), but did not discriminate between different aspects of JA or expressive and receptive language abilities.

IJA has been associated with concurrent expressive language at 3 years (Sigman & McGovern, 2005; Toth et al., 2006). Still, these studies failed to find a longitudinal association. In a study by Luyster et al. (2008), IJA and RJA was correlated with concurrent expressive language (*N*=164). However, both variables had too low impact to be included in further regression analysis. Similarly, Stone and Yoder (2001) found an association between IJA at 2 years and expressive language at 4 years, but the association was non-significant after controlling for initial language. In other words, these is some evidence of the concurrent association between IJA and expressive language, but how well it predicts expressive language longitudinally is still unclear.

Few studies have divided measures of IJA into higher and lower order, when investigating its relationship with expressive language. Still, research has indicated that early pointing predicts expressive language in late childhood (*N*=40; Gulsrud et al., 2014). Moreover, Özçalışkan et al. (2016) found that pointing and showing to indicate an object at 2–3 years predicted expressive language one year later (*n*=23). On the other hand, Charman et al. (2003) found that alternating gaze at 20 months was only associated with receptive, not expressive, language at 42 months (*N*=18). These results indicate that higher order IJA may be closer related to expressive language, compared to lower order IJA.

RJA seems to be a robust predictor of both concurrent and subsequent expressive language (Bottema-Beutel, 2016; Edmunds et al., 2017; Sigman et al., 1999; Weismer & Kover, 2015; Yoder et al., 2015). In a sample of ~50 children with ASD, early RJA was related to expressive language at adolescence (Sigman et al., 1999) and continued to predict gains in language abilities at early adulthood (Sigman & McGovern, 2005). Weismer and Kover (2015) investigated a large sample of children with ASD between 2½–5½ years (*N*=129). RJA emerged as a predictor for concurrent expressive language, but not expressive language growth. Further, Edmunds et al. (2017) studied high risk infants (infants with heightened risk of ASD), and found that RJA at 12 months was not associated with concurrent nor subsequent expressive language, but predicted growth in expressive language from 15 to 18 months. Similarly, in a study on 87 minimally verbal children with ASD, RJA predicted growth in expressive language between 12–48 months to approximately one year later (Yoder et al., 2015). Moreover, Bottema-Beutel (2016) conducted a systematic literature review using data from 71 published and unpublished study reports between year 1970 and 2015. In the study, RJA was closely related to expressive language.

In terms of JE, SJE has been linked to subsequent expressive language in preschool children with ASD (Adamson et al., 2009; Bottema-Beutel et al., 2014). Bottema-Beutel et al. (2014) found that SJE at 3 years predicted expressive language 8 months later (*N*=63). Moreover, symbol-infused SJE at 3 years predicted expressive language one year later, in a sample of 18 children with ASD and 53 TD children (Adamson et al., 2009). The contribution of symbol-infused CJE added variance to the regression model, but did not reach significance. A criterion for the interaction being coded as symbol-infused, was that the child was attending to language, either by producing itself or following the mother's statements or instructions. Although the amount of research is limited, early JE seems to be associated with later expressive language. However, it should be noted that SJE may be a more robust predictor than CJE. To my knowledge, no previous studies have investigated the impact of early IJA, RJA and JE on expressive language in late childhood.

2.7.3 Nonverbal Cognition

Several studies have investigated how nonverbal cognition predicts expressive language. In general, studies have included a broader measure of nonverbal cognition (Anderson et al., 2007; Charman et al., 2003; Thurm et al., 2007; Thurm, Manwaring, Swineford, & Farmer, 2015; Weismer & Kover, 2015), but some has used visual reception as a proxy of nonverbal cognition (Luyster et al., 2008). Anderson et al. (2007) found that nonverbal cognition at 2

years predicted concurrent and growth in language abilities between 2–9 years, in 156 children with ASD. Similarly, nonverbal cognition at 2 years predicted expressive language in 59 children with ASD at 5 years, in study by Thurm et al. (2007). Moreover, in sample of 47 minimally verbal children with ASD, nonverbal cognition at 2 years and nonverbal cognition change between 2–5 years predicted expressive language at 5 years (Thurm et al., 2015). Wodka et al. (2013) investigated 535 children between 4–18 years of age with ASD and a history of severe language delays. The results showed that a higher level of nonverbal cognition was associated with acquisition of phrase and fluent speech, and earlier phrase speech attainment. Further, Weismer and Kover (2015) found that nonverbal cognition at 2½ years was a significant predictor of both concurrent and growth in expressive language from 2½–5½ years (*N*=129). Similarly, nonverbal cognition predicted concurrent expressive language in a large sample of toddlers with ASD (Luyster et al., 2008). In contrast, Charman et al. (2003) did not find an association between nonverbal cognition at 20 months and expressive language at 42 months. However, the small sample size (*N*=18) may limit interpretation of the results. In summary, nonverbal cognition seems to be a robust predictor of expressive language in children with ASD. Still, to author's knowledge, no studies have looked at how well nonverbal cognition at early age predicts expressive language at late childhood, when compared to different aspects of social communication and interaction, and fine motor.

2.7.4 Motor Skills

The association between fine motor skills and language has been widely studied (Bedford et al., 2016; Choi et al., 2018; LeBarton & Iverson, 2013; LeBarton & Landa, 2019; Leonard, Bedford, Pickles, & Hill, 2015; Luyster et al., 2008). Still, most studies on the subject has been focused on infants and toddlers. Leonard et al. (2015) studied motor skills and language in a sample of 101 high and low risk infants. For the 17 children with confirmed ASD, gross motor, but not fine motor, predicted expressive language development rate between 7–36 months. In contrast, Choi et al. (2018) found that fine motor skills at 6 months predicted expressive language outcome at 3 years (*N*=170). The results did not differ between infants with or without ASD. Similarly, LeBarton and Iverson (2013) found that fine motor between 12–24 months predicted expressive language at 36 months in 34 high risk infants.

Using the subscales from Peabody Motor Developmental Scales–2 (PMDS-2; Folio & Fewell, 2000), LeBarton and Landa (2019) assessed the relationship between motor skills and expressive language in 99 high and low risk infants. The scores on the *stationary* (gross

motor) and *grasping* (fine motor) scales at 6 months predicted expressive language at 30 months. Grasping also predicted expressive language at 36 months. On the contrary, *visual-motor integration* scale (fine motor) was non-significant, indicating that some aspects of fine motor, may be more important than others. Similarly, Bedford et al. (2016) found that gross motor at 2 years predicted growth in expressive language between 2–9 years (n=139).

In summary, there is a vast amount of research on predictors of expressive language. As would be expected, early expressive language seems to be associated with subsequent expressive language. Although results are somewhat ambiguous, most studies seem to support a relationship between early nonverbal cognition and expressive language abilities in late childhood. Moreover, fine and gross motor skills seem to be associated with expressive language, and Bedford et al. (2016) found an association between early gross motor and expressive language growth from early into late childhood. However, we know little about how well early fine motor skills predict expressive language in late childhood, as most studies have been focused on infants and toddlers. The current literature review also shows that different aspects of social communication and interaction are important for both concurrent and subsequent expressive language. RJA, the most widely studied, seems to be a robust predictor of subsequent expressive language. IJA has been shown to be a predictor of concurrent expressive language in some studies, but research have failed to find a longitudinal association (Sigman & McGovern, 2005; Toth et al., 2006). Still, few studies have investigated how higher order IJA specifically predicts later expressive language. However, some aspects, like pointing or showing may be of importance (Gulsrud et al., 2014; Özçalışkan et al., 2016). According to previous research, early JE predicts subsequent expressive language during the early childhood period, but research is yet to investigate how it predicts expressive language in late childhood.

2.8 Aims of Current Study

As outlined in the article, no previous studies have investigated how early fine motor, nonverbal cognition and different aspects of social communication and interaction (i.e., JE, IJA, and RJA) predict expressive language in late childhood. Moreover, several studies on the topic have limited sample sizes (e.g., Adamson et al., 2009; Charman et al., 2003; LeBarton & Iverson, 2013; Mundy et al., 1990; Sigman & McGovern, 2005; Stone & Yoder, 2001). The current study sought to fill this knowledge gap, by investigating how a multitude

of early potential predictors are related to expressive language in late childhood. To investigate this, the study had two main aims:

1) *To assess how well social communication and interaction, fine motor and nonverbal cognition collectively explains the variance in later expressive language, after controlling for initial expressive language.*
2) *To investigate which of the individual potential predictors have the strongest relationship with later expressive language.*

3 Method

3.1 Design

This study can be characterized as a quantitative study with a descriptive longitudinal design. The study uses numerical data collected from surveys, video observations and standardized testing (Bryman, 2012; de Vaus, 2014). The descriptive design implies that the independent variables were not manipulated by the researcher. The topic was investigated as it exists in its current state (Dulock, 1993), using longitudinal data from two follow-up studies of randomized controlled trials (RCT). The first study was conducted in Norway, at Oslo University Hospital (OUH), the second in USA, at University of California, Los Angeles (UCLA). Both studies assessed children at five timepoints. However, only data from the first and last assessments were used in this study, as the question of interest was the long-term prediction of expressive language in children with ASD. A weakness of the study design, is the limited conclusion one can draw in terms of causality, as such inferences are difficult without manipulation or control of the independent variables (Bryman, 2012; Shadish, Cook, & Campbell, 2002). Still, the longitudinal design provides some control in terms of the direction of the relationship between the variables.

3.2 Participants

3.2.1 Norwegian Sample

The sample consists of participants from Norway and USA. The Norwegian participants were initially recruited through the Child and Adolescence Mental Health Clinic (CAMHC) in East and West of Norway on a basis of the following inclusion criteria: (a) chronological age between 24-60 months, (b) diagnosis of childhood autism based on ICD-10 criteria, and (c) preschool attendance. Participants were excluded if there were evidence of (a) severe CNS disorders (e.g., cerebral palsy and epilepsy) or (b) non-Norwegian speaking parents. 65 eligible participants were identified during a two-year period, and the families were invited to participate in the original RCT. Two families and two preschools declined participation, and four participants were excluded, resulting in a final sample of 61 children. All children had a diagnosis of childhood autism, from a clinical evaluation. 49 participants had been tested with Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000) and/or Autism Diagnostic Interview-Revised (ADI-R; Lord, Rutter, & Le Couteur, 1994). Lack of testing with ADOS and ADI-R was due to site diagnostic practice. When the children reached ages between 10–14 years, the same sample were re-invited by phone to participate in the

longitudinal follow-up study. 51 families accepted participation. The last visit assessments were performed at the local schools, for the convenience of parents and children. 50 of the returners were included in this study (one excluded due to lack of score on outcome variable).

3.2.2 American Sample

At UCLA the invited participants were already enrolled in an Early Intervention Program (EIP) on site. The participants were invited to participate on the basis of meeting a set of criteria, similar to the OUH sample. These criteria were (a) chronological age <60 months and (b) diagnosis of autistic disorder. The exclusion criteria were prevalence or history of seizures or medical co-occurring conditions. The sample at entry consisted of 58 participants. The eligible UCLA participants were re-assessed for ASD at site by clinicians at both timepoints, using ADOS and ADI-R. When the participants were between 8-10 years of age, the families were re-invited to participate in the follow-up study. Forty participants accepted participation and returned for the follow-up. However, one was excluded in the present study due to lack of score on the outcome variable.

3.2.3 Total Sample: Characteristics

In the total sample of 89 children, 74 (81.3%) were male. They had a mean age of 46.25 (*SD*=8.5) months at first visit, and 135.15 (*SD*=18.1) months at last visit (Table 1). The parents of the American children were slightly higher educated (estimated by mean years of education), compared to the Norwegian sample. An explanation may be due to differences in the recruitment process between the sites. The samples were similar in terms of ethnicity. Further similarities were found in terms of school placement at last visit. Mean IQ test-score for the total sample at last visit was 68.73 (*SD*=32.37), indicating that several cases scored within the range of ID. However, there was great variability within the sample on both sites. The OUH participants showed lower cognitive ability at last visit compared to the UCLA participants, with mean IQ-scores of 61.31 (*SD*=32.33) and 78.01 (*SD*=30.31), respectively. It is unclear whether this is an artifact of using different instruments (Bishop, Guthrie, Coffing, & Lord, 2011) or reflecting a difference in cognitive abilities between the samples. The majority of children received special education support. In addition, there was a notable age difference at last visit between the samples, as the UCLA participates were recruited at a younger age. The issue of age was accounted for, by running an additional regression analysis, including age as an independent variable in the first step and comparing the results to the main regression analysis.

Table 1 Sample Characteristics Overall and Split by Site.

	OUH (*n* = 50)		UCLA (*n* = 39)		Total (*N* = 89)	
	Mean (*SD*)	Range	Mean (*SD*)	Range	Mean (*SD*)	Range
CA (First visit)[a]	48.86 (8.7)	29-60	42.72 (6.9)	33-59	46.21 (8.6)	29-60
CA (Last visit)[a]	157.88 (13.4)	127-185	105.82 (7.4)	94-122	135.07 (28.3)	94-185
Gender *n (%)*						
Male	41 (82.0%)		32 (82.1%)		73 (82.0%)	
Female	9 (18.0%)		7 (17.9%)		16 (18.0%)	
DQ (First visit)[b]	56.85 (20.5)	20-105	55.02 (14.6)	26-90	56.05 (18.1)	20-105
IQ (Last visit)[c]	62.31 (30.5)	20-108	78.12 (30.5)	20-132	69.38 (31.3)	20-132
SES (Parental education)[d]	14.21 (2.8)	9-18	16.23 (1.6)	11-18	15.14 (2.5)	9-18
Child ethnicity *n (%)*[e]						
Black	2 (4.0%)		1 (2.6%)		3 (3.4%)	
White	38 (76.0%)		27 (69.2%)		65 (73.0%)	
Hispanic	0 (0%)		2 (5.1%)		2 (2.2%)	
Asian	6 (12.0%)		5 (12.8%)		11 (12.4%)	
Other	2 (4.0%)		4 (10.2%)		6 (6.7%)	
School (Last visit) *n (%)*[f]						
Reg. Ed.	1 (2.0%)		5 (12.8%)		6 (6.7%)	
Reg. Ed. + Spes. Ed.	16 (32.0%)		17 (43.6%)		33 (37.1%)	
Spes. Ed.	19 (38.0%)		18 (46.2%)		37 (41.6%)	
Other	1 (2.0%)		0 (0.0%)		1 (1.1%)	

[a] Chronological age in months.

[b] Developmental Quotient; calculated based on all four scales of MSEL.

[c] Intelligence Quotient; DAS/MSEL for UCLA sample and WASI/MSEL for OUH sample.

[d] Socioeconomic status; Combined measure of mean maternal and paternal education in no. of years.

[e] 2 missing.

[f] School type; Parent report. *Reg. Ed.* = Regular education; *Reg. Ed. + Spes. Ed.* = regular education with special education support; *Spes. Ed.* = special education classroom. 12 missing.

The merging of the samples has some advantages and disadvantages. A disadvantage is the potential differences in participant characteristics across the two sites, as well as differences in diagnostic criteria. As stated in the previous paragraph, discrepancies between the two samples were found in some areas, including some of the first visit measures, as well as expressive language and IQ at last visit. Strangely, mean scores on expressive language at last visit were higher in the UCLA sample, compared to OUH, although the participants were younger (Table 2). This difference was further reflected in the last visit IQ scores. Although inclusion and exclusion criteria were similar between sites, the diagnosis of autism at intake was given according to two different diagnostic manuals (DSM-IV and ICD-10). These two instruments are generally considered to be comparable, but not identical (Volkmar, Reichow, & McPartland, 2012). In other words, there is a risk of the two samples coming from two

different populations, which would weaken the representability of the total sample. Another explanation could be the differences in sampling procedure, where the American participants were already enrolled in the EIP at UCLA, while the Norwegian participants were recruited from CAMHC. Alternatively, the differences could be due to measurement error, in terms of different testing procedures. Still, it should be noted that the population of children with ASD is heterogeneous, and sampling error will occur in most moderate sized samples (de Vaus, 2014). In other words, some variability between samples is expected. However, a major strength of merging the samples is the increased sample size, allowing for more predictors to be included in the regression model and decreasing the chance of sampling error (Brace, Kemp, & Snelgar, 2006; Bryman, 2012; de Vaus, 2014). Further, including participants from different locations enhances generalization to a wider population, as sampling from one area may not reflect the broader population.

Table 2 Descriptive Statistics for Predictor and Outcome Variables.

	OUH (*n* = 50)		UCLA (*n* = 39)		Total (*N* = 89)	
	Mean (*SD*)	Range	Mean (*SD*)	Range	Mean (*SD*)	Range
Predictors (First visit)						
Expressive language[a]	21.64 (12.59)	3-60	20.05 (8.37)	7-38	20.94 (10.92)	3-60
JE[b]	45.59 (23.33)	2.33-89.46	65.79 (22.23)	4.89-98.11	54.44 (24.86)	2.33-98.11
RJA[c]	45.98 (38.39)	0-100	50.49 (39.24)	0-100	47.85 (38.57)	0-100
Nonverbal cognition[d]	32.80 (15.04)	7-66	24.70 (6.39)	14-46	29.72 (13.04)	7-66
Fine motor[e]	31.45 (10.97)	12-57	25.30 (5.05)	16-39	29.11 (9.62)	12-57
IJA[f]	1.08 (1.68)	0-8	3.26 (6.02)	0-22.84	2.03 (4.29)	0-22.84
Outcome (Last visit)						
Expressive language[g]	67.78 (35.77)	1-115	76.67 (33.24)	8-149	71.67 (34.77)	1-149

[a] Expressive language; RDLS age equivalent. Scores <4 stanine for 1.5 years based on MSEL.

[b] Joint Engagement; Combined measure of percent of time in coordinated joint attention and supported joint attention during 10-15 min play.

[c] Response to joint attention; ESCS. 7 missing.

[d] Age equivalent from visual reception scale; MSEL. 10 missing.

[e] Age equivalent from fine motor scale; MSEL. 10 missing.

[f] Initiation of joint attention; No. higher order initiations of joint attention (point, show or give) during 10 min play.

[g] Expressive language; EVT age equivalent. Raw scores below norm (raw <21) based on MSEL.

3.3 Procedure

At both visits, the participants were assessed with a comprehensive battery of tests, including assessment of language, social skills and cognitive tests. In addition, the children were videotaped during a mother-child play interaction of 10-15 minutes duration, for assessment of JA and JE. For the OUH sample, both first and last visit assessments were performed in the course of one day. Prior to the assessments, the parents had filled out a questionnaire. The UCLA participants were tested during two days at the first and last visits, each assessment day lasted approximately two hours. As mentioned, the different procedures could affect the assessment results. Finishing all assessments in one day, as for the OUS sample, may result in participants being exhausted. Thus, preforming worse on the last tests, compared to if they were to take the tests well rested. Moreover, an unfamiliar setting and new environment may cause stress for some children, especially for children with ASD. Such stress could interfere with the performance on the assessments.

Originally, both studies were RCTs, where the baseline assessments were completed prior to assignment to control or treatment groups. The RCTs were targeting JA, skills that were included among the independent variables in this study. However, the present study does not take the intervention into account. Although this could be considered problematic, since the manipulation of the variable could be thought to affect the outcome, this was justified by the short duration of the interventions and the large time gap between the intervention and follow-up.

3.4 Measures

The present chapter includes discussion on the strengths and limitations for all measures used in this study, including their reliability and construct validity. As various tests were used to measure developmental level and expressive language, the chapter will also include a discussion on the process of merging the scores from different measures. In addition, a discussion on the process and challenges of obtaining measures of demographic information will be provided.

3.4.1 Language

The *Expressive Vocabulary Test* (EVT; Williams, 1997) is a measure of vocabulary knowledge and word retrieval and does not measure the full complex construct of expressive language. Therefore, using EVT as a measure of expressive language have some challenges

(Kasari et al., 2012; Williams, 1997). Still, measuring expressive vocabulary can provide an indication of the individuals expressive language ability (Bottema-Beutel, 2016; Tager-Flusberg et al., 2009). In addition, EVT has been shown to have good convergent validity with other measures of expressive language, such as *Oral and Written Language Scales* (OWLS; Carrow-Woolfolk, 1995). Tasks in the EVT involve naming pictures and providing synonyms. One strength of the EVT is the wide age range, making it suitable for longitudinal research (Williams, 1997). According to the manual, the EVT is a reliable measure of expressive vocabulary, in terms of internal reliability (median Cronbach's alpha of .95 and median split-half reliability of .91) and test-retest reliability (Test-retest reliability coefficient ranging from .77–.90). The manual does not report interrater reliability.

The *Reynell Developmental Language Scales* (RDLS; Edwards et al., 1997; Hagtvet & Lillestølen, 1985) is measure of expressive and receptive language. For the purpose of this study, only the language production scale (expressive language scale) was used. The third edition of the RDLS (RDLS-III) was used for the UCLA sample, while the OUH sample received a Norwegian translation of a previous version. In addition to measure vocabulary, it also taps into grammatical aspects of language production. The test involves tasks like naming, explaining semantic meaning of words, and independent use of language by giving explanations from presented pictures. The authors of the Norwegian RDLS adaption states that measuring language is a complex and insuperable process (Hagtvet & Lillestølen, 1985). Thus, these language measures only provide an indication of expressive language level and does not measure the full complex construct of expressive language. RDLS-III has shown moderate correlations with other language measures, and such values are expected between tests measuring similar, but not identical, constructs (Edwards, Garman, Hughes, Letts, & Sinka, 1999). In terms of reliability, the RDLS-III has shown high internal reliability (Kuder–Richardson Formula 20 reliability coefficient = .96; Edwards et al., 1999). The Norwegian manual reports high internal reliability (split-half reliability between .77–.95), test-retest reliability (r=.78) and interrater reliability for scores on two subscales (r=.93–.99; Hagtvet & Lillestølen, 1985). Moreover, the Norwegian version has shown strong convergent validity with *Words said* from *MacArthur-Bates Communicative Development Inventory* (CDI; Fenson et al., 1993) and *MSEL Expressive language scale* (Nordahl-Hansen, Kaale, & Ulvund, 2014).

Mullen Scales of Early Learning (MSEL; Mullen, 1995) is a cognitive measure for infants and toddlers aged 0–68 months. The test consists of four subscales (the optional *gross motor*

scale not included), yielding standard scores and age equivalents. The expressive language scale was used as a measure of expressive language ability. The scale includes tasks that range from early skills such as sucking or swallowing, to repeating 12-word sentences (Bradley-Johnson, 1997). Although the measure is not normed for children age >68 months, it is frequently used in research to measure cognitive functioning and language in children outside its normed age range (Lord et al., 2006; Thurm et al., 2015), as few other measurements capture the variability in the lower range of functioning. In addition, it has been considered particularly useful in assessing cognitive functioning and language in children with ASD, as it includes low demand tasks, making it suitable for assessing lower functioning children (Shank, 2011). Age equivalents from the expressive language scale were used, as the MSEL did not yield standard scores for the children outside age range. The expressive language scale has shown convergent validity with other measures of expressive language, such as the *Verbal ability* scale from *Preschool Language Assessment* (PLA; Zimmerman, Steiner, Evatt, & Pond, 1979), *RDLS expressive language scale* (Nordahl-Hansen et al., 2014)*, Communication and Socialization Scales* from *Vineland scales of adaptive behavior* (Akshoomoff, 2006; Mullen, 1995; Sparrow, Balla, & Cicchetti, 1984), and *Words said* from *CDI* (Luyster et al., 2008; Nordahl-Hansen et al., 2014). When it comes to reliability of the expressive language scale in MSEL, the manual reports high internal reliability (split-half coefficients .77–91), acceptable test-retest reliability in age range 25–56 months (r=.71) and satisfying interrater reliability of .98 (Mullen, 1995)

The decision of using scores from two different measures were based on the RDLS and EVT suffering from floor effects in lower score range. Age equivalents were derived from all measures, and MSEL scores were used for those scoring below the 4th stanine on RDLS at first visit and below the norm for EVT at last visit (raw score < 21). It should be noted that age equivalent is not true ratio level scale, as the degree of changes in language age at lower ranges (e.g., 1-2 years) are different from language age at higher ranges (e.g., 10-11; Robertson, 2007). Ideally, using raw scores would have captured the full range of scores in the sample. However, merging raw scores from different measures would not yield valid results, as these are not equal. Further, as some participants were outside the normed age range in the test they were assigned, the test did not yield valid standard scores. Since age equivalents were provided by all language measures, these were used as an interval-level substitute to be able to include the full sample, rather than exclude the low scorers that did not receive valid scores on the EVT and RDLS. In addition, the use of age equivalents on the

MSEL may be more useful than standard scores when measuring lower scoring children (Akshoomoff, 2006).

3.4.2 Demographic Information

Demographic information, including gender, parental education level, children's school placement and ethnicity were obtained through parent reported questionnaires at both timepoints. The cultural differences between USA and Norway affected how variables such as ethnicity, parental education and school program were coded. Ethnicity were coded as *black, white, Hispanic, Asian* and *other* at UCLA. The OUH data were coded as *Norwegian* and *other*, with a follow-up question regarding specification of "other"-item. In the process of merging the data, each case in the OUH sample were investigated thoroughly and then recoded to match the UCLA coding, based on parents' nationality. Still, it should be noted that health research from USA has a tradition of reporting ethnicity/race more frequently compared to Norwegian research, as such may be linked to socioeconomic position and cultural differences (Krieger, Williams, & Moss, 1997). However, these associations may not be transferable to Norwegian society. Still, the choice of choosing the UCLA coding system was based on following norms of international and American research.

To counter merging issues regarding differences in the education system in Norway and USA, the variables *maternal* and *paternal education* were recoded into approximate number of years in education, based on the parent report of their own education level for both sites. Subsequently, a mean of mother and father education in years were calculated, and used as an indicator of *socioeconomic status (SES)*. Similar to the case of ethnicity, it should be noted that that level of education is not directly comparable between Norway and USA, as the structure of the education system is different. Thus, using number of years in education instead of degree or level, is merely considered to be a substitute. The number of categories in the categorical variable *school type (child)* were quite extensive in the OUH data, while fewer categories of school type were reported in the UCLA data. To be able to match the different coding systems, the number of categories were reduced and recoded into the categories *regular education, regular education with special education support, special education classroom* and *other.*

3.4.3 Cognition

Developmental level was measured at first visit using Mullen Scales of Early Learning (MSEL; Mullen, 1995). The MSEL provides an Early Learning Composite (ELC), which

functions as a summative measure of cognitive level. The ELC is derived from scores on the subscales *Expressive language, Receptive language, Fine motor* and *Visual reception* using T-scores. Since a majority of participants scored below the norm-referenced T-scores on one or more of the MSEL subscales, a *developmental quotient (DQ)* was computed for all participants using mental age (averaged age equivalent from all four scales) divided by chronological age multiplied by 100. In other words, the ratio measure of cognitive ability (i.e., DQ) was used instead of the ELC, as this is a common practice in research (Bishop et al., 2011). Although most participants were assessed with MSEL, ten participants from the UCLA sample had already been assessed with other tests of cognitive ability prior to the research assessments. These tests included WPPSI-R (Wechsler, 1989), BSID-II (Bayley, 1993), Stanford-Binet Intelligence Scale (Thorndike, Hagen, & Sattler, 1986) and Merrill-Palmer Scale of Mental Tests (Stutsman, 1948). Since these children already had a recent test of cognitive ability, MSEL tests were not conducted. However, using DQ from MSEL made it possible to merge DQ with IQ-scores from the other measures, as these are comparable.

To measure cognitive level at last visit, different tests were used. For the UCLA-sample, the participants were tested with either DAS (*n*=31; Elliott, 1993) or MSEL (*n*=8), depending on level of cognitive ability. For OUH participants, a Norwegian version of WASI (*n*=33; Ørbeck & Sundet, 2007) or MSEL (*n*=17) were administered. On both sites, the MSEL was used if the participants were not likely to receive a basal score on WASI or DAS. Since the participants were outside the normed age range of the MSEL test, DQ scores were calculated using same formula as stated in the previous paragraph. However, as measures of DQ/IQ is can be unreliable in the lower ranges (Tillmann et al., 2018), a lower bound of 20 were set for the lowest scorers for both first and last visit. MSEL have received criticism in terms of construct validity, as the author's theoretical understanding of intelligence lacks empirical supportive data (Bradley-Johnson, 1997; Shank, 2011). Still, MSEL has been shown to have high convergent validity with other cognitive measures, such as the DAS (Bishop et al., 2011; Shank, 2011). Further, DAS and WASI has shown convergent validity with other measures of cognitive ability (Bishop et al., 2011; Canivez, Konold, Collins, & Wilson, 2009; Gordon & Elliott, 2001).

3.4.4 Joint Attention and Joint Engagement

The *Early Social Communication Scale* (ESCS; Mundy et al., 2003; Seibert, Hogan, & Mundy, 1982) was used to measure RJA. ESCS is a standardized test procedure, where a tester introduces a child to a series of toys. The tester-child play interaction was videotaped

and coded. To measure RJA, the tester provided bids to JA by pointing to posters on walls in the test room. The response was coded as successful if the child turned or looked at the poster. An issue regarding ESCS, was the use of different versions in the two samples, where UCLA administered an older version of the test. The main difference between the procedure in the two tests were the maximum number of trials. The older version had a maximum of six trials, whereas the more recent version had eight. To counter this issue, a percentage of successful responses was calculated. The ESCS has been shown to have good validity and reliability (Kasari et al., 2006; Mundy et al., 1994). Interrater reliability using Intra Class Coefficient (ICC; an index for assessing interrater reliability) for ESCS RJA was .87 for UCLA sample (Kasari et al., 2012), using approximately 20% of the tapes coded by two independent coders. However, interrater reliability for the OUH data on ESCS RJA has not yet been assessed, as the variable has not previously been used (and it was out of the scope of this thesis to train coders and preform an evaluation). Further, few studies have assessed the construct validity of ESCS. Still, some support of its reliability and validity was found in a study by Mundy et al. (1994).

A mother-child play interaction with a duration of 10–15 minutes was recorded on video. The participants received a set of toys and were told to play as they would normally do. The play sequence was coded for IJA and engagement states, according to Bakeman and Adamson (1984). Specifically, the interaction was duration coded for six mutually exclusive engagement states: Unengaged, on-looking, object engaged, person engaged, SJE and CJE. SJE was coded when the mother and child were attending to the same object, but where the child was not actively acknowledging the mother. CJE was characterized as an attention triad, a state where mother and child were attending to the same object as well as each other. The total duration of these two states were combined to a measure of JE, as done in previous studies (Gulsrud, Hellemann, Shire, & Kasari, 2016; Kaale, Smith, Nordahl-Hansen, Fagerland, & Kasari, 2018; Shire, Gulsrud, & Kasari, 2016). In the two samples, the duration of play session was different. In the OUH study, the assessment lasted ten minutes. The UCLA assessments lasted longer, with approximately fifteen minutes. Since the total duration of the interaction differed in length, a percentage of time in JE of the total interaction was calculated. The child's IJA skills (i.e., point, show, give and alternating gaze between object and partner) were coded separately, and later combined into two measures: *IJA lower order* (i.e. alternating gaze) and *IJA higher order* (i.e., point, show and give; Mundy et al., 1994). Initiations prompted verbally or by gestures of mother were excluded. To account for different duration of interaction, the frequency of IJA was divided by total time in seconds

and 60, multiplied by 10, to receive a measure of number of IJA per 10 minutes. In this study, only IJA higher order was used as a measure of IJA. This could be problematic, as many previous studies have used a composite of IJA higher and lower order (Kasari et al., 2012; Luyster et al., 2008). Moreover, alternating gaze may be a more sensitive index and occur more frequently in younger children with ASD (Kaale, 2014). However, this choice was made on the basis of the higher order skills, such as pointing and showing may have a closer relationship with language development compared to the lower order skill, alternating gaze (Charman et al., 2003; Gulsrud et al., 2014; Özçalışkan et al., 2016). In terms of reliability, interrater reliability for JE, IJA and RJA coding were measured separately for both studies (Kasari et al., 2006; Kaale et al., 2012). ICC value for JE and IJA higher order in the OUH study using 16% of the tapes by two coders, was .80 and .79, respectively (Kaale et al., 2012). In the UCLA study, ICC for the overall coding of mother-child interaction was .78, ranging between .64–.95 (Kasari et al., 2006).

3.4.5 Nonverbal Cognition and Fine motor

To measure nonverbal cognitive ability and fine motor skills, the subscales *Visual reception* and *Fine motor* from MSEL (Mullen, 1995) were used. In the MSEL, fine motor ability is measured through various tasks that require control, coordination, and the ability to manipulate small objects (Dumont & Willis, 2007). The fine motor scale is a measure of visual-motor ability, with involves visual discrimination (i.e., motor-planning) and the "output" of visual organization. This includes unilateral and bilateral manipulation, and the child's writing readiness (Mullen, 1995). Visual reception involves "visual organization, visual sequencing, and visual spatial awareness, including concepts of position, shape and size" (Mullen, 1995, p. 2). Examples of tasks included in the measure are simple manipulating and sorting of objects, and looking for a hidden toy (Mullen, 1995). MSEL is often used in the cognitive assessment of children with ASD, as the test have low verbal demands and yield separate scores for verbal and nonverbal cognition (Bishop et al., 2011; Gotham et al., 2011). The visual reception and fine motor scales are commonly used to make a composite of nonverbal cognition (Bishop et al., 2011; C. Farmer, Golden, & Thurm, 2016; Tillmann et al., 2018). However, to include fine motor in the regression, visual reception was used as a proxy for nonverbal cognition in this study.

To capture the full range of abilities, age equivalent scores from the two scales were used in the analysis. The fine motor scale has shown strong correlations with other measures of fine motor skills (Mullen, 1995). Thus, strengthening the evidence of its construct validity

(Strauss & Smith, 2009). To my knowledge, there is no evidence of convergent validity of the visual reception scale with other measures. However, nonverbal DQ (composite of both scales) has shown adequate correlation with the nonverbal IQ-scale from DAS (Bishop et al., 2011), supporting the construct validity of this composite as a measure of nonverbal cognition. Moreover, the MSEL manual provides some evidence to support the construct validity of the different scales (Bradley-Johnson, 1997; Mullen, 1995).

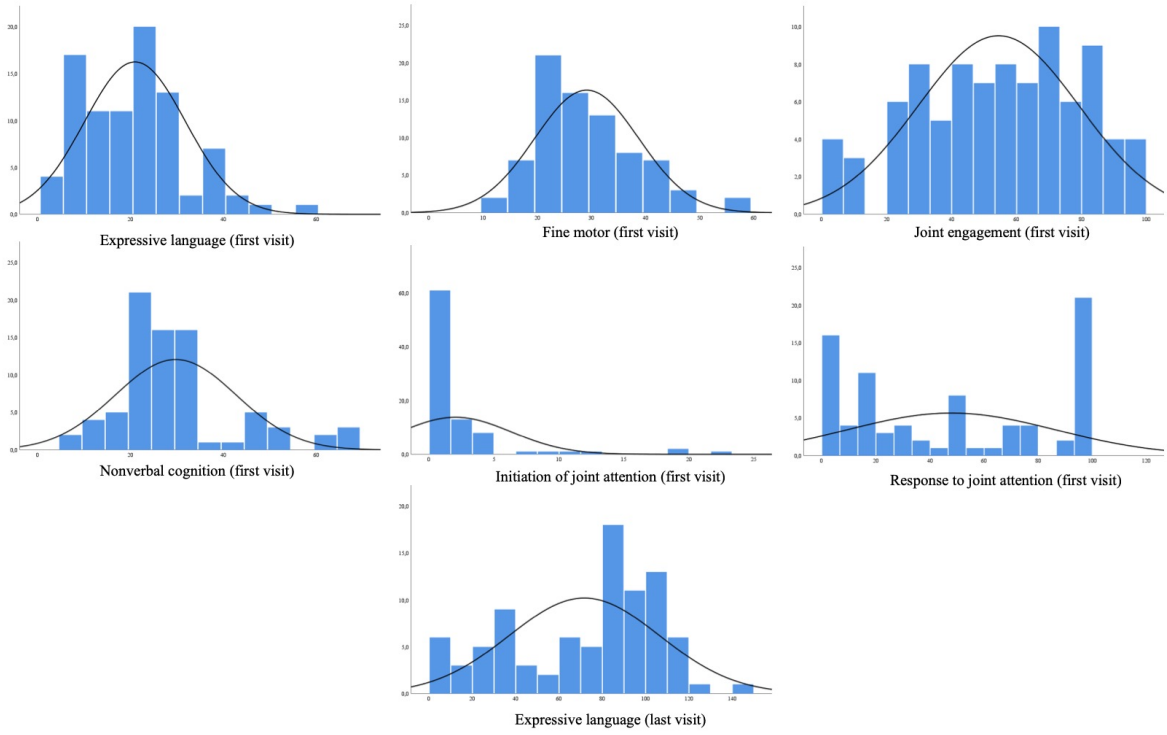
3.5 Statistical Analysis

3.5.1 Assumptions and Data Screening

Multiple regression requires a series of assumptions (Tabachnick & Fidell, 2018). These assumptions are: *Ratio of cases to independent variables, absence of multicollinearity, normality, linearity, homoscedasticity,* and *independence of residuals*. The assumptions are important to evaluate, as gross violations could produce biased or invalid results. In addition, the data needs to be screened for univariate and multivariate outliers, as these can affect the precision of the estimation of the regression weights (Tabachnick & Fidell, 2018). Prior to checking the assumptions, the data was screened for *outliers* by graphical examination, examination of z-scores and Mahalanobis distance. First, one univariate outlier was detected by examination of z-scores and box plots. The case in question had a high score on expressive language at first visit ($z = 3.6$). Next, the data was screened for multivariate outliers using Mahalanobis distance (Tabachnick & Fidell, 2018). Two multivariate outliers (including the univariate outlier) were detected using Mahalanobis distance with $p < .001$. To investigate which variables were causing these cases to be outliers, one stepwise regression was run for each of the two outliers, according to Tabachnick and Fidell (2018). In the stepwise regression, a dummy variable (with the outlier case coded as 1 and the rest of the cases coded as 0) was used as a dependent variable and the other variables were used as independent variables. The results indicated that low score on IJA and high on RJA caused the first case to be an outlier, and high score on both RJA and expressive language (first visit) caused the second. The outliers were investigated further and were subsequently assumed to be part of the population of interest. In addition, no evidence of measurement error was found. Thus, the outliers were not excluded from further analysis. In spite of this evidence, there are no way to be certain of these assumptions (Leys, Klein, Dominicy, & Ley, 2018). Therefore, it is important to bear in mind such decisions when interpreting the results, as this uncertainty could result in inaccurate regression weights, and subsequently drawing inaccurate conclusions.

As mentioned, ten of the participants were measured using different tests of cognitive ability. These tests did not provide compatible measures of visual reception and fine motor skills. Thus, 10 participants were coded as *missing* on both variables. These participants received different tests since they had already been assessed with other cognitive tests prior to inclusion in the study. Furthermore, *RJA* had missing values. The variables were screened using missing values analysis and were assumed to be missing completely at random. To avoid a substantial loss of cases, pairwise exclusion was used in the regression analysis (Tabachnick & Fidell, 2018). A suggested rule of thumb when it comes to cases to independent variables ratio is ten cases per predictor (Brace et al., 2006; Chenausky et al., 2018). Given six predictor variables in the regression analysis, a total sample size of N=89 deemed adequate.

Figure 1 Histograms displaying distribution of independent and dependent variables.



To check the assumptions of homoscedasticity, normality, linearity and independence of residuals, the data was screened through various programs in IBM SPSS 25. First, the distribution of each variable included in the regression analysis was investigated through histograms (Figure 1) and distribution statistics. IJA showed extreme positive skew and kurtosis, while RJA showed strong negative kurtosis. In addition, bivariate scatterplots

between the independent variables and the dependent variable were visually checked for linearity. Assumption of linearity was assumed met, as no non-linear trend was detected. Second, the assumptions were investigated further through examination of normal probability plot of the regression standardized residuals (Figure 2) and scatterplot of standardized residuals against predicted standardized value of expressive language at last visit (Figure 3; Statistics Solutions, 2013a, 2013b; Tabachnick & Fidell, 2018). Examination of the normal probability plot revealed that the assumption of normality of the residuals was satisfied, as the points followed a diagonal line, with no strong deviations (Statistics Solutions, 2019b). In addition, investigation of the residual scatterplot showed that the data was homoscedastic, as the data points were approximate randomly scattered within a rectangular shape (Statistics Solutions, 2019a; Tabachnick & Fidell, 2018). Thus, no transformations were made of skewed variables, as no severe violations of the assumptions of linearity and homoscedasticity were found, and to avoid hampering interpretation of the analysis (Feng et al., 2014; Tabachnick & Fidell, 2018).

Figure 2 Normal probability plot of regression standardized residual.

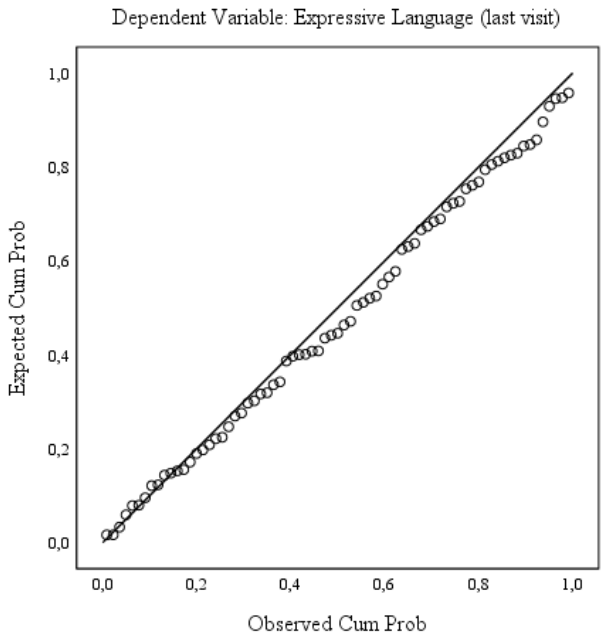
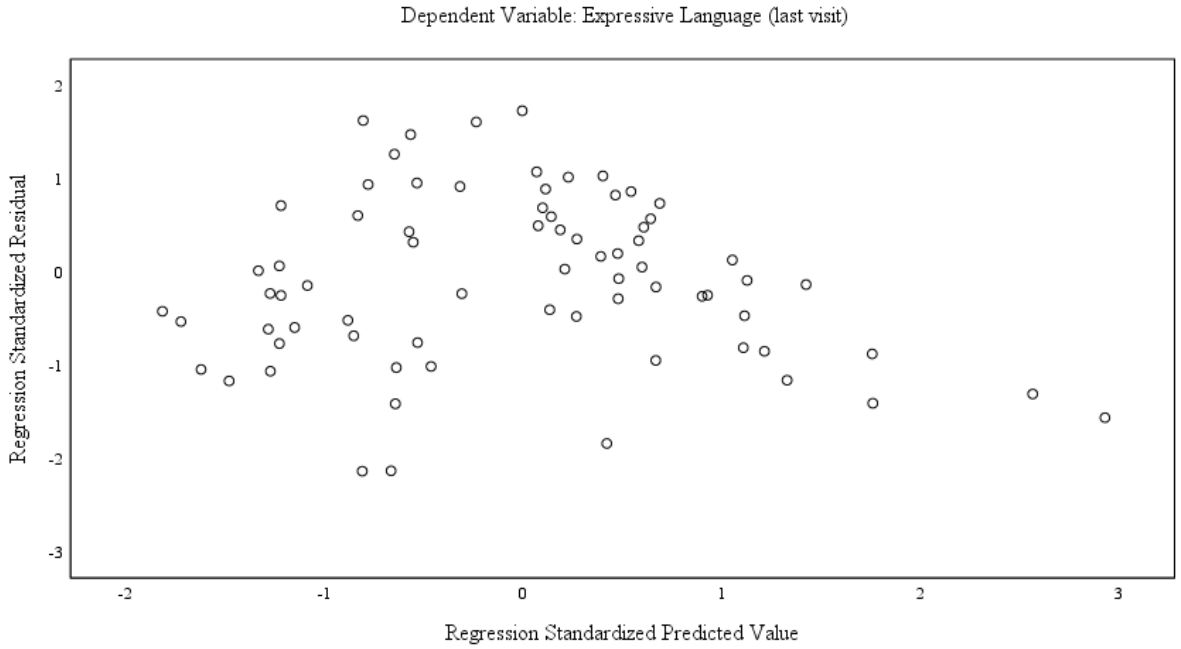


Figure 3 Scatterplot of standardized residuals against predicted standardized value of dependent variable.



3.5.2 Descriptive Statistics

All data handling and analysis were performed using IBM SPSS 25 package. Only participants who returned for the follow-ups and had valid scores on the outcome variable were included in the analysis ($N = 89$). First, descriptive statistics were performed using SPSS DESCRIPTIVES to describe the nature of the data, and to retrieve measures of central tendency, dispersion and distribution for the interval/ratio-level variables (de Vaus, 2014). Following output was retrieved: *mean, range,* and *standard deviation (SD)*. The variables included in the descriptive statistics were demographic information and sample characteristics, predictor variables, and the outcome variable. Descriptive statistics using SPSS FREQUENCIES were performed to retrieve proportion statistics for the categorial variables *SES*, *child ethnicity* and *school type*.

3.5.3 Bivariate Correlation

Next, a correlation analysis was conducted using Pearson's Correlation *r*, to assess the bivariate relationship between the variables included in the hierarchal regression analysis, and to screen for multicollinearity (Brace et al., 2006). Pearson's *r* measures the *linear* relationship between two interval/ratio-level variables (Bryman, 2012; de Vaus, 2014). However, it does not measure relationship strength of other types of relationships, such as relationships with curvilinear trends. Thus, a weakness of the statistic is a chance of masking

a relationship, if a relationship is non-linear. To counter this issue, each predictor variable was investigated in a scatterplot against the outcome variable. No non-linearity was found. The Pearson's *r* statistic provides a correlation coefficient ranging from a perfect negative relationship (–1.0), to no relationship (0.0) and a perfect positive relationship (1.0), with an associated *p*-value. A common alpha-level (significance level) for social sciences is $\alpha = .05$, where α corresponds to the probability of making a Type I error (rejecting the null hypothesis, when it in reality is true; Diez, Barr, & Çetinkaya-Rundel, 2015). Thus, $\alpha = .05$ was chosen as the most appropriate level of significance, meaning all correlations and further regression analysis with $p < .05$ were considered significant in this study. Further discussion on possible consequences of the chosen alpha-level is presented in the *Validity*-chapter (p. 32).

In terms of multicollinearity, most correlation coefficients were considered to be within acceptable range (Table 3). A violation of the assumption of absence of multicollinearity could result in problems of inference on individual predictor variables, by producing non-significant regression weights due to large size of standard error (Brace et al., 2006; Tabachnick & Fidell, 2018). Although there was little sign of multicollinearity, the bivariate correlation between fine motor and nonverbal cognition was slightly above .80, implying that these needed to be evaluated more closely. However, by examining Variance Inflation Factor (VIF) and tolerance statistics in the regression output, no evidence of multicollinearity was found, as VIF < 5 and tolerance > .01 in all predictor variables (Brace et al., 2006; Tabachnick & Fidell, 2018).

Table 3 Pearson's Product-Moment Correlation Coefficient Matrix for Predictor and Outcome Variables

	1	2	3	4	5	6
1. EL (Last visit)[a]						
2. EL (First visit)[b]	.703***					
3. JE[c]	.435***	.272**				
4. RJA[d]	.565***	.666***	.291**			
5. Nonverbal cognition[e]	.526***	.755***	.228*	.561***		
6. Fine motor[f]	.590***	.731***	.137	.567***	.820***	
7. IJA[g]	.328**	.232*	.374***	.278*	.109	.095

****p < .001, **p < .01, *p < .05*

[a] Expressive language; RDLS age equivalent. Scores <4 stanine for 1.5 years based on MSEL.

[b] Expressive language; EVT age equivalent. Raw scores below norm (raw <21) based on MSEL.

[c] Joint Engagement; Combined measure of percent of time in coordinated joint attention and supported joint attention during 10-15 min play.

[d] Response to joint attention; ESCS. 7 missing.

[e] Age equivalent from visual reception scale; MSEL. 10 missing.

[f] Age equivalent from fine motor scale; MSEL. 10 missing.

[g] Initiation of joint attention; No. higher order initiations of joint attention (point, show or give) during 10 min play.

3.5.4 Hierarchical Regression Analysis

To investigate how early social and individual factors predicted later expressive language after controlling for expressive language at first visit, a hierarchal regression with two blocks of entry was performed with *expressive language (last visit)* as a dependent variable. A hierarchal regression is a form of multiple regression, where variables are entered into the model sequentially. A multiple regression is used when one wants to predict the outcome of a dependent variable, based on scores on multiple independent variables (Brace et al., 2006). Two partial regression coefficients are provided, estimating how much impact the different independent variables has on the dependent variable, removing the shared variance with the other independent variables (de Vaus, 2014). Both the unstandardized coefficient (*b*) and standardized coefficient (β) estimate the change in the dependent variable for each unit of increment in the independent variable (de Vaus, 2014). While the *b* uses the same units of measurement as the dependent variable, the β is standardized (i.e., measured in units of standard deviation), which in this case allowed a comparison of which early factors best

predicted expressive language at last visit (Brace et al., 2006). In addition, the multiple regression also provides a coefficient called R^2, which gives information of the overall successfulness of the model, or how well early social communication and interaction, nonverbal cognition and fine motor collectively explained the variance in expressive language at last visit (Brace et al., 2006; de Vaus, 2014). In addition, an adjusted form of the R^2 (adjusted R^2) takes into account the sample size and number of predictors, to avoid overestimating the explanatory power of the model (Brace et al., 2006), which is considered a risk when analyzing smaller samples (Tabachnick & Fidell, 2018). To assess whether the results on R^2 is due to sampling error, an analysis of variance (ANOVA) is run, using the F-test to evaluate the overall significance of the model (de Vaus, 2014).

In a standard multiple regression analysis, all independent variables are entered simultaneously. In a hierarchical regression, however, the independent variables are entered into the model in steps. In order to assess the predictive power of the independent variables, while controlling for initial expressive language, *expressive language age (first visit)* was included in the first step (Pallant, 2010). This was justified by results from previous research and logical reasoning (Tabachnick & Fidell, 2018), which states that early expressive language is strongly associated with later expressive language (Sigman & McGovern, 2005; Sigman et al., 1999; Stone & Yoder, 2001; Weismer & Kover, 2015). The variables *RJA, IJA, JE, fine motor* and *nonverbal cognition* were then added in the second step. In a hierarchical regression, the same coefficients and statistics are provided as for standard multiple regression, but for each step. In addition, a R^2 *change* is provided. This coefficient allowed for investigating how much of the variance in expressive language at last visit is accounted for by initial expressive language alone. In addition, the R^2 *change* gave an estimate of how the other predictors collectively explained the variance in expressive language at last visit, when the effect of initial expressive language was accounted for (Tabachnick & Fidell, 2018). Results from the hierarchical regression analysis is presented in Table 4. Finally, to adjust for the wide age range at last visit, an additional regression analysis was performed, adding *Chronological age (last visit)* as an additional control in the first step.

Table 4 Summary of Hierarchical Regression Analysis for Variables Predicting Expressive Language ($N = 89$)[a]

Step	Predictor	*Unstandardized coefficients*		*Standardized coefficients*		R^2	ΔR^2	R^2 *Change*	F	p
		B	*SE B*	β	*p*					
1						.49	.49	.49	70.43	.000***
	EL[b]	2.25	.27	.703	.000***					
2						.60	.57	.11	3.67	.005**
	EL[b]	1.57	.44	.50	.001***					
	JE	0.35	0.12	.25	.005**					
	RJA[c]	0.07	0.10	.07	.499					
	NV[d]	-0.60	0.40	-.22	.134					
	FM[e]	1.21	0.52	.33	.024**					
	IJA	0.75	0.70	.09	.290					

****p<.001, **p<.01, *p<.05*

[a] Expressive language; RDLS age equivalent. Scores <4 stanine for 1.5 years, based on MSEL.

[b] Expressive language; EVT age equivalent. Raw scores below norm (raw <21), based on MSEL.

[c] Joint Engagement; Combined measure of percent of time in coordinated joint attention and supported joint attention during 10-15 min play.

[d] Response to joint attention; ESCS. 7 missing.

[e] Nonverbal cognition; Age equivalent from MSEL visual reception scale. 10 missing.

[f] Fine motor; Age equivalent from MSEL fine motor scale. 10 missing.

[g] Initiation of joint attention; No. higher order initiations of joint attention (point, show or give) during 10 min play.

3.6 Reliability

A brief general discussion of reliability in the current study will be considered in terms of three relevant types of reliability: *Test-retest*, *internal* and *interrater reliability* (Bryman, 2012; Sattler, 2008). First, test-retest reliability reflects the stability of the measures, often calculated through correlation between measurements performed on two occasions on the same individuals. Second, internal reliability is about the consistency of the test, subscale or index, by how scores on one indicator reflects the score on other indicators in the same scale. This is usually assessed using Cronbach's alpha, Kuder-Richardson formula 20 or split-half method (i.e., Spearman-Brown correction formula). Third, interrater reliability reflects the agreement between two independent coders on the same test and individual, using correlation, percent agreement, ICC or kappa. More detailed information regarding reliability of each measure is provided in the *Measures*-chapter (p. 16–23).

Most measures used in the regression analysis are standardized measures with generally satisfying reliability. In terms of coding the social communication and interaction variables, a threat to the reliability could be the subjective perspective of the coders (Sattler, 2008). To account for this issue, the coders were trained prior to the assessments. Still, in observational tests there will always be some discrepancies between the coders. Thus, interrater reliability between two coders was assessed, yielding ICC values between .78–.87, which is to be considered moderate to good reliability (Koo & Li, 2016; Sattler, 2008). It should be noted that interrater reliability for the variable ESCS RJA for the OUH sample was not calculated, as the variable was not used in the original study. In other words, the lack of information regarding coder agreement weakens the reliability of the measure, and in turn the validity of the results, as reliability of the measurements is a necessity for validity (Bryman, 2012). Still, as interrater agreement was highest on RJA (ICC=.87) compared to IJA and JE in the UCLA study, it could provide an insight into the interrater reliability of the measure.

In terms of test-retest and internal reliability, all measures used in current study generally reports satisfying values. In addition, the measures of cognition, language, and social communication and interaction is commonly used in research on children with ASD (e.g., Anderson et al., 2007; Bottema-Beutel et al., 2014; Sigman et al., 1999; Thurm et al., 2007; Özçalışkan et al., 2016). However, assessment of test-retest reliability in RDLS III was unobtainable. Still, different versions of the RDLS has been widely used in ASD research (e.g., Charman et al., 2003; Sigman & McGovern, 2005). In addition, the Norwegian edition reports a test-retest correlation coefficient of .78, which supports the reliability of the measure. In terms of social communication and interaction, it should be noted that IJA is a more unstable measure, compared to RJA, which can be affected by the selection of toys and the child's familiarity with these (Bottema-Beutel, 2016). Thus, weakening its reliability (Sattler, 2008).

When it comes to reliability in general, different factors may affect the reliability of the current study, as no test is free of errors (Sattler, 2008). For example, the children in the OUH sample were assessed during the course of one day, which could affect concentration. Thus, producing measurement errors. Further, none of the standardized tests reports excellent reliability on test-retest reliability, implying that there will always be some error in the reported results.

3.7 Validity

To assess the validity of inference in the current study, the discussion will be in light of Cook and Campbells validity types from 1979: *Statistical conclusion validity*, *internal validity*, *construct validity* and *external validity* (as cited in Shadish, 2010). Statistical conclusion validity refers to the validity of inference regarding the relationship between independent and dependent variable, in terms of statistical significance and strength of the relationship. Internal validity refers to the inference of causality in this relationship, that variable A has an effect on B, and not the other way around, without other intervening factors (Lund, 2002; Shadish, 2010). The construct validity is about how the theoretical constructs used to make inference are operationalized, in terms of measuring what they are stated to measure. Finally, external validity concerns whether the results generalize to the population in question, to variation in the population, to different times and settings.

3.7.1 Statistical Conclusion Validity

In this study, statistical conclusion validity applies to the statistics used to assess how the predictor variables (independent variables) predicted the outcome variable (dependent variable). The correlation analysis, hierarchical regression, and ANOVA (used to test the significance of R^2) all produced coefficients and *p*-values to estimate the strength and significance of the relationship between the predictor variables and the outcome. In such tests, there will always be an error-margin. In this study, an alpha level of $\alpha = 0.05$ was chosen, as it is the most commonly used significance level in social sciences (Brace et al., 2006). The use of significance levels to make inferences will often imply a risk of making a type I or type II error (Diez et al., 2015). In layman's terms, assuming there is a relationship when there is none (type I), or assuming there is no relationship when there is a relationship between the variables (type II). Decreasing the alpha-level would increase the risk of making a type II error, while the risk of making a type I error would increase with a higher significance level. Thus, it was important to assess the magnitude of the coefficients and *p*-values from the correlation matrix, hierarchical regression and ANOVA in light of each other, to minimalize the risk of making incorrect inferences.

A strength in the current study is the large sample size, compared to other similar studies. A larger sample size allowed for inclusion of more relevant variables in the regression model. Still, there is some variability in recommendations on ratio between number of participants and predictors in a hierarchical regression. Brace et al. (2006) suggest ten participants per

independent variable, but Tabachnick and Fidell (2018) has a more conservative recommendation. In this study, 6 predictors were used in analysis of 89 cases. Including more predictors than appropriate could affect how the predictors predicts the score on the outcome variable, creating a perfect, yet meaningless, prediction (Tabachnick & Fidell, 2018). In other words, weakening the statistical conclusion validity. Still, such result was not the case in current analysis. However, one could argue that choosing a more conservative approach could yield different results. Thus, careful consideration was put into selecting relevant variables that could be of importance, and excluding less important variables, to avoid overfitting the model.

3.7.2 Internal Validity

In a descriptive design, inference of causality is problematic, as there will be multiple possibilities in terms of direction and relationship nature between the variables (Kleven, 2002). In addition, we have little control of spurious relationships and confounding variables. However, multiple regression techniques allowed me to assess which independent variable had the highest impact on the dependent variable, accounting for its shared variance with the other independent variables in the regression model. In other words, the independent variables' unique prediction. Including multiple independent variables in the model, based on logic reasoning and theoretical considerations, gave me more control over the relationships between variables. Still, the sample size limits the number of predictors (Tabachnick & Fidell, 2018). Thus, limiting the results to the included predictors, as there may be more important predictors than the ones included, which were not assessed nor included in the analysis. Therefore, work was put into selecting the most important potential predictors, based on literature review. In spite of these considerations, there is a high probability that some factors that could have been important were excluded.

The use of longitudinal data, where the predictors were measured at an earlier time point than the outcome variable, gave better control of the relationship direction (Bryman, 2012; Shadish et al., 2002). Thus, strengthening the internal validity. Still, there is no guarantee that the correct variables have been included, and that the data is free of errors. In addition, although the predictor variables were measured at an earlier point than the outcome variable, one can never be certain that the value of the predictors are causing the effect on the outcome variable (Shadish et al., 2002). In other words, the discussion of causality is more relevant to experimental designs.

3.7.3 Construct Validity

Different operationalized constructs were used to address the research question. A review on the measures of cognition, fine motor, language, and measures of social communication and interaction and their construct and convergent validity is provided in the *Measures*-chapter (p. 16–23). In general, all measures in this study are considered to have adequate construct validity, or are considered to be robust indicators of a broader construct. Still, a threat against the construct validity of the current study, could be the use of different measures of expressive language. Although these are designed to measure the same construct, they are operationalized differently, measuring different aspects of spoken language. However, the construct validity is strengthened by the fact that these measures have shown to have convergent validity with other measures of expressive language, supporting their role as robust indicators of expressive language. Furthermore, it should be noted that information regarding convergent validity of JE coding in mother-child interaction was not obtainable. In other words, the validity of the JE construct may not generalize outside the theoretical framework of the concept by Bakeman and Adamson (1984).

Other threats to construct validity could by linked to the assessment procedures. One threat could be that the parents was aware that they were being assessed in the video-taping of social interaction. Thus, producing an unnatural play session, where the adults were trying to "perform better" in the play session (Lund, 2002). As a preventive step, the adults received minimal instructions about the purpose of the assessment and were told to play as they would normally do. Further, the children's language was assessed through direct assessment. One could argue that such way of measuring does not capture the child's use of language in a natural setting. In other words, weakening the validity of the construct expressive language. On the contrary, a more observational approach could make standardization more difficult, and the results could be affected by other unanticipated factors. Thus, the choice of using standardized direct assessment may not capture the child's use of language in everyday life, but have strengths in terms of allowing to compare results to a normative sample (S. S. Farmer & Mendoza, 2007).

3.7.4 External Validity

When it comes to external validity, the inferences of generalization only apply to the population of children early diagnosed with autistic disorder/childhood autism according to DSM-IV and ICD-10 criteria. However, as the sample showed great variety on cognitive and expressive language functioning at first and last visit assessments, the inferences may apply

to the broader population of children with ASD. This can be considered a strength, as a lot of research on ASD focuses solely on the ASD population with *or* without ID (Dykens & Lense, 2011), and results from such research may not generalize to the wider population of children with ASD. However, a concern with including children with and without ID, could be that it is problematic to evaluate which traits in the individuals are due to ID and which are caused by the features of the ASD diagnosis (Dykens & Lense, 2011). Still, as a major part of the population with ASD have co-occurring ID (Baio et al., 2018; Dykens & Lense, 2011; Yeargin-Allsopp et al., 2003), the current sample may be more representative for the broader population (Dykens & Lense, 2011). Thus, strengthening the external validity.

Another potential threat to the current study's external validity could be the socioeconomic status of the sample. As most of the parents in the UCLA sample were highly educated, this could impose a threat to the external validity in terms of generalization to children of parents with a lower socioeconomic status. However, the education level for the parents in OUH sample was lower, which could aid in extending the results to a wider population. Still, due to increased knowledge of ASD, improvement of standardized tests, and development of new diagnostic manuals, the inferences may not generalize to a wider time perspective (Newschaffer et al., 2007; Shadish et al., 2002). On the contrary, a strength in terms of external validity, is the use of participants from two different countries, and different parts of Norway in the Norwegian sample, which strengthens the representativeness to a broader population (Bryman, 2012).

3.8 Research Ethics and Data Security

The present study is classified as health research and was approved by The Norwegian National Committees for Research Ethics (Appendix C). The data used in this study was collected prior to the start of this study, and is characterized as *red*, meaning sensitive personal data has been collected. Thus, to ensure data security, all data was stored and processed on a secure server (TSD), according to the rules and guidelines of University of Oslo, Oslo University Hospital and the national committees for research ethics. In addition, a written informed consent was obtained from all parents at first and last visit at both sites (Appendix D, E and F). The written information about the study was presented in a neutral way to ensure that no participants felt pressured to participate (Appendix F, G and H). The parents consented on behalf of the participants, as the children were too young at inclusion to provide a consent themselves. Although the written information and consent form from

UCLA at first visit exist, it was not obtainable for this thesis. A renewed consent was not collected for the current study report. However, the topic of this thesis was considered to be within the same research topic as the parents originally consented to. In terms of confidentiality, no personal information was provided on single cases, as the results were reported on the participants as a group.

As the current paper reports on data that were already collected, it entailed no additional risks for the participants or families involved. Still, some issues are to be considered in terms of the collection of data in the original studies. An important ethical consideration is that the research should not cause harm to participants (Den nasjonale forskningsetiske komité for samfunnsvitenskap og humaniora [NESH], 2016). However, researchers may encounter unanticipated situations that causes unintended harm, especially when researching on vulnerable groups. For example, for children with ASD, an unfamiliar setting may cause stress, and some children may feel unsafe. These situations could be considered as harm (Bryman, 2012; Stangor, 2007). Such stress may also be amplified, if a child knows it is being evaluated. Thus, the assessments were conducted with caution to preserve the child's well-being. To preserve the child's sense of security, the assessments were performed with parents nearby. In addition, the assessments were conducted by trained professionals, according to the guidelines of The World Medical Association (July 9, 2018). These testers were aware of possible challenges that could arise an assessment situation. Furthermore, the parents or participants were free to leave the studies at any time.

An issue regarding the young participant group with ASD, is the lack of ability to provide informed consent. However, research on language development in children with ASD, can only be performed on this group, as results from similar studies on TD children may not be transferable. In such situations, where the participants are not able to provide informed consent, it is vital that the research is beneficial for the group in question (NESH, 2016; The World Medical Association, July 9, 2018). The results from this study could provide indication of which areas the research needs to explore further, to develop interventions that could benefit the study group, as well as other children with the same characteristics. Although there are some ethical issues regarding research on children with ASD, the importance of such research may outweigh some of the risks. Still, the cost/benefit ratio must be evaluated continuously when researching on vulnerable groups.

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Appendix A: Article manuscript

Predicting Expressive Language in Children with Autism Spectrum Disorder

Author: *Joakim Rudebjer*

Journal: *Journal of Autism and Developmental Disorders*

Journal URL:

https://www.springer.com/psychology/child+%26+school+psychology/journal/10803?detailsPage=pltci_3161162

Predicting Expressive Language in Children with Autism Spectrum Disorder

Joakim Rudebjer[1]

[1]*Department of Special Needs Education, University of Oslo, Sem Sælands vei 7, 0371 OSLO*

Corresponding author:

Joakim Rudebjer. E-mail: rudebjer@gmail.com. Tel.: +4747249312

Acknowledgements:

The following paper is a part of a master's thesis, which uses data from two earlier studies. Thus, no additional grants were received for the current paper. Originally, the first study from Oslo University Hospital was supported by grants (no. 20005069) from South-Eastern Norway Regional Health Authority, Oslo University Hospital, Regional Center for Child and Adolescent Mental Syndrome and Narcolepsy. The study at University of California, Los Angeles was supported by grants from the Collaborative Program of Excellence in Autism (P01-35470), Autism Centers of Excellence (P50-HD-55784), and Health Resources and Services Administration (UA3MC11055). The author thanks the families and children for their participation in the studies.

Abstract

The present study investigates how early social communication and interaction, fine motor and nonverbal cognition predicts expressive language in late childhood in 89 children with autism spectrum disorder from Norway and US. Using hierarchical regression, early joint engagement and fine motor predicted expressive language in late childhood, controlling for initial expressive language. Fine motor was the strongest predictor. Early initiation of joint attention, response to joint attention, and nonverbal cognition correlated with later expressive language, but was non-significant in the regression analysis. Collectively, the predictors accounted for 60% of the variance in subsequent expressive language. These results are an important step towards identifying which early factors have the strongest relationship with expressive language in late childhood.

Keywords: Autism spectrum disorder; expressive language; joint engagement; fine motor; nonverbal cognition; predictors

Correspondence concerning this article should be addressed to:

Joakim Rudebjer, rudebjer@gmail.com

Running head: PREDICTING EXPRESSIVE LANGUAGE IN ASD

Predicting Expressive Language in Children with Autism Spectrum Disorder

Abstract

The present study investigates how early social communication and interaction, fine motor and nonverbal cognition predicts expressive language in late childhood in 89 children with autism spectrum disorder from Norway and US. Using hierarchical regression, early joint engagement and fine motor predicted expressive language in late childhood, controlling for initial expressive language. Fine motor was the strongest predictor. Early initiation of joint attention, response to joint attention, and nonverbal cognition correlated with later expressive language, but was non-significant in the regression analysis. Collectively, the predictors accounted for 60% of the variance in subsequent expressive language. These results are an important step towards identifying which early factors have the strongest relationship with expressive language in late childhood.

Predicting Expressive Language in Children with Autism Spectrum Disorder

Deficits in social communication is a core issue in autism spectrum disorder (ASD; American Psychiatric Association 2013), and impairments in language and communication are common reasons for referral among children later diagnosed with ASD (Schaefer-Whitby et al. 2017; Tager-Flusberg et al. 2005). These language and communication deficits at early age can negativity affect outcome later in life (Venter et al. 1992; Billstedt et al. 2005; Howlin et al. 2000). Further, the ability to communicate verbally is essential for expression of personal needs and participation in social contexts, and is impaired in many individuals with ASD (Anderson et al. 2007; Mundy et al. 1990; Özçalışkan et al. 2016; Kasari et al. 2012; Sigman and McGovern 2005). Still, the level of verbal abilities is diverse among these individuals, from those with a high level of expressive language to those remaining nonverbal (Sigman and McGovern 2005; Thurm et al. 2007; Anderson et al. 2007; Bottema-Beutel 2016). To facilitate our understanding of how these skills are developed and which factors contribute to low or high levels of language outcome, studying early predictors of later expressive language is crucial. Several studies have looked at different factors in the child's early development and how they relate to later expressive language. However, there is still need for more knowledge. This kind of research could be beneficial in the development of intervention programs, because it could help identifying potential intervention targets, seeking to increase language outcome for children with ASD. In addition, research on predictors, even though they are not directly targetable by intervention programs, could expand our knowledge of why some achieve a higher level of expressive language and some do not (Stone and Yoder 2001).

Which factors that strongest predict later expressive language are still somewhat unclear. Early language abilities have been shown to be associated with later language in studies on

children with ASD (Sigman and McGovern 2005; Stone and Yoder 2001; Weismer and Kover 2015; Sigman et al. 1999), with some exceptions (Mundy et al. 1990). Previous research has also found aspects of *social communication and interaction* (e.g., response to joint attention [RJA], initiation of joint attention [IJA], and states of joint engagement [JE]), *nonverbal cognition*, and *motor skills* to be significant predictors of expressive language (Bedford et al. 2016; Kasari et al. 2012; Özçalışkan et al. 2016; Mundy et al. 1990; Sigman and McGovern 2005; Anderson et al. 2007; Charman et al. 2003; LeBarton and Landa 2019; Choi et al. 2018; Luyster et al. 2008; Yoder et al. 2015; Bottema-Beutel et al. 2014; Adamson et al. 2009; Adamson et al. 2019). When it comes to states of JE, supported joint engagement (SJE) has been linked to subsequent expressive language in preschool children with ASD (Bottema-Beutel et al. 2014; Adamson et al. 2009). In extension, a recent study by Adamson et al. (2019) found that *fluency and connectedness* at 2 years predicted expressive language at 2½ years, where fluency and connectedness in a child-mother interaction was used as a marker for JE. Fluency and connectedness was measured by investigating the quality of the interaction, in terms of turn-taking structure and flow.

Aspects of joint attention (JA) seems to be one of the most studied predictors of language (Anderson et al. 2007; Sigman and McGovern 2005; Mundy et al. 1990; Stone and Yoder 2001). Deficits in these skills are present in many children with ASD (Sigman and McGovern 2005; Gulsrud et al. 2014; Bottema-Beutel 2016), and studies have found different aspects of JA to be associated with later expressive language (Kasari et al. 2012; Sigman et al. 1999; Weismer and Kover 2015; Özçalışkan et al. 2016; Gulsrud et al. 2014). Stone and Yoder (2001) found an association between IJA and subsequent expressive language in their study on 35 children with ASD. However, the association was non-significant after controlling for initial expressive language level. Further, IJA has been significantly associated with concurrent language (Sigman and McGovern 2005; Toth et al. 2006). Still, these studies have

failed to find a longitudinal association. In contrast, neither IJA or RJA predicted concurrent expressive language in a large sample of toddlers with ASD, although both correlated significantly with concurrent expressive language (Luyster et al. 2008). In several other studies, RJA has been a significant predictor of concurrent or subsequent expressive language outcome and/or language growth (Weismer and Kover 2015; Sigman et al. 1999; Edmunds et al. 2017; Yoder et al. 2015). Moreover, in two follow-up studies on a sample of preschool children with ASD, early childhood RJA significantly predicted expressive language at adolescence (Sigman et al. 1999) and continued to predict expressive language at early adulthood (Sigman and McGovern 2005). In a systematic literature review by Bottema-Beutel (2016), RJA was closely related to expressive language. Further, in a study that followed 30-months old children with ASD for one year, Özçalışkan et al. (2016) found deictic gestures (i.e., gestures to indicate an object, in form of pointing and showing) to be a predictor of expressive language. Other gestures such as conventional (i.e., gestures with cultural shared meaning) or give (i.e., requesting object by reaching) gestures did not predict later language. This finding is in accordance with Gulsrud et al. (2014), who found support of early pointing in preschool age being related to later expressive language. On the other hand, Charman et al. (2003) found an association between JA skills (e.g., alternating gaze) and receptive, but not expressive, language. Thus, some aspects of JA seem to be more closely related to expressive language than others. However, which aspect contributes the most to language outcome is still unclear.

Visual reception taps into visual processing, visual discrimination, and visual memory (Dumont and Willis 2007; Bradley-Johnson 1997; Mullen 1995), and has been used in previous studies as a proxy of nonverbal cognition (LeBarton and Iverson 2013; Choi et al. 2018; Bedford et al. 2016; Luyster et al. 2008). Since nonverbal cognition has been known to be associated with language (Anderson et al. 2007; Thurm et al. 2007), nonverbal cognition

(or visual reception) is often used as a covariate, rather than a predictor in statistical models (LeBarton and Iverson 2013; Choi et al. 2018). Some studies that included nonverbal cognition as a predictor have found nonverbal cognition at 2 years to predict expressive language at 5 years (Thurm et al. 2007), concurrent verbal skills at 2 years, as well as growth in verbal abilities from 2 to 9 years (Anderson et al. 2007). In addition, higher nonverbal cognition in a sample followed from 4 to 18 years of age was associated with an increased likelihood of phrase and fluent speech acquisition, and earlier phrase speech attainment (Wodka et al. 2013). Similarity, in another large study on ASD toddlers, nonverbal cognition significantly predicted concurrent expressive language (Luyster et al. 2008). Moreover, Weismer and Kover (2015) found that nonverbal cognition at 2½ years was a significant predictor for language production growth at 5 years. On the contrary, Charman et al. (2003) did not find a significant relationship between nonverbal cognition and expressive language. To the author's knowledge, however, no studies have looked at how well nonverbal cognition at preschool age predicts expressive language at late childhood, compared to other factors such as fine motor, and different aspects of social communication and interaction.

Several studies, such as the one conducted by Leonard et al. (2015), have investigated the relationship between motor skills and language. According to previous studies, early gross motor skills seem to predict later expressive language (Bedford et al. 2016; LeBarton and Landa 2019). Leonard et al. (2015) studied the relationship between these two domains. They found a relationship between gross motor skills and expressive language development, and similar patterns for fine motor skills. However, the results for fine motor was not statistically significant. In terms of motor skill in general, it did not predict concurrent expressive language in ASD toddlers, in a study by Luyster et al. (2008). In studies on high risk infants (i.e., infants with heightened risk of ASD), fine motor predicted expressive language (LeBarton and Iverson 2013; Choi et al. 2018). In addition, LeBarton and Landa (2019)

found that fine motor (e.g. grasping) at 6 months predicted expressive language at 30 and 36 months. Still, since most of the research on the link between fine motor and expressive language are done with infants and toddlers, including fine motor as a potential predictor in studies of older children seems beneficial.

Although there is a significant amount of research on predictors for expressive language, few studies have investigated how different aspects of social communication and interaction, nonverbal cognition and fine motor at early age predict later expressive language at late childhood in children with ASD. Moreover, previous studies have few potential predictors included in their models (Stone and Yoder 2001; Leonard et al. 2015; Bottema-Beutel et al. 2014; Choi et al. 2018) and/or small sample sizes (Charman et al. 2003; Mundy et al. 1990; Stone and Yoder 2001; LeBarton and Iverson 2013; Sigman and McGovern 2005). Furthermore, some of the research performed on high risk infants did not screen participants for confirmation of ASD diagnosis (Edmunds et al. 2017). Small sample sizes and limited number of potential predictors are limitations that can make interpretation of the results difficult. Finally, only few studies have investigated the long-term relationships between early predictors and expressive language in ASD (Anderson et al. 2007; Bedford et al. 2016; Sigman and McGovern 2005; Sigman et al. 1999). Of these longitudinal studies, only two studies included multiple aspects of JA (Sigman and McGovern 2005; Sigman et al. 1999). However, none of these included a multitude of potential predictors covering JE, fine motor skills or nonverbal cognition.

The current study aims to investigate early predictors for expressive language in late childhood in children with ASD. This study includes a wider range of potential predictors, while controlling for initial expressive language level. The purpose was to gain more knowledge of how well these factors collectively explained the variance in later expressive

language, and which of these factors best contributed to the prediction of later expressive language. Such knowledge will enable us to get an enhanced understanding of how social communication and interaction (i.e, RJA, IJA and JE), fine motor and nonverbal cognition (i.e., visual reception) are associated with language functioning in children with ASD. Moreover, the larger sample size compared to similar studies is considered a strength, since it allows for inclusion of a wider spectrum of potential predictors, covering different aspects and abilities regarding the child. Although this study primarily investigates abilities and aspects of the child's functioning, the JE measure also includes a contextual element, since it requires a dyad of child and adult engagement in the same activity (Bakeman and Adamson 1984). The study had two main aims: *First*, to assess how well social communication and interaction, fine motor and nonverbal cognition collectively explains the variance in later expressive language, after controlling for initial expressive language. *Second*, to investigate which of the individual potential predictors have the strongest relationship with later expressive language.

Methods

Design

Using a descriptive longitudinal design, the current study uses data from two follow-up studies of randomized controlled trials (RCT). The first study was conducted at Oslo University Hospital (OUH), Norway (Kaale et al. 2012) and the second at UCLA, CA, USA (Kasari et al. 2006). The participants in these studies were measured at five timepoints, but only data from the first and last visit were used for the purpose of this study. Participation in the studies was based on written informed consent.

Participants

The participants from Norway were recruited via the regional autism specialist center/Child and Adolescence Mental Health Clinic (CAMHC). They were invited to participate on the basis of meeting a set of inclusion criteria: (a) chronological age between 24-60 months, (b) diagnosis of childhood autism based on ICD-10 criteria from a comprehensive clinical evaluation by CAMHC, and (c) preschool attendance. Participants were excluded if there were evidence of (a) severe CNS disorders (e.g. cerebral palsy and epilepsy) or (b) non-Norwegian speaking parents. Prior to the assessments, the parents were asked to fill out a questionnaire. At UCLA, the participants in the sample were recruited from an early intervention program (EIP) on site. Criteria for inclusion were (a) chronological age <60 months and (b) diagnosis of autistic disorder, according to DSM-IV criteria. Similar to the OUH sample, exclusion criteria for the UCLA study were the prevalence or history of seizures or medical cooccurring conditions.

The participants in UCLA sample were re-assessed for ASD at entry on site, by independent clinicians blind to the research purpose. The diagnostic assessment for OUH participants was completed prior to inclusion in the study. All of the UCLA participants and most of the OUH participants were assessed with Autism Diagnostic Observation Schedule (ADOS; Lord et al. 2000) and Autism Diagnostic Interview-Revised (ADI-R; Lord et al. 1994). Lack of assessment with ADOS and ADI-R among OUH participants was due to site diagnostic practice.

In the OUH and UCLA studies, 61 and 58 children with were assessed at first visit, respectively. 51 participants returned for the last follow-up in the OUH sample, while 40 returned in the UCLA study. However, one participant from each site was excluded from the current study, as they did not have valid scores on the outcome variable, leading to a total sample size of 89 participants. The final sample consisted of 73 males and had a mean age of

135.15 (*SD*=18.1) months at last visit. The descriptive statistics showed a large range of developmental levels within the sample (see Table 1). Moreover, the group of children exhibited great variability in terms of expressive language at both timepoints (see Table 2). The group of parents of the participants in the UCLA sample were slightly higher educated (in mean years of education), compared to the parents in the OUH sample. In addition, the children in the OUH sample were at a higher age at last visit, compared to the UCLA sample.

[Insert Table 1 about here]

[Insert table 2 about here]

Procedure

At first and last visit, the participants were assessed with a comprehensive battery of tests, including assessment of language, social skills and cognition. In addition, the children were videotaped during a mother-child play interaction of 10–15 minutes duration, for assessment of JA skills and JE. For the OUH sample, first visit assessments were performed at the regional CAMHC, while the last visit assessments were done at the children's respective schools, for the participants' and their parents' convenience. Both assessments were conducted during the course of one day. The UCLA participants were tested on site at the research lab in two separate visits, at both timepoints.

Measures

Demographic Information

For both samples, demographic information was obtained using parent-reported questionnaires. Due to cultural differences between Norway and USA, the data regarding child ethnicity, school type and maternal and paternal education were recoded and merged

into new variables for compatibility. For example, in the categorical variables *maternal education* and *paternal education*, the categories were recoded into number of years of education. Subsequently, a mean of the two were calculated, and used as an indicator of *socioeconomic status* (SES).

Developmental Level

Developmental level at first visit was measured using Mullen Scales of Early Learning (MSEL; Mullen 1995). Since a majority of participants scored below the norm-referenced T-scores on one or more of the MSEL subscales, a *developmental quotient* (DQ) was computed for all participants, using mental age divided by chronological age, multiplied by 100. Although most participants were assessed with MSEL, 10 participants from the UCLA sample had already been assessed with other tests of cognitive ability prior to the research assessments. These included WPPSI-R (Wechsler 1989), BSID-II (Bayley 1993), Stanford-Binet Intelligence Scale (Thorndike et al. 1986) and Merrill-Palmer Scale of Mental Tests (Stutsman 1948). Since these children already had a test of cognitive ability, MSEL tests were not conducted. Thus, DQ from MSEL was merged with IQ scores from the other measures.

To measure cognitive level at last visit, different tests were used. For the UCLA-sample, the participants were tested with either Differential Ability Scales (DAS; Elliott 1993; n=31) or MSEL (n=8), depending on level of cognitive ability. For OUH participants, a Norwegian edition of Wechsler Abbreviated Scale of Intelligence (WASI; Ørbeck and Sundet 2007; n=33) or MSEL (n=17) was administered. The MSEL was used if the participants were not likely to receive a basal score on the WASI or DAS. Since the participants were outside the normed age range of the MSEL test, DQ scores were calculated using same formula as stated

in the previous paragraph. However, as measures of DQ/IQ can be unstable in the lower ranges, a lower bound of 20 were set for the lowest scorers.

Fine Motor and Nonverbal Cognition

Age equivalents of the MSEL subscales *fine motor* and *visual reception* at first visit were used in analysis as predictors in the regression model, as some participants scored outside the normed range and did not receive standard scores. Visual reception was used in the current study as a proxy of *nonverbal cognition*. However, as the other cognitive tests at first visit did not provide compatible subscales for *fine motor* and *visual reception*, the cases with other cognitive tests than MSEL were coded as missing on the predictor variables fine motor and nonverbal cognition.

Language

Both samples were assessed with Reynell Developmental Language Scales (RDLS) at first visit. The participants from UCLA received RDLS-III (Edwards et al. 1997) at first visit, and the OUS participants received a Norwegian translation of a previous version (Hagtvet and Lillestølen 1985). For those scoring below the fourth stanine on RDLS, MSEL scores were used to capture the full range and to account for floor effects on the RDLS (Charman et al. 2003). The language production section in RDLS is a measure of expressive language which taps into vocabulary and grammatical aspects of language production (Edwards et al. 1999). At last visit, the Expressive Vocabulary Test (EVT; Williams 1997) was administered (Norwegian translation for the OUH sample). Contrary to the RDLS, which is a broader measure of expressive language, EVT is a measure of expressive vocabulary, and does not measure the full complex construct of expressive language (Williams 1997). However, it has been frequently used in previous research on expressive language, since EVT and vocabulary size in general provides a reliable indication of expressive language level (Özçalışkan et al.

2016; Bottema-Beutel 2016). For participants with scores below the norm of the EVT at last visit, MSEL expressive language age equivalent scores were used.

Early Social Communication Scale

The Early Social Communication Scale (ESCS; Mundy et al. 2003; Seibert et al. 1982) was used to measure RJA. ESCS is a semi-structured test, where a tester introduces a child to a series of toys. The tester-child play interaction was videotaped and coded. To measure RJA, the tester provided bids to JA by pointing to posters on walls in the test room. The response was coded as successful if the child turned or looked at the poster. The ESCS has been shown to have good validity and reliability (Kasari et al. 2006; Mundy et al. 1994). As the two studies used different versions of the ESCS, a percentage of successful points to posters was calculated, to account for variation in number of trials provided.

Mother-Child Interaction

A mother-child play interaction with a duration of 10-15 minutes was recorded on video, where the participants received a set of toys and were told to play as they would normally do. The play sequence was coded for IJA and engagement states, according to Bakeman and Adamson (1984). Specifically, the interaction was duration coded for six mutually exclusive engagement states: Unengaged, on-looking, object engaged, person engaged, SJE and coordinated joint engagement (CJE). Only SJE and CJE were used for the purpose of this study. SJE was coded when the mother and child were attending to the same object, but where the child was not actively acknowledging the mother. CJE was characterized as an attention triad, a state where mother and child were attending to the same object as well as each other. The total duration of these two states were combined to a measure of JE, as done in previous studies (Kaale et al. 2018; Gulsrud et al. 2016; Shire et al. 2016). Since the total duration of the interaction differed in length, a percentage of time in JE of the total

interaction was calculated. The JA skills (i.e., point, show, give and alternating gaze between object and partner) were coded separately, and later combined into two measures: Alternating gaze as *IJA lower order*, and point, show and give as *IJA higher order.* Only child initiations were coded; initiations prompted verbally or by gestures of mother were excluded. To account for different lengths of video recorded interaction, the frequency of IJA was divided by total time in seconds and 60, multiplied by 10, to receive a measure of number of IJA per 10 minutes. Only IJA higher order was used as a predictor variable, since skills such as pointing or showing are thought to be more closely related to expressive language development compared to the lower order skill, alternating gaze (Charman et al. 2003; Gulsrud et al. 2014; Özçalışkan et al. 2016). Interrater reliability for coding of JE, IJA and RJA were measured separately for both studies (Kaale et al. 2012; Kasari et al. 2006).

Statistical Analysis

All data handling and analysis were performed using IBM SPSS 25 package. Only participants who returned for the last visit assessments and had valid scores on the outcome variable were included in the analysis ($N = 89$). First, descriptive statistics were performed using SPSS DESCRIPTIVES to describe the nature of the data, and to retrieve measures of central tendency, dispersion and distribution (de Vaus 2014). The variables included in the descriptive statistics were demographic information and sample characteristics, predictor variables, and the outcome variable.

Next, a bivariate analysis was conducted using Pearson's Correlation *r*, to assess the bivariate relationship between the variables included in the hierarchal regression analysis, and to screen for multicollinearity. In addition, statistics of Variance Inflation Factor (VIF) and tolerance were examined. To investigate how early social and individual factors predicted later expressive language, a hierarchal regression with two blocks of entry was performed

with *expressive language (last visit)* as a dependent variable. In order to be able to assess the predictive power of the variables, while controlling for initial expressive language, *expressive language (first visit)* was included in the first step. The variables *RJA, IJA, JE, fine motor* and *nonverbal cognition* were then added to the second step (Tabachnick and Fidell 2018). Finally, to adjust for age range at last visit, an additional regression analysis was preformed, adding *Chronological age (last visit)* as an additional control.

Results

Prior to running the regression analysis, the data was screened for *outliers* by graphical examination, examination of z-scores and Mahalanobis distance. Two multivariate outliers were detected using Mahalanobis distance with $p < .001$. The outliers were investigated further and were subsequently assumed to be part of the population of interest. In addition, no evidence of measurement error was found. Thus, the outliers were not excluded from further analysis. In addition, the data was screened for *homoscedasticity, normality, linearity* and *independence of residuals* through various programs in IBM SPSS 25. The variable IJA higher order showed extreme positive skew and kurtosis, and RJA showed strong negative kurtosis. Still, no transformations were made, to avoid hampering interpretation of the analysis (Tabachnick and Fidell 2018; Feng et al. 2014). The rest of assumptions for multivariate analysis were met. Further, the variables *nonverbal cognition, fine motor,* and *RJA* had missing values. The variables were screened using missing values analysis and were assumed to be missing completely at random. To avoid a substantial loss of cases, pairwise exclusion was used in the regression analysis (Tabachnick and Fidell 2018). Given six predictor variables in the regression analysis a total sample size of N=89 deemed adequate (Brace et al. 2006).

Table 3 displays the bivariate correlations between the predictor and outcome variables. First, a screen for multicollinearity revealed no evidence of violation of the assumption. Further, all predictor variables were significantly correlated with the outcome variable (r = .33–.70, p = .002 – > .001). As expected, *expressive language* at first and last visit were strongly correlated (r (87) = .70, p < .001). Moreover, the variables *fine motor,* (r (77) = .59, p < .001), *nonverbal cognition* (r (77) = .53, p < .001), and *RJA* (r (80) = .57, p < .001) showed the strongest relationship with expressive language at last visit. The variables *IJA* (r (87) = .33, p = .002) and *JE* (r (87) = .44, p < .001) were also moderately correlated with expressive language at last visit. Significant correlations were also found among the predictors, including concurrent expressive language. As expected, *fine motor* and *nonverbal cognition* were strongly correlated (r (77) = .82, p < .001). In addition, all measures of social communication and interaction (i.e., IJA, RJA and JE) were significantly intercorrelated.

[Insert Table 3 about here]

In the first step of the hierarchical regression analysis, *expressive language (first visit)* was added to the model, with *expressive language (last visit)* as the dependent variable. With only the control variable expressive language (first visit) included in the analysis, the model explained 49 % of the variance in expressive language at last visit (R^2 = .49*,* F (1, 72) = 70.425*,* p < .001). In the next step, the remaining predictor variables *fine motor, nonverbal cognition, IJA, RJA* and *JE* were added to the model. The final model added a significant increment in R^2, explaining an additional 10,8% of the variance in later expressive language after controlling for initial expressive language (R^2 *change* = .108*, F change* (5, 67) = 3.661*,* p = .005). Thus, resulting in a final model accounting for 60% of the total variance in expressive language at last visit (R^2 = .60*,* F (6, 67) = 16.957*,* p < .001). The results from the hierarchical regression analysis are presented in table 4.

[Insert Table 4 about here]

Apart from expressive language (first visit), only JE and fine motor emerged as significant predictors in the final model. The predictor that contributed most to the model apart from the control variable was fine motor (β = .332, p = .024). Early JE was the second strongest predictor of later expressive language (β = .251, p = .005). As expected, expressive language at first visit strongly predicted later expressive language (β = .490, p = .001). Although children's IJA (β = .091, p = .290), RJA (β = .073, p = .499) and nonverbal cognition (β = -.224, p = .134) showed a bivariate correlation with the outcome variable, these variables failed to reach significance in the regression analysis.

To account for the possible issue of the range in chronological age at last visit affecting expressive language outcome, an additional regression analysis was performed using chronological age (last visit) in months as a control. Chronological age (last visit) as an independent variable in the model did not have impact on the model predicting expressive language at last visit. In addition, it did not change the impact of the other predictors. Thus, strengthening the results of the initial regression analysis.

Discussion

This study investigated early predictors for later expressive language in children with ASD. A sample of 89 participants from Norway and USA were involved in the investigation of how various aspects of social communication and interaction, fine motor skills and nonverbal cognitive abilities at early age predicted expressive language abilities in late childhood. Combined, expressive language, JE, IJA, RJA, fine motor and nonverbal cognition at early age explained approximately three fifths of the variance in expressive language at late

childhood. In terms of the individual predictors, fine motor ability and duration in JE with mother during play session at early age significantly predicted expressive language in late childhood. Fine motor accounted for a larger part of the variance in later expressive language, compared to JE. However, the control variable (i.e., expressive language at first visit) contributed the most to the final model. These results are in accordance with some previous studies, stating that fine motor (Choi et al. 2018; LeBarton and Iverson 2013), JE (Bottema-Beutel et al. 2014; Adamson et al. 2009) and early expressive language (Sigman and McGovern 2005; Stone and Yoder 2001; Weismer and Kover 2015; Sigman et al. 1999) are associated with later expressive language in children with ASD.

Collectively, early expressive language, social communication and interaction, fine motor and nonverbal cognition explained a major part of the variance in expressive language at last visit. After the effect of initial expressive language was accounted for, the remaining predictors explained one tenth of the variance. This result suggest that the study have successfully identified important aspects that contribute to later expressive language. Still, it also suggest that there might be other factors that play an important role in expressive language development. As this study mainly focuses on traits of the individual, in addition to social interaction with a caregiver, other contextual factors may also have importance for language development, such as socioeconomic status (Weismer and Kover 2015) or intervention. In addition, gross motor skills may also contribute to expressive language development (Leonard et al. 2015).

The investigation of the bivariate relationship between the predictor and outcome variables, yielded interesting results. All included variables in the regression model were significantly correlated with both concurrent and subsequent expressive language. Although only early JE and fine motor predicted later expressive language in the regression model, all included

measures seem to have some relationship with expressive language. This could imply that IJA, RJA and nonverbal cognition has some role in expressive language development. All predictors of social communication and interaction were significantly intercorrelated, which could imply a relationship between these variables.

Consistent with previous research (Choi et al. 2018; LeBarton and Landa 2019; LeBarton and Iverson 2013), fine motor predicted later expressive language. Still, a novel finding is the longitudinal prediction of fine motor skills at early age on expressive language at late childhood. The reason why early fine motor predicts later expressive language is beyond the scope of this study, as we are still to find out why fine motor skills are important for language acquisition. However, some hypotheses have been introduced. One explanation could be that fine motor skills enable the child to explore the world by manipulating objects and engaging in play in ways that facilitate meaning construction and knowledge about objects properties (LeBarton and Landa 2019; Hellendoorn et al. 2015). Another explanation could be shared underlying brain mechanisms between some language and motor functions (LeBarton and Iverson 2013; Groen and Buitelaar 2011; Iverson and Thelen 1999). For example, activation in portions of Broca's area (a brain area which is central in language production and processing) has been found during motor tasks such as hand movement in typically developing individuals (Iverson and Thelen 1999). Still, these findings indicate that the association between fine motor and expressive language in ASD needs to be explored further, to be able to develop early interventions targeting appropriate areas important for expressive language development. In addition, the finding that early motor skills predict later expressive language could be helpful in assessing the long-term prognosis for preschool children with ASD.

Although nonverbal cognition was significantly correlated with last visit expressive language, it was not a significant predictor. These findings are in contrast to previous findings where nonverbal cognition (i.e. visual reception) was a predictor of expressive language (Luyster et al. 2008). The different findings may be linked to difference in age group and the fact that they only investigated concurrent predictors. In addition, Luyster et al. (2008) did not include fine motor in their regression model. As these measures are highly correlated, it may account for the discrepancy. The results from this study may indicate that visual reception is not a strong predictor of expressive language after its shared variance with fine motor is removed. Further, since a composite of MSEL fine motor and visual reception is often used as a measure of nonverbal cognition in the studies where nonverbal cognition predicted expressive language (Thurm et al. 2015), the results of the current study could indicate that fine motor abilities contributes more to the relationship between nonverbal cognition and expressive language than visual reception.

This study has investigated the unique contribution of different aspects of social interaction and communication to later expressive language. In contrast to previous studies (Edmunds et al. 2017; Stone and Yoder 2001; Sigman and McGovern 2005; Yoder et al. 2015), early RJA was not found to be a predictor of later expressive language. In addition, IJA did not predict expressive language. This is, however, consistent with previous studies, where IJA has failed to predict expressive language longitudinally (Sigman and McGovern 2005; Toth et al. 2006; Stone and Yoder 2001). However, among the variables measuring social interaction and communication, JE emerged as a significant predictor, strengthening the conclusions of previous research, stating that early JE plays an important role in language acquisition (Bottema-Beutel et al. 2014; Adamson et al. 2019; Adamson et al. 2009).

The results of the current study, comparing different aspects of social communication and interaction and their predictive effects on later expressive language, is particularly interesting. In the state of JE, mother and child are actively attending to the same object/activity and each other during a play session or social interaction. In comparison to the variables IJA and RJA measuring the individual's capacity of JA, JE is a dyadic measure involving parent's collaboration and interaction with the child (Bottema-Beutel 2016). JE being a significant predictor for expressive language in this study, could emphasize the importance of the child's ability of JA, but also the caregivers' role in play. Yoder et al. (2015) found that parental linguistic responses in child-parent play predicted language growth, in their study on minimally verbal children with ASD. Similar to JE, parental linguistic responses involve active caregiver engagement. Although these measures are not solely measures of parental involvement, since it requires child's engagement in activities and play (Adamson et al. 2009), these results emphasize the importance of parental involvement in child's activities and play for expressive language development. In other words, caregiver's active engagement, in terms of providing linguistic input on the activities and objects the child is engaged in, is an important facilitator when it comes to language acquisition. This is further supported by previous research, indicating that SJE may have a stronger impact on expressive language development compared to CJE (Bottema-Beutel et al. 2014; Adamson et al. 2009).

Developmental theories suggest that language is learned through socialization and shared experiences, and with scaffolding by a caregiver (Bakeman and Adamson 1984; Bottema-Beutel 2016). The results of this study could suggest that caregivers' role in facilitating language development weighs more than the child's ability to actively respond or initiate JA in terms of longitudinal expressive language outcome. However, for the child to be aware of the parents' verbal input, one can argue that some capacity of JA is required. As mentioned, these skills are often impaired in children with ASD (Adamson et al. 2009; Bottema-Beutel

2016). In addition, children with ASD are less likely to stay in states of JE (Adamson et al. 2009). On the basis of previous research and of RJA being moderately correlated with expressive language outcome in this study, the role of the individual's JA skills in language development should not be neglected.

A strength in the present study is the large sample size, compared to similar studies. In addition, few other studies have investigated the combined measures of JA and JE with fine motor and nonverbal cognition to assess their unique prediction of later expressive language. Moreover, the study provides a unique contribution to existing research, in terms of investigating how these early age predictors longitudinally predict expressive language into late childhood. In spite of these strengths, some limitations are to be considered. This study reports on data from one study that was concluded some time prior to the other. Thus, a limitation of this study could be that some of the data were collected approximately twenty years prior to the current study report. It could be assumed that data collected closer to current date could yield different results, for example due to improvement of standardized tests. In addition, although the report and merging of data were done in close collaboration with the researchers of the original studies, some information may have been lost over time. In terms of measurements, the use of different expressive language measures at first and last visit could weaken the construct validity. However, as this study uses data from two different studies, the same measures of expressive language from both timepoints were not available. Still, both EVT and RDLS provide an indication of expressive language (Tager-Flusberg et al. 2009; Williams 1997). Thus, it is considered unlikely that a consistent use of the same measure at both timepoints would yield vastly different results. Using MSEL for the low scorers could also be problematic, as MSEL measures other aspects of productive use of language at the early stages of language development, in addition to vocabulary (Mullen 1995). However, combining the measures was necessary to capture the full range of

expressive language functioning, and is a common procedure (Sigman and McGovern 2005; Thurm et al. 2007). Moreover, the measures have shown to be highly correlated with other measures of expressive language and to be robust indicators of expressive language (Williams 1997; Mullen 1995; Edwards et al. 1997; Hagtvet and Lillestølen 1985; Luyster et al. 2008; Nordahl-Hansen et al. 2014). Further, different versions of the ESCS were used to measure RJA across the two sites. The main difference in the test procedure between the two were six trials compared to eight, in UCLA sample and OUH sample, respectively. The difference was accounted for by using the percentage of successful responses, instead of frequency. The strength of the RJA measure is its highly structured form (Bottema-Beutel 2016), making it more robust for different examiners. For the IJA measure, however, the frequency of child's initiations could be more sensitive to the variation of toys available and the child's familiarity with these (Bottema-Beutel 2016). This is to be considered a threat to the reliability of the measure (Kleven 2002; Sattler 2008). This became evident in the investigation of the descriptive statistics, in terms of differences in IJA scores between the two sites. Therefore, the results from this measure should be interpreted with caution.

Clinical Implications and Further Research

The current study provides more insight into how early social communication and interaction, fine motor and nonverbal cognitive abilities relate to later expressive language in children with ASD. An important discovery was the predictive value of JE, compared to RJA and IJA. JE being a significant predictor for expressive language could indicate importance of developing early interventions targeting the child's JA skills, but also the relevance of helping parents to learn how to facilitate language development for their children and how to increase time in JE (Kaale et al. 2018). Previous intervention studies have investigated the effect of interventions targeting parents' responsiveness to communication acts in ASD (Venker et al. 2011; Shire et al. 2016). The results indicated that improving parent

responsiveness increased the children's frequency of prompted communication acts (Venker et al. 2011) and time in JE (Shire et al. 2016). The results of this study could suggest that such interventions may have importance for expressive language development.

In the current study, the measure of JE was a combined measure of CJE and SJE. Further research should study the role of JE into more discrete measures of JE, as proposed by Bottema-Beutel et al. (2014), to investigate in more detail which aspects of JE are important for later expressive language. In addition, further research should be conducted to assess the relationship between fine motor skills and expressive language, to explore why fine motor predicts expressive language. As the measure used the in current study does not distinguish between different processes involved in fine motor abilities, such as sensory, execution and planning aspects of fine motor abilities (Gowen and Hamilton 2013), further research need to examine how the different aspects affect language acquisition. Moreover, further knowledge is necessary to determine if targeting fine motor skills has an effect on language development.

The emerge of early JE, fine motor and expressive language as predictors for later expressive language, has further clinical implications: To help researchers and clinicians understand the underlying mechanisms of expressive language development, and to be able to assess the prognosis of later expressive language outcome in children early diagnosed with ASD by investigating these areas. In terms of external validity, the results can only be generalized to the population of children early diagnosed with childhood autism/autistic disorder without a history of severe CNS disorders or other medical cooccurring conditions. However, as the participants at last visit showed a large variability in terms of cognitive functioning and language level, the results could provide an indication of how social communication and

interaction, motor skills and nonverbal cognitive abilities at early age affect later expressive language in the broader population of children with ASD.

Compliance with Ethical Standards

The author declares no conflict of interest. The study was approved by the Regional Committees for Medical and Health Research Ethics. All procedures and data handling were according to the ethical rules, guidelines and standards of the University of Oslo, Oslo University Hospital, the national committees for research ethics and the 1964 Helsinki declaration and its later amendments. Written informed consent was obtained from the parents of all individual participants included in the study.

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Tables

Table 1 *Sample Characteristics Overall and Split by Site.*

	OUH (*n* = 50)		UCLA (*n* = 39)		Total (*N* = 89)	
	Mean (*SD*)	Range	Mean (*SD*)	Range	Mean (*SD*)	Range
CA (First visit)[a]	48.86 (8.7)	29-60	42.72 (6.9)	33-59	46.21 (8.6)	29-60
CA (Last visit)[a]	157.88 (13.4)	127-185	105.82 (7.4)	94-122	135.07 (28.3)	94-185
Gender *n (%)*						
Male	41 (82.0%)		32 (82.1%)		73 (82.0%)	
Female	9 (18.0%)		7 (17.9%)		16 (18.0%)	
DQ (First visit)[b]	56.85 (20.5)	20-105	55.02 (14.6)	26-90	56.05 (18.1)	20-105
IQ (Last visit)[c]	62.31 (30.5)	20-108	78.12 (30.5)	20-132	69.38 (31.3)	20-132
SES (Parental education)[d]	14.21 (2.8)	9-18	16.23 (1.6)	11-18	15.14 (2.5)	9-18
Child ethnicity *n (%)*[e]						
Black	2 (4.0%)		1 (2.6%)		3 (3.4%)	
White	38 (76.0%)		27 (69.2%)		65 (73.0%)	
Hispanic	0 (0%)		2 (5.1%)		2 (2.2%)	
Asian	6 (12.0%)		5 (12.8%)		11 (12.4%)	
Other	2 (4.0%)		4 (10.2%)		6 (6.7%)	
School (Last visit) *n (%)*[f]						
Reg. Ed.	1 (2.0%)		5 (12.8%)		6 (6.7%)	
Reg. Ed. + Spes. Ed.	16 (32.0%)		17 (43.6%)		33 (37.1%)	
Spes. Ed.	19 (38.0%)		18 (46.2%)		37 (41.6%)	
Other	1 (2.0%)		0 (0.0%)		1 (1.1%)	

[a] Chronological age in months.

[b] Developmental Quotient; calculated based on all four scales of MSEL.

[c] Intelligence Quotient; DAS/MSEL for UCLA sample and WASI/MSEL for OUH sample.

[d] Socioeconomic status; Combined measure of mean maternal and paternal education in no. of years.

[e] 2 missing.

[f] School type; Parent report. *Reg. Ed.* = Regular education; *Reg. Ed. + Spes. Ed.* = regular education with special education support; *Spes. Ed.* = special education classroom. 12 missing.

Table 2 *Descriptive Statistics for Predictor and Outcome Variables.*

	OUH (*n* = 50)		UCLA (*n* = 39)		Total (*N* = 89)	
	Mean (*SD*)	Range	Mean (*SD*)	Range	Mean (*SD*)	Range
Predictors (First visit)						
Expressive language[a]	21.64 (12.59)	3-60	20.05 (8.37)	7-38	20.94 (10.92)	3-60
JE[b]	45.59 (23.33)	2.33-89.46	65.79 (22.23)	4.89-98.11	54.44 (24.86)	2.33-98.11
RJA[c]	45.98 (38.39)	0-100	50.49 (39.24)	0-100	47.85 (38.57)	0-100
Nonverbal cognition[d]	32.80 (15.04)	7-66	24.70 (6.39)	14-46	29.72 (13.04)	7-66
Fine motor[e]	31.45 (10.97)	12-57	25.30 (5.05)	16-39	29.11 (9.62)	12-57
IJA[f]	1.08 (1.68)	0-8	3.26 (6.02)	0-22.84	2.03 (4.29)	0-22.84
Outcome (Last visit)						
Expressive language[g]	67.78 (35.77)	1-115	76.67 (33.24)	8-149	71.67 (34.77)	1-149

[a] Expressive language; RDLS age equivalent. Scores <4 stanine for 1.5 years based on MSEL.

[b] Joint Engagement; Combined measure of percent of time in coordinated joint attention and supported joint attention during 10-15 min play.

[c] Response to joint attention; ESCS. 7 missing.

[d] Age equivalent from visual reception scale; MSEL. 10 missing.

[e] Age equivalent from fine motor scale; MSEL. 10 missing.

[f] Initiation of joint attention; No. higher order initiations of joint attention (point, show or give) during 10 min play.

[g] Expressive language; EVT age equivalent. Raw scores below norm (raw <21) based on MSEL.

Table 3 *Pearson's Product-Moment Correlation Coefficient Matrix for Predictor and Outcome Variables*

	1	2	3	4	5	6
1. EL (Last visit)[a]						
2. EL (First visit)[b]	.703***					
3. JE[c]	.435***	.272**				
4. RJA[d]	.565***	.666***	.291**			
5. Nonverbal cognition[e]	.526***	.755***	.228*	.561***		
6. Fine motor[f]	.590***	.731***	.137	.567***	.820***	
7. IJA[g]	.328**	.232*	.374***	.278*	.109	.095

****p* < .001, ***p* < .01, **p* < .05*

[a] Expressive language; RDLS age equivalent. Scores <4 stanine for 1.5 years based on MSEL.

[b] Expressive language; EVT age equivalent. Raw scores below norm (raw <21) based on MSEL.

[c] Joint Engagement; Combined measure of percent of time in coordinated joint attention and supported joint attention during 10-15 min play.

[d] Response to joint attention; ESCS. 7 missing.

[e] Age equivalent from visual reception scale; MSEL. 10 missing.

[f] Age equivalent from fine motor scale; MSEL. 10 missing.

[g] Initiation of joint attention; No. higher order initiations of joint attention (point, show or give) during 10 min play.

Table 4 *Summary of Hierarchical Regression Analysis for Variables Predicting Expressive Language (N = 89)*

		Unstandardized coefficients		*Standardized coefficients*						
Step	Predictor	*B*	*SE B*	*β*	*p*	R^2	ΔR^2	R^2 *Change*	*F*	*p*
1						.49	.49	.49	70.43	.000***
	EL (First visit)[a]	2.25	.27	.703	.000***					
2						.60	.57	.11	3.67	.005**
	EL (First visit)[b]	1.57	.44	.50	.001***					
	JE[c]	0.35	0.12	.25	.005**					
	RJA[d]	0.07	0.10	.07	.499					
	Nonverbal cognition[e]	-0.60	0.40	-.22	.134					
	Fine motor[f]	1.21	0.52	.33	.024**					
	IJA[g]	0.75	0.70	.09	.290					

****p* < .001, ***p* < .01, **p* < .05*

[a] Expressive language; RDLS age equivalent. Scores <4 stanine for 1.5 years, based on MSEL.

[b] Expressive language; EVT age equivalent. Raw scores below norm (raw <21), based on MSEL.

[c] Joint Engagement; Combined measure of percent of time in coordinated joint attention and supported joint attention during 10-15 min play.

[d] Response to joint attention; ESCS. 7 missing.

[e] Age equivalent from visual reception scale; MSEL. 10 missing.

[f] Age equivalent from fine motor scale; MSEL. 10 missing.

[g] Initiation of joint attention; No. higher order initiations of joint attention (point, show or give) during 10 min play.

Author Note

Joakim Rudebjer, *Department of Special Needs Education, University of Oslo, Sem Sælands vei 7, 0371 OSLO, Norway.*

The following paper is a part of a master's thesis, which uses data from two earlier studies. Thus, no additional grants were received for the current study. Originally, the first study from Oslo University Hospital was supported by grants (no. 20005069) from South-Eastern Norway Regional Health Authority, Oslo University Hospital, Regional Center for Child and Adolescent Mental Syndrome and Narcolepsy. The study at University of California, Los Angeles was supported by grants from the Collaborative Program of Excellence in Autism (P01-35470), Autism Centers of Excellence (P50-HD-55784), and Health Resources and Services Administration (UA3MC11055). The author thanks the families and children for their participation in the studies.

Correspondence concerning this article should be addressed to corresponding author: Joakim Rudebjer, Badebakken 20, 0467 OSLO, rudebjer@gmail.com, +47 472 49 312.

Appendix B: Author instructions (Journal of Autism and Developmental Disorders)

Instructions for Authors

EDITORIAL PROCEDURE

Double-Blind Peer Review

MANUSCRIPT FORMAT

All JADD manuscripts should be submitted to Editorial Manager in 12-point Times New Roman with standard 1-inch borders around the margins.

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Text must be double-spaced; APA Publication Manual standards must be followed.

As of January 20, 2011, the Journal has moved to a double-blind review process. Therefore, when submitting a new manuscript, DO NOT include any of your personal information (e.g., name, affiliation) anywhere within the manuscript. When you are ready to submit a manuscript to JADD, please be sure to upload these 3 separate files to the Editorial Manager site to ensure timely processing and review of your paper:

A title page with the running head, manuscript title, and complete author information. Followed by (page break) the Abstract page with keywords and the corresponding

author e-mail information.
The blinded manuscript containing no author information (no name, no affiliation, and so forth).
The Author Note

TYPES OF PAPERS

Articles, Commentaries Brief Reports, Letters to the Editor

- The preferred article length is 20-23 double-spaced manuscript pages long (not including title page, abstract, tables, figures, addendums, etc.) Manuscripts of 40 double-spaced pages (references, tables and figures counted as pages) have been published. The reviewers or the editor for your review will advise you if a longer submission must be shortened.
- Special Issue Article: The Guest Editor may dictate the article length; maximum pages allowed will be based on the issue's page allotment.
- Commentary: Approximately 20-25 double-spaced pages maximum, with fewer references and tables/figures than a full-length article.
- A Brief Report: About 8 double-spaced pages with shorter references and fewer tables/figures. May not meet the demands of scientific rigor required of a JADD article – can be preliminary findings.
- A Letter to the Editor is 6 or less double spaced pages with shorter references, tables and figures.

Style sheet for Letter to the Editor:

- A title page with the running head, manuscript title, and complete author information including corresponding author e-mail information
- The blinded manuscript containing no author information (no name, no affiliation, and so forth):-

  - 6 or less double spaced pages with shorter references, tables and figures

  - Line 1: "Letter to the Editor"

  - Line 3: begin title (note: for "Case Reports start with "Case Report: Title")

  - Line 6: Text begins; references and tables, figure caption sheet, and figures may follow (page break between each and see format rules)

REVIEW YOUR MANUSCRIPT FOR THESE ELEMENTS

1. Order of manuscript pages

Title Page with all Author Contact Information & Abstract with keywords and the corresponding author e-mail information.

Blinded Manuscript without contact information and blinded Abstract, and References

Appendix

Figure Caption Sheet

Figures

Tables

Author Note

MANUSCRIPT SUBMISSION

Manuscript Submission

Submission of a manuscript implies: that the work described has not been published before; that it is not under consideration for publication anywhere else; that its publication has been approved by all co-authors, if any, as well as by the responsible authorities – tacitly or explicitly – at the institute where the work has been carried out. The publisher will not be held legally responsible should there be any claims for compensation.

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Please ensure you provide all relevant editable source files. Failing to submit these source files might cause unnecessary delays in the review and production process.

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The title page should include:

- The name(s) of the author(s)
- A concise and informative title
- The affiliation(s) and address(es) of the author(s)
- The e-mail address, telephone and fax numbers of the corresponding author

ABSTRACT

Please provide an abstract of 120 words or less. The abstract should not contain any undefined abbreviations or unspecified references.

KEYWORDS

Please provide 4 to 6 keywords which can be used for indexing purposes.

TEXT

Text Formatting

Manuscripts should be submitted in Word.

- Use a normal, plain font (e.g., 10-point Times Roman) for text.
- Use italics for emphasis.
- Use the automatic page numbering function to number the pages.
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- Use tab stops or other commands for indents, not the space bar.
- Use the table function, not spreadsheets, to make tables.
- Use the equation editor or MathType for equations.
- Save your file in docx format (Word 2007 or higher) or doc format (older Word versions).

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Please use no more than three levels of displayed headings.

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Abbreviations should be defined at first mention and used consistently thereafter.

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Footnotes can be used to give additional information, which may include the citation of a reference included in the reference list. They should not consist solely of a reference citation, and they should never include the bibliographic details of a reference. They should also not contain any figures or tables.

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Always use footnotes instead of endnotes.

Acknowledgments

Acknowledgments of people, grants, funds, etc. should be placed in a separate section on the title page. The names of funding organizations should be written in full.

BODY

- The body of the manuscript should begin on a separate page. The manuscript page header (if used) and page number should appear in the upper right corner. Type the title of the paper centered at the top of the page, add a hard return, and then begin the text using the format noted above. The body should contain:
- Introduction (The introduction has no label.)
- Methods (Center the heading. Use un-centered subheadings such as: Participants, Materials, Procedure.)
- Results (Center the heading.)
- Discussion (Center the heading.)

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Level 1: Centered

Level 2: Centered Italicized

Level 3: Flush left, Italicized

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Center the label “Footnotes” at the top of a separate page. Footnotes can be used to give additional information, which may include the citation of a reference included in the reference list. They should not consist solely of a reference citation, and they should never include the bibliographic details of a reference. They should also not contain any figures or tables.

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AUTHOR NOTE

The first paragraph contains a separate phrase for each author's name and the affiliations of the authors at the time of the study (include region and country).

The second paragraph identifies any changes in the author affiliation subsequent to the time of the study and includes region and country (wording: "authors name is now at affiliation".)

The third paragraph is Acknowledgments. It identifies grants or other financial support and the source, if appropriate. It is also the place to acknowledge colleagues who assisted in the study and to mention any special circumstances such as the presentation of a version of the paper at a meeting, or its preparation from a doctoral dissertation, or the fact that it is based on an earlier study.

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Please always use internationally accepted signs and symbols for units (SI units).

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Generic names of drugs and pesticides are preferred; if trade names are used, the generic name should be given at first mention.
Please use the standard mathematical notation for formulae, symbols etc.:

Italic for single letters that denote mathematical constants, variables, and unknown quantities

Roman/upright for numerals, operators, and punctuation, and commonly defined functions or abbreviations, e.g., cos, det, e or exp, lim, log, max, min, sin, tan, d (for derivative)

Bold for vectors, tensors, and matrices.

REFERENCES

Citation

Cite references in the text by name and year in parentheses. Some examples:

Negotiation research spans many disciplines (Thompson 1990).
This result was later contradicted by Becker and Seligman (1996).
This effect has been widely studied (Abbott 1991; Barakat et al. 1995; Kelso and Smith 1998; Medvec et al. 1999).

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The list of references should only include works that are cited in the text and that have been published or accepted for publication. Personal communications and unpublished works should only be mentioned in the text. Do not use footnotes or endnotes as a substitute for a reference list.

Reference list entries should be alphabetized by the last names of the first author of each work.

- Journal article

Harris, M., Karper, E., Stacks, G., Hoffman, D., DeNiro, R., Cruz, P., et al. (2001). Writing labs and the Hollywood connection. Journal of Film Writing, 44(3), 213–245.

- Article by DOI

  Slifka, M. K., & Whitton, J. L. (2000) Clinical implications of dysregulated cytokine production. Journal of Molecular Medicine, https://doi.org/10.1007/s001090000086

- Book

  Calfee, R. C., & Valencia, R. R. (1991). APA guide to preparing manuscripts for journal publication. Washington, DC: American Psychological Association.

- Book chapter

  O'Neil, J. M., & Egan, J. (1992). Men's and women's gender role journeys: Metaphor for healing, transition, and transformation. In B. R. Wainrib (Ed.), Gender issues across the life cycle (pp. 107–123). New York: Springer.

- Online document

  Abou-Allaban, Y., Dell, M. L., Greenberg, W., Lomax, J., Peteet, J., Torres, M., & Cowell, V. (2006). Religious/spiritual commitments and psychiatric practice. Resource document. American Psychiatric Association. http://www.psych.org/edu/other_res/lib_archives/archives/200604.pdf. Accessed 25 June 2007.

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EndNote style (zip, 3 kB)

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- All tables are to be numbered using Arabic numerals.
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- Identify any previously published material by giving the original source in the form of a reference at the end of the table caption.
- Footnotes to tables should be indicated by superscript lower-case letters (or asterisks for significance values and other statistical data) and included beneath the table body.

Each table should be inserted on a separate page at the back of the manuscript in the order noted above. A call-out for the correct placement of each table should be included in brackets within the text immediately after the phrase in which it is first mentioned. Copyright permission footnotes for tables are typed as a table note.

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- Name your figure files with "Fig" and the figure number, e.g., Fig1.eps.

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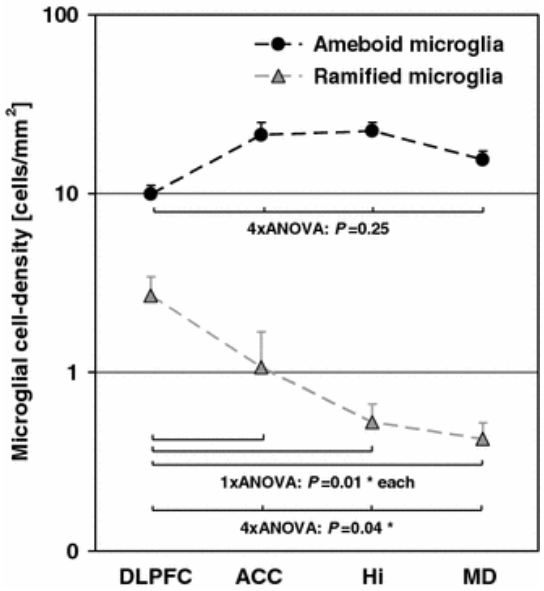

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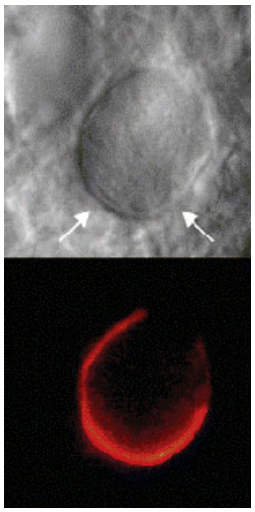

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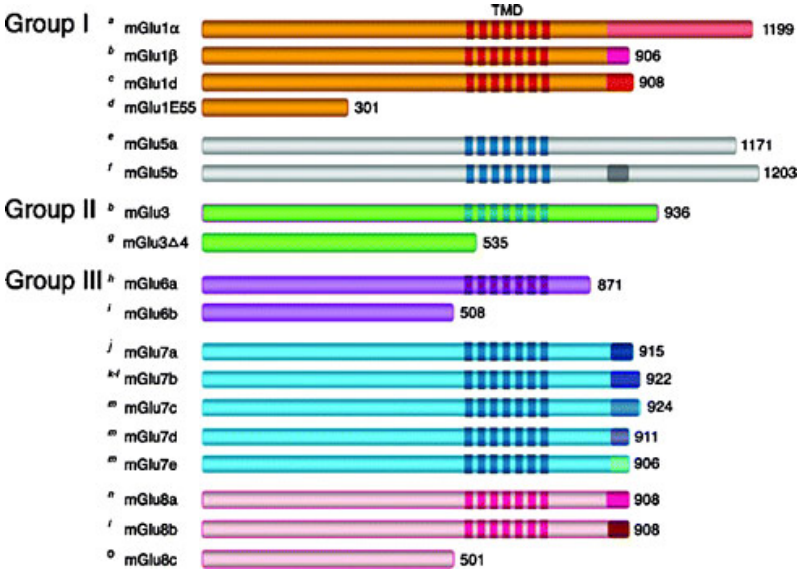

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Color art is free of charge for online publication.
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Name the files consecutively, e.g. “ESM_3.mpg”, “ESM_4.pdf”.

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Disclosure of potential conflicts of interest
Research involving Human Participants and/or Animals
Informed consent

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If articles do not contain studies with human participants or animals by any of the authors, please select one of the following statements:

"This article does not contain any studies with human participants performed by any of the authors."

"This article does not contain any studies with animals performed by any of the authors."

"This article does not contain any studies with human participants or animals performed by any of the authors."

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The following statement should be included:

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If identifying information about participants is available in the article, the following statement should be included:

“Additional informed consent was obtained from all individual participants for whom identifying information is included in this article.”

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Appendix C: Approval REK

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Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK sør-øst	Hege Cathrine Finholt, PhD	22857547	17.12.2018	2015/1268/REK sør-øst D
			Deres dato:	Deres referanse:
			07.12.2018	

Vår referanse må oppgis ved alle henvendelser

Anett Kaale
Oslo universitetssykehus

2015/1268 Utvikling og tiltak for barn med autismespekterforstyrrelse: 3-13 år

Forskningsansvarlig: Oslo Universitetssykehus
Prosjektleder: Anett Kaale

Vi viser til søknad om prosjektendring datert 07.12.2018 for ovennevnte forskningsprosjekt. Søknaden er behandlet av leder for REK sør-øst D på fullmakt, med hjemmel i helseforskningsloven § 11.

Endringene innebærer:

Nye prosjektmedarbeidere: Joakim Rudebjer, [redacted]
Nye analyser av innsamlete prosjektdata: De nye prosjektmedarbeiderne er masterstudenter og skal bruke de innsamlete prosjektdataene i sine respektive masteroppgaver. Prosjektbeskrivelse til hver masteroppgave er vedlagt søknaden. Masteroppgavene faller innenfor prosjektets opprinnelige formål.

Vurdering
REK har vurdert søknaden og har ingen forskningsetiske innvendinger til endringen av prosjektet.

Vedtak
REK har gjort en forskningsetisk vurdering av endringene i prosjektet, og godkjenner prosjektet slik det nå foreligger, jf. helseforskningsloven § 11.

Vi gjør samtidig oppmerksom på at etter ny personopplysningslov må det også foreligge et behandlingsgrunnlag etter personvernforordningen. Det må forankres i egen institusjon.

Klageadgang
REKs vedtak kan påklages, jf. forvaltningslovens § 28 flg. Eventuell klage sendes til REK sør-øst D. Klagefristen er tre uker fra du mottar dette brevet. Dersom vedtaket opprettholdes av REK sør-øst D, sendes klagen videre til Den nasjonale forskningsetiske komité for medisin og helsefag for endelig vurdering.

Vi ber om at alle henvendelser sendes inn på korrekt skjema via vår saksportal: http://helseforskning.etikkom.no. Dersom det ikke finnes passende skjema kan henvendelsen rettes på e-post til: post@helseforskning.etikkom.no.

Vennligst oppgi vårt referansenummer i korrespondansen.

Besøksadresse: Gullhaugveien 1-3, 0484 Oslo
Telefon: 22845511
E-post: post@helseforskning.etikkom.no
Web: http://helseforskning.etikkom.no/

Med vennlig hilsen

Finn Wisløff
Professor em. dr. med.
Leder

Hege Cathrine Finholt, PhD
Rådgiver

Kopi til: *odd.bakken@ous-hf.no; nikari@ous-hf.no; oushfdlgodkjenning@ous-hf.no*

Appendix D: Consent form, OUH first visit

Samtykkeerklæring

Samtykke til deltakelse:
Jeg/vi har mottatt skriftlig informasjon om undersøkelsen "Effekt av å trene felles oppmerksomhetsferdigheter hos småbarn med autisme – en randomisert og kontrollert behandlingsstudie" og vil med dette meddele at vi samtykker i å delta i undersøkelsen.

Dato: ……...Signatur: ……..……

Barnets navn: ……..…… **Fødselsdato**:……..……

Mors navn:	**Far navn**:
…… ……	……..
Adresse: ……..	Adresse: ……..
……	……
Tlf: ……. …….	Tlf: ……. …….
Mobli: …….	Mobli: …….
E-post: …….	E-post: …….

Samtykke til å innhente og benytte informasjon:
Jeg/vi samtykker i at Anett Kaale, Eili Sponheim og Lars Smith som driver udersøkelsen "Effekt av å trene felles oppmerksomhetsferdigheter hos småbarn med autisme – en randomisert og kontrollert behandlingsstudie" får tillatelse til å benytte informasjon om vårt barn innhentet ved diagnostisk utredning ved:

……..
(skiv inn navn på tjenesten som har utredet og diagnostisert barnet)

Dato: ……...Signatur: ……..……

Barnehage
Går barnet i barnehagen (sett kryss) Ja …….. Nei ……. Begynner (dato) ……

Fulltid…….
Deltid……..

Navn på barnehagen: ……..……

Adresse til barnehagen: ……...
……...

Samtykkeerklæringen sendes til
Anett Kaale, Klinikk for psykisk helse – barn og ungdom, Postboks 26 Vinderen, 0319 Oslo

Appendix E: Consent form, OUH last visit

ASF:2-14

Oslo universitetssykehus

Samtykkeerklæring til deltakelse i forskningsprosjektet: ASF: 2-14

«Barn med autismespekterforstyrrelse (ASF): utvikling og tiltak fra tidlig førskole- til skolealder»

I.

Som foresatte til_____ ___ (fullt navn)
samtykker jeg/vi til at han/hun kan delta i oppfølgingsstudien ASF: 2-14.

Sted og dato	Foresattes signatur
	Foresattes navn med trykte bokstaver
Sted og dato	Foresattes signatur
	Foresattes navn med trykte bokstaver

II.

Deling av avidentifisert* informasjon med andre forskningsinstitusjoner i inn- og utlandet:
(sett kryss ved alternativ A eller B)

Jeg/vi samtykker til at avidentifisert informasjon om barnet kan deles

med andre forskningsinstitusjoner i inn- og utlandet — Ja, samtykker ◯

Nei, samtykker IKKE ◯

*Avidentifisert informasjon = informasjon som ikke kan knyttes til det enkelte barnet

III.

A. Jeg/vi samtykker til innhenting diagnostisk informasjon fra spesialisthelsetjenesten — Ja, samtykker ◯

Nei, samtykker IKKE ◯

B. Jeg/vi samtykker til innhenting informasjon om sakkyndige vurderinger,

enkeltvedtak og skolefaglige kartlegginger fra kommunen — Ja, samtykker ◯

Nei, samtykker IKKE ◯

Vi presiserer at det er mulig å krysse av for nei på ett eller flere av punktene over og allikevel være med i oppfølgingsstudien.
Vedlagt er et kontaktinformasjonsskjema som vi ønsker at dere vil fyller ut for å sikre at vi har oppdatert informasjon.

ASF:2-14

Oslo universitetssykehus

Ønske om å bidra til forskningsprosjektet: ASF: 2-14

«Barn med autismespekterforstyrrelse (ASF): utvikling og tiltak fra tidlig førskole- til skolealder»

I.
Elevens fulle navn: _____

Skolen er positive til å bidra til ASF: 2-14 ◯

Skolen ønsker IKKE å bidra til ASF: 2-14 ◯, skriv gjerne hvorfor:

II.
Bekreftelse fra lærer, støttepedagog, assistent el. andre.

Jeg bekrefter at jeg ønsker å bidra til oppfølgingsstudien ASF: 2-14:

Navn med trykte bokstaver

Telefonnummer E-postadresse

Rolle i forhold til eleven (lærer, støttepedagog, assisten, annet)

Navn på skolen

Skolens postadresse

Sted og dato signatur

Jeg tror jeg kan få til å være med på undersøkelsesdagen ◯
(ingen forpliktelse før vi har avtalt nærmere)

Jeg tror det kan bli vanskelig å få til å være med på undersøkelsesdagen, men vil forsøke ◯

Jeg tror vi skal få til å fylle ut spørreskjemaet ◯

Jeg tror det kan bli vanskelig å få til å fylle ut spørreskjemaet, men vil forsøke ◯

III.
Rektors signatur:

Sted og dato signatur

Appendix F: Information and consent form, UCLA last visit

University of California, Los Angeles
CONSENT TO PARTICIPATE IN RESEARCH

Longitudinal Follow-up and Extension of Joint Attention Intervention

- **INTRODUCTION**

You and your child are asked to participate in a research study conducted by Dr. Connie Kasari, Ph.D., from the Graduate School of Education at the University of California, Los Angeles. You were selected as a possible participant in this study because you and your child participated in an earlier study "Experimental manipulation of communication in autism" with Dr. Kasari, Dr. S. Freeman, and Dr. Paparella. This study is a follow-up study to your previous participation, and will involve a number of developmental assessments. You and your child are being asked to participate because your child was assessed and received intervention in our early study. We are interested in examining longer-term effects of the intervention and how your child has developed skills.

You and your child's participation is VOLUNTARY. The decision whether or not to participate will not affect you or your child's access to health care or other services at UCLA, or other NPI staff.

- **PURPOSE OF THE STUDY**

This research project will study the long-term effectiveness of interventions aimed at changing core deficits in young children with autism. More specifically, the study will assess your child's current developmental strengths and weaknesses and compare current abilities with previous assessments that your child received while in our research program.

- **PROCEDURES**

If you volunteer to participate in this study, your child will receive the following assessments:

- Autism Diagnostic Observation Schedule (ADOS). This observational tool will be used as a means of determining the extent to which your child continues to meet research criteria for autism. Some examples of the skills the Schedule focuses on include how often children give unsolicited information about themselves, how children look at the adults in the room, and how children show emotion.
- Reyenell Developmental Language Scales, or the Clinical Evaluation of Language Fundamentals (CELF)-preschool depending on the language level of your child. Your child might be asked to describe a picture, follow directions such as, "put the smallest red pencil in the box," or describe what "hot" means.

Date of Preparation:
UCLA IRB Number:
Expiration Date:

HS-3 (1/98)

- Mullen Scales of Early Learning, WPPSI (from 3 to 6 years), or WISC-III (6 years and older). These assessments yield a developmental score for general cognitive abilities.
- Early Social Communication Scales (ESCS). This assessment will be used as a means of examining your child's use of gestures and language to communicate. Thus, as your child is presented with certain toys and exciting materials, we would score how often your child points, uses eye contact, or talks with the experimenter about the items.
- Structured Play Assessment (SPA). This assessment will be used as a means of examining your child's ability to play functionally and symbolically with toys. For example, your child might receive figures and furniture and we would examine how your child plays with those toys.
- Imitation and Theory of Mind Tasks. These assessments measure your child's ability to imitate and take another persons' perspective, respectively. In terms of imitation, your child might watch an adult sniff a flower, we would give the flower to your child, and observe what they do with it. In terms of taking another persons' perspective, we might present your child with information that others don't know – ask how they think the other would respond given new information.

If you volunteer to participate in this study, you will be asked to participate in the following interviews and questionnaires:

- Autism Diagnositic Interview-Revised (ADI-R). This parent interview is a source of determining the extent to which your child meets research criteria for autism.
- The Parenting Stress Index (PSI). This questionnaire is used to obtain a measure of family stress regarding yourself and your child.
- The Teacher Assessment of Social Behaviors. This questionnaire is used to examine your child's peer social behaviors. You will be asked to complete this form as parents can complete this form as well as teachers. You will also be asked to ask your child's teacher to complete this questionnaire. You will be asked to give the teacher this questionnaire with your child's name on it, and a self-addressed stamped envelope so the teacher may return the questionnaire by mail to the researchers. This will enable the teacher to remain anonymous. Items on this assessment include questions about how often your child plays with other children, what they do when they play, and how they approach other peers.
- Intervention History form. This questionnaire examines the type and amount of intervention your child has received.

Testing session will take approximately 2 and 1/2 hours and will all take place at the laboratory at UCLA/NPI. This can be done in one visit or two visits. The ADOS takes approximately 45 minutes, the developmental and language scales together take approximately 1 hour. The ESCS, SPA, and Imitiation/Theroy of Mind take approximately 45 minutes. The ADI-R can be carried out with you in one hour while your child participates in the developmental assessments. You will receive the forms prior to your arrival and can complete them at home or complete them in the other one

- **PARTICIPATION AND WITHDRAWAL**

You (and your child, if appropriate) can choose whether to be in this study or not although your child cannot choose to be in this study without you. If you and your child volunteer to be in this study, you both may withdraw at any time without any consequences. You and your child may also refuse to answer any questions you don't want to answer and still remain in the study.

- **IDENTIFICATION OF INVESTIGATORS**

If you have any questions or concerns about the research, please feel free to contact Connie Kasari, Ph.D., Graduate School of Education, University of California, Los Angeles, 1029 Moore Hall, Los Angeles, California 90095, (310) 825-8342.

- **RIGHTS OF RESEARCH SUBJECTS**

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact the Office for Protection of Research Subjects, 2107 Ueberroth Building, UCLA, Box 951694, Los Angeles, CA 90095-1694, (310) 825-8714.

SIGNATURE OF RESEARCH SUBJECT

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to have my child participate in this study. I have been given a copy of this form.

_____
Name of Child

_____
Name of Parent

_____ _____
Signature of Parent Date

I understand the procedures described above. My questions have been answered to my satisfaction and I agree to also participate in this study. I have been given a copy of this form.

_____
Name of Parent

_____ _____
Signature of Parent Date

Date of Preparation: 8/29/01
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Expiration Date:

HS-3 (1/98)

and one half hours of assessments. You will receive a detailed letter describing your child's developmental strengths and weaknesses.

- **POTENTIAL RISKS AND DISCOMFORTS**

No risks are anticipated for your child from this study, although it is possible that your child may have a negative reaction to some of the assessment measures. If this should occur, that particular assessment will be stopped.

No risks are anticipated for you in this study, although it is possible that you might become distressed or upset as a result of some of the items on the Parenting Stress Index. If this should occur, you may either skip the distressing items or discontinue the completion of the form. If you feel extremely distressed as a result of this Index, we can also provide referrals to parent support groups and parent counselors that are familiar with families of children with autism.

- **POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY**

You will benefit from the assessments in that you will receive detailed information about your child's cognitive, language, and communication skills both currently and in comparison to the last assessments s/he received with us.

The results of this study may benefit society in that your child's current strengths build our knowledge of the effectiveness of our previous intervention. We may be able to determine what child characteristics fit best with our intervention to yield long term positive results. Benefits that you and your own child derive from the study may lead to greater benefits for all children with autism as we translate our research findings into educational practice.

- **CONFIDENTIALITY**

Any information that is obtained in connection with this study and that can be identified with you or your child will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be maintained by removing all names from any records that are kept by the research staff, and all data files will be maintained in locked cabinets. Videotapes will not be destroyed, instead they will be stored confidentially.

As part of the study, your child will be videotaped during the assessment sessions. You may review these videotapes at any time. The videotape will be used for teaching and/or research purposes only. Your child's name will not be disclosed. You have the right to refuse to have the tape used for educational purposes. You have the right to review, edit, or erase the research tape of your child's participation in the research study in whole or part.

Date of Preparation: 8/29/01
UCLA IRB Number:
Expiration Date:

HS-3 (1/98)

Appendix G: Information to parents, OUH first visit

ULLEVÅL universitetssykehus
Klinikk for psykisk helse – Barn og Ungdom
Forskningsenheten

Regionsenter for barn og unges psykiske helse
Helseregion ØST og SØR

R.BUP

Til foreldre

Invitasjon til deltakelse i forskningsprosjekt;

Effekt av å jobbe med utvikling av felles oppmerksomhet hos småbarn med autisme

Barn med autisme har store vansker med å dele oppmerksomhet om et objekt eller en hendelse med andre mennesker. Disse vanskene er sentrale i utviklingen av deres kommunikasjons- og samspillsproblemer. I forskningsprosjektet vil vi undersøke effekten av en behandlingsmetode som fokuserer på utvikling av barnas felles oppmerksomhet. I løpet av 2006, 2007 og 2008 vil vi rekruttere 60 to-fire år gamle barn med autisme fra Øst- og Vestlandet til undersøkelsen. Vi inviterer dere til å delta i studien.

Hva innebærer det å være med i forskningsprosjektet
Har behandlingen av felles oppmerksomhet effekt? For å kunne få vite det, er det nødvendig å sammenligne to grupper av barn med autisme; en som får og en som ikke får behandling. Fordelingen til behandlingsgruppen eller kontrollgruppen vil trekkes tilfeldig av en computer. Alle barna, både de som kommer i kontrollgruppen og de som kommer i intervensjonsgruppen, skal fortsette med sitt ordinære barnehagetilbud gjennom hele studieperioden. Barna som trekkes til behandlingsgruppen får felles oppmerksomhetsbehandling i barnehagen i tillegg til sitt vanlige tilbud. Deltakelse i undersøkelsen forutsetter at også barnehagen er positiv til å være med. Vi tar kontakt med barnehagen når vi vet om dere ønsker å være med. Fordelingen til gruppene gjøres først etter at både foreldrene og barnehagen har sakt ja til å delta.

Alle barna som blir med i prosjektet, uansett gruppe de kommer i, skal testes grundig i forhold til språkfunksjon, sosial kommunikasjon og generell fungering. Vi vil gjennomføre fire testrunder; den første med en gang barnet blir med i studien, den andre etter ca. 10 uker, den tredje etter ½ år og den fjerde etter 1 år. Testene vil utføres av erfarne fagpersoner tilknyttet forskningsprosjektet, i lokaler i deres hjemfylke. Etter at vi har testet barnet første og siste gang vil vi skrive en rapport som oversendes foreldrene, med kopi til hjelpeapparatet dersom foreldrene ønsker det. Før hver testrunde vil vi sende barnehagen et spørreskjema som omhandler barnets sosial kommunikasjon og språk.

Første testrunde er den mest omfattende og vil strekke seg over en dag. De resterende testrundene forventes å ta fra 2-4 timer. Det vil ta om lag en time å fylle ut spørreskjemaene. Det er fint om både foreldrene og en fra barnehagen kan følge barnet til testing. Vi ønsker også å ta et kort videoopptak av mor og barnet og barnehagepersonalet og barnet i vanlig lek.

Hvis barnet deres kommer i behandlingsgruppen vil en ansatt i barnehagen med spesielt ansvar for deres barn, få opplæring i metoden. Deretter starter felles oppmerksomhetsbehandlingen. Behandlingen er basert på lystbetont lek og samspill mellom voksen og barn, og vil gjøres i barnehagen i to økter á 20 minutter pr dag over en periode på 8 uker med ukentlig veiledning fra spesialisthelsetjenesten. For å følge prosessen vil behandlingen filmes en gang pr uke.

Prosjekt:
Effekt av å trene felles oppmerksomhet hos småbarn med autisme – en randomisert og kontrollert behandlingsstudie

Prosjektleder:
Dr.med Eili Sponheim

Kontaktperson:
Anett Kaale
tlf: 984 72 132
anett.kaale@r-bup.no

Tlf sentralbord:
23 49 21 00
Fax:
23 49 23 02

Besøksadresse/ Postadresse:
Sognsvannsveien 63
Postboks 26 Vinderen
0319 Oslo

Om vi finner at behandlingen har en positiv effekt skal alle barna som kommer i kontroll-gruppen gis det samme eller et tilsvarende behandlingstilbud etter at studien er avsluttet.

Informasjon om diagnostisk utredning
I forbindelse med analyser og publisering av resultater av undersøkelsen trenger vi informasjon om deltakerbarnas diagnose. Vi ber derfor om samtykke til å innhente resultater fra vurderinger knytte til avklaring av barnets autismediagnose.

Frivillighet
Det er selvsagt helt frivillig å delta i prosjektet. Om dere samtykker til å være med kan dere på hvilket som helst tidspunkt trekke dere fra undersøkelsen og kreve at alle opplysninger, inkludert videoopptak, slettes, uten å måtte begrunne dette nærmere. Hvorvidt dere velger å delta i forskningsprosjektet eller ikke får ingen betydning for deres videre kontakt med hjelpeapparatet eller for barnets barnehagetilbud.

Taushetsplikt
Prosjektgruppen består av stipendiat Anett Kaale, dr. med Eili Sponheim og professor Lars Smith. Det er ingen andre enn oss som får tilgang på de personidentifiserbare opplysningene. Vi er alle underlagt taushetsplikt og opplysningene vil bli behandlet strengt konfidensielt. I en hver sammenheng der resultatene diskuteres med andre enn barnets foreldre eller barnehage-personalet, vil data anonymiseres slik at det ikke er mulig å gjenkjenne det enkelte barn.

Mot slutten av prosjektperioden (november 2009) vil vi spørre om deres samtykke til at vi fortsetter å lagre informasjon og videofilmer av barnet med tanke på en senere oppfølging. Om dere ikke ønsker videre lagring, vil testmateriellet bli anonymisert og videoopptak slettet ved prosjektslutt (31.12.2009). Undersøkelsen er tilrådd av personvernombudet ved Ullevål Universitetssykehus og Regional komité for medisinsk forskningsetikk.

Deres rettigheter
Hvis dere sier ja til å delta i studien, har dere rett til å få innsyn i hvilke opplysninger som er registrert om barnet. Dere har også rett til å få rettet eventuelle feil i opplysningene vi har registrert.

Ansvarlig for undersøkelsen
Undersøkelsen drives av dr. med Eili Sponheim, forskningskoordinator ved Senter for psykisk helse – barn og Ungdom, Ullevål Universitetssykehus, professor Lars Smith ved Psykologisk institutt, UIO, professor Berit Grøholt ved Institutt for psykiatri, UiO og stipendiat cand. ed Anett Kaale ved Ullevål Universitetssykehus og Regionsenter for barn og unges psykiske helse.

Skriftlig samtykkeerklæring
Dersom dere ønsker å delta i undersøkelsen må dere signere og fylle ut samtykkeerklæringen og sende den til oss i vedlagt frankert svarkonvolutt så snart som mulig.

Spørsmål kan rettes til Anett Kaale, tlf. 23492100/98472132 eller e-post: anett.kaale@r-bup.no.

Med hilsen,

Eili Sponheim
Forskningskoordinator dr. med
Klinikk for psykisk helse - barn og ungdom, UUS

Anett Kaale
Cand. ed/stipendiat
Klinikk for psykisk helse - barn og ungdom, UUS
og
Regionsenter for barn og unges psykiske helse

Appendix H: Information to parents, OUH last visit

Oslo universitetssykehus

ASF:2-14

Forespørsel om deltakelse i forskningsprosjekt

Kjære tidligere deltaker i studien «Effekt av å trene felles oppmerksomhet hos små barn med autisme—en randomisert og kontrollert studie».

Det har gått 6-7 år siden vi møttes sist, og vi gjerne invitere deres barn og dere til å delta i en oppfølgingsstudie.

Studien har vi kalt «Barn med autismespekterforstyrrelse (ASF): utvikling og tiltak fra tidlig førskole- til skolealder» - eller **ASF: 2-14**.

Formålet med ASF: 2-14 er å få mer kunnskap om:

- hvordan barna har utviklet seg fra førskolealderen og frem til nå
- langtidseffekt av tidlige tiltak
- tiltak i skolen

På de neste sidene kan dere lese mer om bakgrunn for studien, hva det innebære og delta, hvilke informasjon vi ønsker å innhente, frivillighet og personvern. Vedlagt er et samtykkeskriv som dere må fylle ut og sende inn om dere ønsker at barnet skal delta studien.

Hvem inviteres til å delta?

ASF: 2-14 er en oppfølgingsstudie av barna som tidligere deltok i intervensjonsstudien «Effekt av å trene felles oppmerksomhet hos små barn med autisme: en randomisert og kontrollert studie». Barna var 2-4 år da de ble med i studien. De er nå 10-14 år gamle.

Alle som deltok i intervensjons-studien inviteres til å være med; både de som har omfattende vansker og de som har små eller kanskje ingen problemer.

Bakgrunn og hensikt

For å gi bedre og mer individualisert hjelp til barn med ASF og deres familier, trenger vi mer kunnskap om barnas utvikling over tid, hva som bidrar til ulike utviklingsforløp, tilrettelegging og tiltak i skolen og langtidseffekt av tidlige tiltak.

Vi ønsker å innhente oppdatert informasjon om alle barna som deltok i intervensjonsstudien, og se denne i sammenheng med informasjonen vi har fra da barna var små. Slik kan vi lære mer om de viktige forholdene.

Hva innebærer det å delta?

Full deltakelse i ASF:2-14 innebærer at 1) barnet er med på en undersøkelse (noen tester og observasjoner), 2) foreldre og 3) en fra skolen fyller ut et spørreskjema.

Det er selvfølgelig fint om dere deltar på hele oppfølgingsstudien, men vi forstår om det ikke er mulig. Derfor kan dere være med på deler (f. eks. at dere eller skolen fyller kun ut et spørreskjema, at dere ikke fyller ut spørreskjema, men er med på hele eller deler av undersøkelsen, osv).

Organisering av undersøkelsen er fleksibel. Den kan gjøres på dag- eller ettermiddagstid, evt. i helgen, i løpet av vinter/vår 2016 (evt. høst 2016), ved spesialisthelsetjenesten, skolen eller hjemme hos dere. Om dere ønsker det kan en fra skolen møte sammen med barnet. Under er mer informasjon om undersøkelsen og spørreskjema.

Som en takk til deltakerfamiliene og barnas lærere, støttepedagoger og assistenter arrangerer vi et seminar høsten 2016 (kostnadsfritt) der erfarne fagpersoner fra ASF-feltet vil snakke om tilrettelegging i skolen og presentere resultater fra ASF:2-14.

Alle som deltar i studien er også med i trekningen av to valgfrie gavekort på 4000,-.

Undersøkelsen og spørreskjema

Undersøkelsen: Barnet kan komme til undersøkelsen med

foreldre og/eller en fra skolen. Vi er særlig opptatt av å forstå språk, kognisjon og sosial fungering. Derfor vil vi gjerne gjøre noen tester og observasjoner av barna, samt at vi ønsker å videofilme dem i en aktivitet (f. eks bygging, tegning) med en av foreldrene og/eller en fra skolen Alle testene er aktivitets- og lekebaserte og vil ikke medføre ubehag for barnet. De tilpasses barnets utviklingsnivå. Om barnet er med på hele undersøkelsen vil det ta ca. 3 timer. Barna får velge en gave eller et gavekort som takk for deltakelsen. Testene og observasjonene vil bli gjort av personer med kompetanse på undersøkelse av barn og ungdom.

Fordi mange barn og ungdom med ASF trenger struktur og forutsigbarhet tar vi gjerne imot råd fra dere og evt. barnets lærer, om hvordan vi kan tilrettelegge undersøkelsesdagen.

Etter undersøkelsen vil vi skrive en rapport til dere. Om dere og/eller skolen ønsker det, kommer vi gjerne på et møte for å legge frem resultatene og drøfte hvordan disse kan forstås og brukes i tilretteleggingen rundt barnet. Om det avdekkes forhold som bør følges opp kan vi bistå med råd om hvor dere kan søke hjelp.

Spørreskjema: Spørreskjema omhandler barnets fungering og hvilken støtte og hjelp det mottar. Det kan fylles ut av foreldrene og/ eller en fra skolen. Skjemaet sendes evt. hjem til dere, og det returneres pr post eller leveres til oss på undersøkelsesdagen. Utfyllingen vil ta ca. 1 time. Om dere samtykker vil vi kontakte skolen og spørre om lærer eller en annen som kjenner barnet godt kan fylle ut et spørreskjema.

Videre ber vi om deres tillatelse til å innhente informasjon fra utredninger som er gjort av barnet i spesialisthelsetjenesten og enkeltvedtak, sakkyndig vurderinger og kartlegginger fra skoleverket.

Dekning av utgifter

Etter avtale dekker vi gjerne reisekostnader t/r undersøkelsen.

Frivillig deltakelse

Det er frivillig å delta i studien. Dersom dere ønsker å delta i hele eller deler av studien ber vi dere sende signert samtykke i vedlagt svarkonvolutt (porto er betalt). Etter at vi har mottatt samtykke vil vi ta kontakt for å høre hvordan dere vil delta og gjøre nærmere avtaler.

Dere kan når som helst og uten å oppgi noen grunn trekke samtykke. Dersom dere trekker barnet fra studien, kan dere kreve å få slettet innsamlede opplysninger, med mindre opplysningene allerede har inngått i analyser eller er brukt i vitenskapelige publikasjoner. Dersom dere senere ønsker å trekke samtykke, eller dere har spørsmål til studien, kan dere kontakte prosjektleder Anett Kaale på telefon (+47 417 800 45) eller e-post **anett.kaale@r-bup.no**.

Hva skjer med informasjonen?

Informasjonen om barnet skal kun brukes slik som beskrevet under hensikten med studien. Dere har rett til innsyn i hvilke opplysninger som er registrert og rett til å få korrigert eventuelle feil. Alle opplysningene vil bli behandlet uten navn og fødselsdato eller andre direkte gjenkjennende opplysninger. En kode knytter barnet til opplysningene gjennom en navneliste.

Prosjektleder har ansvar for den daglige driften av forskningsprosjektet og at opplysninger om barnet blir behandlet på en sikker måte. Det vil ikke være mulig å identifisere barnet eller dere i resultatene av studien når disse publiseres. Studien avsluttes i 2025, og informasjon om barnet vil bli slettet eller anonymisert senest 6 måneder etter prosjektslutt.

Samarbeide med andre

Vi ber dere også vurdere om dere samtykker til at opplysninger om barnet kan deles med andre forskningsinstitusjoner i inn- og utlandet. Det er aktuelt fordi vi via samarbeid med andre lettere kan finne svar på noen av de sentrale problemstillingene.

Vi vil til enhver tid benytte de samarbeidspartnerne som er mest hensiktsmessige. Den mest aktuell er University of California, Los Angeles. Ved samarbeid med land med svakere personvernlovgivning enn Norge, som for eksempel USA, vil vi stille samme strenge krav til beskyttelse av informasjon. Kun avidentifisert informasjon om barnet vil deles. Koden som knytter barnet til de personidentifiserende opplysninger vil ikke bli utlevert. Vi ber dere krysse av i samtykkeskjemaet for om dere samtykker til at opplysningen deles med andre forskningsinstitusjoner.

Informasjon til barnet

Vi ber dere informere barnet om studien slik dere mener er mest hensiktsmessig ut fra dets forståelsesnivå.

Flere oppfølgingsstudier

Det er mulig vi vil gjøre en ny oppfølgingsstudie når barna blir eldre. Dersom det blir aktuelt tar vi kontakt med dere igjen.

Godkjenning

Oppfølgingsstudien er godkjent av Regional komite for medisinsk og helsefaglig forskningsetikk (REK, saksnummer: 2015/1268). Oslo universitetssykehus er ansvarlig for studien.

Kontaktinformasjon

Prosjektleder: Anett Kaale, PhD.
Nasjonalt kompetansesenter for nevroutviklingsforstyrrelser og hypersomnier (NevSom), Oslo universitetssykehus, HF
E-post: anett.kaale@r-bup.no
Telefon: +47 417 800 45

Oslo universitetssykehus