School of Psychology and Speech Pathology

Early Intervention to Improve Later Speech and Language Trajectories in Young Autistic Children

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DECLARATION

To the best of my knowledge and belief this thesis titled ‘Early Intervention to Improve Later Speech and Language Trajectories in Young Autistic Children’ contains no material previously published by any other person except where due acknowledgement has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

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ABSTRACT

The pivotal role of joint attention as a preverbal indicator of childhood autism and as a precursor for later language, play, and social development has been noted by many researchers. Despite the wide and varied literature highlighting the importance of joint attention deficits in young autistic children and calling for intervention approaches, only a small number of intervention studies exist. Few of these studies specifically target joint attention skills. Moreover, the small numbers of studies which directly teach joint attention do not provide sufficient detail to enable replication of the research. Clear objectives and rationales for the treatment are missing and often language is not considered as an outcome variable. The proposed research is an attempt to address this problem, and hence explored the impact of systematically promoting joint attention abilities in verbal autistic preschool children to improve later speech and language trajectories. The intervention sessions were explained by providing information on the general approach during intervention and specific sample tasks. Objectives of the intervention followed developmental trajectories of typically developing children and were clarified by providing rationales. A single subject multiple-baseline design across participants was implemented to evaluate intervention effects on four autistic children. It involved measurements taken from videos of each session of the intervention (coding of joint attention) and outcome variables (coding of language). In addition, there were quantitative measures completed with each child at pre-intervention, post-intervention and follow up stages. These involved an Autism Rating Scale and a battery of language measures. The proposed research had the potential to provide a framework for future research relating to specific intervention programs designed to develop joint attention and language skills in autistic children.

Contents

LIST OF ABBREVIATIONS

Abbreviation	Meaning
ABA	Applied Behaviour Analysis
ADHD	Attention-Deficit Hyperactivity Disorder
ADIPS	Australasian Diabetes in Pregnancy criteria
AE	Age-Equivalent
APA	American Psychiatric Association
ASD	Autism Spectrum Disorder
CA	Chronological Age
CARS	Childhood Autism Rating Scale
CDD	Childhood Disintegrative Disorder
CDI	MacArthur Communication Developmental Inventory
DSM	Diagnostic and Statistical Manual of Mental Disorders
ESCS	Early Social Communication Scale
EVT-2	Expressive Vocabulary Test Second Edition
EVT-2-A	Expressive Vocabulary Test Form A
EVT-2-B	Expressive Vocabulary Test Form B
FFA	Fusiform Face Area
fMRI	functional Magnetic Resonance Imaging
GDM	Gestational Diabetes Mellitus
GSV	Growth Scale Value (Peabody Picture Vocabulary Test)
IBR	Initiate Behaviour Requests
IJA	Initiating Joint Attention
MeCP2	Methyl CpG Binding Protein 2 (Rett Syndrome)
MLE	Mean Length of Eye Contact
MLU	Mean Length of Utterances
MLUm	Mean Length of Utterances for morphemes
MLUw	Mean Length of Utterances for words
NCE	Normal Curve Equivalent
PDD	Pervasive Developmental Disorder
PECS	Picture Exchange Communication System
PET	Positron Emission Tomography (cerebral imaging)
PLS-4	Preschool Language Scales-Fourth Edition
PPVT-4	Peabody Picture Vocabulary Test-Fourth Edition

LIST OF ABBREVIATIONS
(Continuation)

PPVT-4-A	Peabody Picture Vocabulary Test Form A
PPVT-4-B	Peabody Picture Vocabulary Test Form B
PRT	Pivotal Response Training
RBR	Respond to Behaviour Requests
RCI	Reliable Change Index
RDLS-3	Reynell Developmental Language Scales Third Edition
RDLS-3-C	Reynell Developmental Comprehension Scales
RDLS-3-E	Reynell Developmental Expressive Scales
REL	Test-Retest Reliability
RS	Raw Score
RJA	Responding to Joint Attention
SD	Standard Deviation
SEM	Standard Error of Measurement
SIB	Self-Injurious Behaviours
SPECT	Single Photon Emission Computed Tomography
TEACCH	Treatment and Education of Autistic and related Communication handicapped Children
TTR	Type Token Ratio
Vineland-II	Vineland Adaptive Behaviour Scales-Second Edition
WPPSI-III	Wechsler Preschool & Primary Scale of Intelligence-3rd ed.

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Chapter 1
Introduction

This study makes a contribution to future research relating to specific intervention programs designed to develop joint attention and language skills in young autistic children. The term “autistic/s” instead of “person/s or children with autism” is used by a few researchers (Aylward et al., 1999; Gernsbacher, Stevenson, Khandakar, & Goldsmith, 2008a; Herbert et al., 2003) and will be employed throughout this thesis. This represents the preference of how autistic individuals call themselves and how they choose to be called by others, and is therefore regarded as more respectful (Gernsbacher et al., 2008a; Sinclair, 1999).

Autism is a pervasive developmental disorder characterized by qualitative impairments in social interaction, communication and repetitive, stereotyped behaviour (Breakey, 2006; Wing, 1996). Developmental peculiarities become apparent in the first years of life. These include difficulties in the skill of sharing attention with another person through eye contact, gaze shifting or gestures. This skill is called joint attention and its pivotal role as a preverbal indicator of autism and a precursor for later language, play, and social development has been noted by many researchers (Charman, 2003; Jones & Carr, 2004; Jones, Carr, & Feeley, 2006).

Despite the wide and varied literature highlighting the importance of joint attention deficits in young autistic children and calling for intervention approaches, only a small number of intervention studies exist (Mundy & Crowson, 1997; Yoder & McDuffie, 2006). Established treatment programmes mainly consist of behavioural programmes for older children and, for instance, focus on speech and language therapy without considering the prior stages of development. Few of the existing studies specifically target joint attention skills.

Moreover, the small numbers of studies, that directly teach joint attention, do not provide sufficient detail to enable replication of the research. Clear objectives and rationales for the treatment are missing and language is not generally considered as an outcome variable.

The current study addressed the gaps in the literature, and hence explored the impact of systematically promoting joint attention abilities in autistic preschool children to improve later speech and language trajectories. A thorough approach accurately took into account the current research on autism during early infancy, developmental stages in the first years of life and knowledge of early intervention strategies to most effectively motivate autistic children to engage in social interaction. These strategies included behavioural methods, such as prompting and reinforcement, as well as child preference, natural consequences and interspersed activities (Jones & Carr, 2004). The intervention sessions were explained by providing information on the general approach during intervention and specific sample tasks. Objectives of the intervention followed developmental trajectories of typically developing children and were further clarified by providing rationales. A single subject multiple-baseline design across participants was implemented to evaluate intervention effects on four autistic children. This involved measurements taken from videos of each session of the intervention (coding of joint attention) and outcome variables (coding of language). In addition, quantitative measures were completed with each child at pre-intervention, post-intervention and follow-up stages. These involved a joint attention measure, an Autism Rating Scale, and a battery of language measures. The variety of different language assessments used to document later language outcome is innovative in that dimension, and a significant aspect of this research. The intervention approach has the potential to serve as a framework for specific intervention programs designed to develop joint attention and language skills in autistic children. Recommendations for successfully interacting with young autistic children and future therapy programmes are provided.

The thesis comprises six chapters. To begin, chapter two provides a review of the autism literature. The complex puzzle of autism is elucidated considering symptom characteristics, correlations with other disorders and explicating diverse subtypes of Autism Spectrum Disorder. Further, subjects of epidemiology and aetiology, specifically genetic and neuropsychological components, are touched upon. The main emphasis lies on autism during infancy and the significance of early recognition of symptoms in young autistic children.

Chapter three focuses on the body of literature relating to joint attention and, in particular, on early intervention studies. To understand joint attention, a review of developmental stages in typically developing children is pinpointed in contrast to autistic children. This leads to possible interpretations of the deficit and a closer look at recent intervention approaches to teach autistic children to successfully engage in joint attention. The crucial role of these intervention programmes is emphasized by demonstrating the association between joint attention and later language development. Accordingly, aims and objectives of the current study and its contribution to the literature are presented including a thorough explanation of the intervention approach.

In chapter four procedural steps undertaken in order to gain reliable and rich data according to the research objectives are explicated. First of all, this includes a consideration of ethical values and rights essential to interacting with young autistic children and families. Afterwards, a description of the recruitment process, participants, study design and data collection is provided. Various quantitative assessment materials employed to measure general development, joint attention and, in particular, language levels are introduced. The analysis of the transcribed material is explained in detail.

Following this, results of the analysis are presented in chapter five of the thesis. This chapter contains the results of language assessments (standardized measures and spontaneous language samples) and joint attention assessments (rating of initiating and responding to joint attention).

Subsequently, chapter six pulls together the findings from the previous chapter in the context of the current literature on joint attention intervention. Conclusions are drawn underlying the main findings of this research, which may lead to a better understanding of autism. This last chapter provides a summary of the current study pointing out its contribution to the present literature, limitations of the study, as well as future prospects. The thesis concludes with specific recommendations for therapists working with young autistic children in early intervention programmes, including suggestions for therapeutic settings and future research.

Chapter 2
The Autism Literature

2.1 Introduction

The diagnosis *autism*, originally from the Greek term αυτός (gr.) “self” is a pervasive developmental disorder (PDD) that manifests in the first 36 months of life. First signs can sometimes be noticed as early as 9 to 12 months of life (Baranek, 1999). Autism is characterised by severe impairments in three major domains: (1) qualitative impairments in social interaction; (2) qualitative impairments in social communication and imagination and (3) a restricted repertoire of interests, behaviours, activities and a repetitive stereotyped behaviour (Breakey, 2006; Wing, 1996). The term Autism Spectrum Disorder (ASD) includes differing types of PDD, such as childhood autism, atypical autism, Rett Syndrome and Asperger Syndrome (Waterhouse, 1996; World Health Organization, 2006). The types of PDD will later be explicated in contrast to childhood autism. There is a strong variation of the degree of autism and the severity of impairments within the differing types of PDD according to each individual.

The first domain of impairments is characterized by restricted nonverbal behaviours in the use of eye gaze, facial expression, body gestures and gestures to regulate social interaction. At an early age, autistic children show difficulties in joint attention, a pivotal skill of “sharing attention”, which is the focus of this study and will be further addressed below. Moreover, speech and language peculiarities become apparent (Gerenser, 2009). These are noticeable in variable degrees of severity within the Autistic Spectrum.

Speech and language abilities range from an intact phonological, syntactical and semantic system, a fluent use of expressive language and huge vocabulary in Asperger Syndrome, to a normal non-verbal ability but preschool language delay in high functioning autism and a total lack of expressive language in severe autism (Gernsbacher, Geye, & Weismer, 2005).

In the latter case some individuals are not able to show alternative, compensative communication such as gestures and facial expressions (Leppert, 2002), whereas autistic individuals with adequate expressive language have subtle difficulties in negotiating communication or starting and finishing a conversation. In many cases a stereotyped, repetitive and idiosyncratic language style is reported, characterised by semantic and pragmatic difficulties (Happé, 1994; Kelley, Paul, Fein, & Naigles, 2006), exceptional prosody (McCann, Peppé, Gibbon, O'Hare, & Rutherford, 2005), echolalia (Büttner, 1995), pronoun reversals (Ritvo, 2006) and use of neologisms (Leppert, 2002; Remschmidt, 2000).

Interaction with peers to establish emotional relationships is challenging for the majority of autistic individuals, even those with high verbal ability. This has been explained by a lack of social emotional reciprocity and difficulties in showing spontaneous happiness and sharing interests with others (Noterdaeme, 2005).

Qualitative impairments in social communication and imagination can be observed through an examination of autistics' play behaviour. Play is often characterized by an absence of varied imaginative or imitative play as well as restricted functional or symbolic play. It is noticeable during play sequences of social interaction that autistics rarely use non-verbal compensation strategies to sustain communication and overcome their delay in language development.

The third major domain of autism represents a restricted repertoire of interests, behaviours, activities and a repetitive stereotyped behaviour. Autistics often rigidly adhere to non-functional rituals or routines and insist on sameness in everyday life.

Further, a rigid adherence is noticeable during play behaviour, which is orientated to specific objects and mainly characterized by constant, repetitive activities with parts of objects and marginal creative play. Moreover, autistics show stereotyped and repetitive motor mannerisms such as bending or expeditious movements of hands and fingers as well as movements of the whole body. They often react with over- or under- sensitivity to touch or sounds in their everyday environment (O'Neill & Jones, 1997).

ASD often coexists with other disorders. These include hyperkinetic disorders, aggressive and self-destructive behaviour, eating and sleeping problems (Kodak & Piazza, 2008), as well as genetic and physical disorders such as Down Syndrome (Howlin, Wing, & Gould, 1995), cerebral palsy (Bax et al., 2005), tuberous sclerosis (Fombonne, 1999; Smalley, 1998) and Fragile X Syndrome (Cohen et al., 1991).

Additionally, cognitive and motor deficits frequently occur within Autism Spectrum Disorders. Ten percent of the autistic population demonstrate savant skills, i.e. outstanding abilities in a specific domain, such as art, music, arithmetic or linguistic skills (Heaton & Wallace, 2004; Hill & Frith, 2003), which are often accompanied by moderate or even poor intellectual ability in other areas (Bölte, Uhlig, & Poustka, 2002).

Epileptic seizures are often reported in autism and mainly emerge in later childhood or adolescence (Tuchman & Rapin, 2002). The prevalence is highest in the autistic population with moderate to severe mental retardation and those with deficits in motor functions and receptive language (Amiet et al., 2008; Trevathan, 2004; Tuchman & Rapin, 2002).

Studies explain the relation between receptive language problems, epilepsy and autism with reference to a temporal-lobe dysfunction that all these three components have in common (Tuchman & Rapin, 2002).

Gillberg and Billstedt (2000) assume that the ‘comorbidity’ of two or more different disorders alongside autism could be “(a) coincidental, (b) causally directly related, one condition leading to the other, or (c) causally indirectly related, another underlying condition/impairment leading both to the core problem *and* the comorbid disorder(s)” (p. 321).

2.2 Classification of Autism Spectrum Disorder

According to the International Classification of Diseases and Related Health Problems (World Health Organization, 2006), several distinctive categories form the Autistic Spectrum, including childhood autism (F84.0), atypical autism (F84.1), Rett Syndrome (F84.2), other childhood disintegrative disorder (F84.3), overactive disorder associated with mental retardation and stereotyped movements (F84.4), Asperger Syndrome (F84.5) as well as some other rare syndromes (Waterhouse, 1996; World Health Organization, 2006).

The different types of PDD will now be explained in contrast to childhood autism. Highlighting analogies and differences will contribute to gain a clearer picture of childhood autism.

Atypical autism is often described in severe intellectually disabled children or children with a developmental disorder of receptive language. It can be distinguished from childhood autism by a later onset of behavioural peculiarities that are present only after age three years (atypical developmental age) and fewer symptoms with abnormalities only in one or two of the three areas (atypical psychopathology) (Remschmidt, 2000).

Rett Syndrome has an onset between seven and 24 months of age and is characterized by a general mental retardation and an almost exclusive occurrence in females. This differs from childhood autism which typically affects males with diverse intellectual profiles (Leonard et al., 2001; Schwartzman, Bernardino, Nishimura, Gomes, & Zatz, 2001).

In Rett Syndrome, distinctive symptoms, such as respiration problems (hyperventilation, bated breath), deceleration in head growth and amyotrophia as well as impairment of motor ability, start to develop by age four years, including a rigid gangway, trunk ataxia and apraxia of extremities and body, dystonia and choreoathetotic movements (Klicpera & Innerhofer, 2002; Weaving, Ellaway, Gécz, & Christodoulou, 2005).

It is remarkable that gaze contact is obtained and sometimes even very intense in Rett Syndrome, unlike for children with childhood autism, who often avoid gaze contact and are not aware of its meaning to direct communication (Leppert, 2002).

Another category of PDD is called *Overactive disorder associated with mental retardation and stereotyped movements* and describes children, who are affected by a severe mental retardation (IQ below 35) and show hyperactive behaviour, such as impulsive and strong emotional responses as well as difficulties in sustaining attention alongside a general short attention span (World Health Organization, 2006).

Asperger Syndrome is characterised by the same triadic pathology as in childhood autism, with qualitative impairments in social interaction, communication and stereotyped, repetitive behaviour (Gernsbacher et al., 2005). However, three distinctions can be noticed: (1) a lack of a general developmental delay, (2) a higher intellectual ability, and (3) clumsiness in motor activity (Leppert, 2002; Waterhouse, 1996). Whereas children with childhood autism show a general speech and language delay, this is not the case for children with Asperger Syndrome who demonstrate grammatical and stylistically highly developed language, often described as a pedantic style (Frith & Happé, 1994; Klicpera & Innerhofer, 2002; Ritvo, 2006). Nevertheless, children with Asperger Syndrome face significant problems in pragmatics, e.g. in understanding metaphors or while processing cohesive sequences of linguistic information (Frith & Happé, 1994; Leppert, 2002). As a result of these pragmatic difficulties, they sometimes avoid social situations, and consequently face problems of integration, rarely make friends and are often described as loners (Landa, 2000; Ritvo, 2006).

Although problems in understanding the meaning of friendship and sometimes extreme forms of emotional bonds, ranging from very intensive to reserved, are common, attempts of social interaction are prevalent compared to children with childhood autism (Berney, 2004).

At the beginning of life, children with other childhood disintegrative disorder (CDD) appear to develop typically in their language, gesture, play and social behaviour; however, after at least two years of typical development, suddenly developmental delays commence. Children may lose social skills and language, and autistic-like behaviour emerges, such as stereotyped, repetitive motor mannerisms (Fombonne, 2002). An associated encephalopathy has been reported in some cases of CDD, but the diagnosis is based on behavioural symptomatology (World Health Organization, 2006). Fombonne (2002) estimates that CDD occurs approximately sixty times less frequently than other disorders within the Autistic Spectrum.

2.3 Epidemiology

The first epidemiological studies reported a prevalence of autism of 4 to 6 per 10000 births (Lotter, 1966; Ritvo et al., 1989). These studies mainly followed Kanner's early definition of autism suggesting inter alia a lack of empathy and the adherence to routines (Kanner, 1943). Consequently, primarily individuals with childhood autism were included (Noterdaeme, 2005). Recent studies account for the difficulties of social interaction and communication as well as stereotyped behaviours and have found prevalence rates of 30 to 40 per 10000 births covering the whole Spectrum (Fombonne, 2003; Ritvo, 2006; Rutter, 2005; Williams, Higgins, & Brayne, 2006). The male-female ratio is 4:1 up to 10:1 (Stone et al., 2004). Rett Syndrome, based on a genetic cause of the MeCP2 gene and peculiar to females with severe intellectual disability, is seen as an exception (Leppert, 2002). The sex ratio differs in the autistic population with high intellectual ability. The male-female ratio in high functioning autism is at least 10:1 (Baron-Cohen, 2002).

In Australia, the prevalence rates for Autism Spectrum Disorder are inconsistent and range enormously according to State and Territory service providers which have differing criteria for data collection and storage. Statistics of 2003-2004 from the Australia Institute of Health and Welfare and Centrelink, a Department of Human Services agency, vary from 8.5 to 15.3 per 10,000 for 0-5 year olds, 12.1 to 35.7 per 10,000 for 6-12 year olds, and 8.3 to 17.4 per 10,000 for 13 to 16 year olds. Data analysed from State and Territory agencies show a prevalence rate ranging from 3.6 to 21.9 per 10,000 for 0-5 year olds, 9.6 to 40.8 per 10,000 for 6-12 year olds, and 4.4 to 24.3 per 10,000 for 13-16 year olds (Williams, MacDermott, Ridley, Glasson, & Wray, 2008). In conclusion, the existing data cannot provide distinct prevalence rates of autism in Australia, mainly due to territorial and institutional variations. The state of Western Australia has shown a rise in diagnosed individuals per year of almost twentyfold in the last twenty years (Glasson, 2002). More than 200 children received the diagnosis of Autism Spectrum Disorder in 2004 (Glasson et al., 2006). This tendency concurs with other studies around the world presenting an increase in Autism Spectrum Disorder of yet unclear genesis (Chakrabarti & Fombonne, 2005; Croen, Grether, Hoogstrate, & Selvin, 2002; Prior, 2003).

2.4 Aetiology

The aetiology of autism remains a matter for debate and multi-causality is proposed. Genetic and neuropsychological components appear to play a pivotal role. Twin studies show that the risk of autism is higher in monozygotic (ca. 60%) than in dizygotic (5%) twins. Furthermore, the ASD rate in siblings of autistic children is higher (6%) than in the general population (0.5%) (Rutter, 2005).

Neuropsychological studies show brain lesions within autism, but the exact location is unclear (Happé & Frith, 1996). Researchers suggest different causes, such as a dysfunction of the cerebellum, the mesencephalon or the subcortical areas (Bishop, 1993; Courchesne et al., 1994; Dawson, 1983; DeLong, 1992; Happé et al., 1996; Hermle & Oepen, 1987; Rosenblum et al., 1980).

Regarding the cerebellum, a dysfunction between the two hemispheres is proposed, while some studies assume a mainly right hemisphere (Hermle & Oepen, 1987) and other studies a left hemisphere dysfunction (Dawson, 1983). Studies of the mesencephalon show a medial frontal lobe syndrome (Happé et al., 1996), a dysfunction of the frontal limbic system (Bishop, 1993), and a hippocampus dysfunction (DeLong, 1992). Further studies on subcortical areas suggest difficulties in brainstem information processing (Rosenblum et al., 1980), or a hypoplasy of the cerebellum (Courchesne et al., 1994). Pathological brain studies show that the brain development in autism is retarded and there is an enlarged brain size during infancy (Ritvo, 2006), explained by an increased white brain matter as well as a reduced grey brain matter (Herbert et al., 2003). Additionally, post-mortem analyses have found smaller purkinje cells in individuals with ASD with severe mental retardation and a dysfunction of the left hemisphere as well as an abnormal modification of the brainstem in individuals with ASD without mental retardation (Ritvo, 2006).

2.5 Autism during Infancy

2.5.1 Challenges of Early Diagnosis

Differential diagnosis of ASD during infancy is challenging because early symptoms appear in similar form in developmentally delayed or intellectually disabled children. Moreover, during the first two years of life specific difficulties are often hard to perceive and may not have fully emerged. Hence, there is uncertainty to relate early difficulties to the Autism Spectrum (Johnson, Siddons, Frith, & Morton, 1992). Another aspect is that experts in different fields, such as psychiatrists and speech pathologists, sometimes vary within their assessment (Botting & Conti-Ramsden, 2003). Thus, autistic children often receive their diagnosis late, mostly around 6 years of age and children with Asperger Syndrome even later, around 12 years of age (Filipek et al., 1999, 2000; Gillberg, Nordin, & Ehlers, 1996). This results in a lack of early support in specific intervention programs. However, by the end of the second year there are clear signs of symptoms for a diagnosis of ASD (Baird, Cass, & Slonims, 2003; Baird et al., 2000; Bölte & Poustka, 2005), which will be further explained below.

2.5.2 Preverbal Indicators

Pre-speech disorders in children subsequently diagnosed with ASD can be observed even before the beginning of speech development. The mutual interaction between mother and child differs markedly compared to typically developing children, due to the fact that autistic children avoid eye-contact, rarely smile when answering and have a noticeably stiff facial expression, gesture and body language (Dawson, Osterling, Meltzoff, & Kuhl, 2000). Furthermore, they tend not to use anticipatory gestures (don't hold out their arms in welcome, show no emotion when they are held up, turn away from the relating person), refuse attention and affection, frequently show no response as a rule to their name being called, and sometimes cannot differentiate between their parents and other people (Grossmann & Grossmann, 2003; Noterdaeme, 2005; Stone, Ousley, Yoder, Hogan, & Hepburn, 1997).

Also the ability to show empathy, that is, to understand how someone else feels, as well as specific behavioural prognoses with the knowledge of a situation, are a great challenge for autistic children (Yirmiya, Sigman, Kasari, & Mundy, 1992).

Dawson, Hill, Spencer, Galpert and Watson (1990) compared the mother and child interaction (social behaviour, emotion, the use of gesture, eye-contact) between 16 autistic and 16 non-autistic infants. The autistic children did not differ from the non-autistic children in the duration or frequency that they made eye-contact with their mothers, however the combination of eye-contact and smiling with social intent, as well as the reaction to the mothers' smiles observed were lower. The researchers suggest that the atypical emotional behaviour of their children produced a reciprocal effect on the mothers' behaviour: they smiled less at their autistic children and reacted less to a smile with social intent, compared to mothers of typically developing children (Dawson et al., 1990).

A further characteristic of the impairment in social interaction concerns the behaviour of young autistic children who tend to be extremely passive at the age of 6 months and often fixate on a particular object at the age of 12 months.

Autistic children often guide the hand of the parent or other children in the direction of a particular object of interest to make them do something, e.g. lifting up a target object. Particularly noticeable is the lack in the use of social communicators such as eye contact, pointing or verbal communication to attract attention to a desired target object (Camaioni, Perucchini, Muratori, & Milone, 1997). This behaviour can be described as an instrumental rather than as a social form of interaction.

Autistic children use few communicative gestures like "bye-bye-waving" or "head-nodding or -shaking" used to indicate "yes" or "no", and show little interest in social imitative games (Noterdaeme, 2005; Wing, 1996). Behaviour is also marked by a reduced expression of positive empathy (verbal and non-verbal), due to the fact that the meaning of empathy and its place in the social context is not comprehended (Zwaigenbaum et al., 2005).

It has been observed that even autistic children with a high intelligence profile have a limited concept of emotion, so that, for example, the difference between sadness and shame is seldom realised, or only after long deliberation (Sigman, Yirmiya, & Capps, 1995).

These difficulties in perceiving emotional expression correlate with the problem of identifying faces. Autistic children tend to perceive visual stimuli, not globally, but segmented into single characteristics, which greatly hinders the identification of faces (Davies, Bishop, Manstead, & Tantam, 1994). They attend to the area around the mouth to identify faces and show less visual focus on the eyes (Joseph & Tanaka, 2003; Pelphrey et al., 2002). Typically developing children or mentally disabled children orient themselves mostly on the upper part of a face to identify faces (Langdell, 1981).

Further, autistic children struggle to identify emotions because they focus on certain details of the face instead of looking at the whole face. This can lead to misinterpretations of facial expressions; for example they have problems in differentiating between the emotion of being tired or being surprised when they look exclusively at the open mouth of the face (Bormann-Kischkel, Vilsmeier, & Baude, 1995).

Remschmidt (2000) assumes that the previously mentioned pre-speech disorders already exist before birth, and influence the later development. At a very young age, autistic children have a different phonetic and pre-verbal behaviour compared to typically developing children. A different quality of screaming is noticeable with autistic children, which makes it more difficult for the mothers to interpret the scream signals. Nine percent of autistic children do not use screaming as a signal to their mothers to communicate their needs. Furthermore, their babbling is more infrequent, and in contrast to typically developing children is characterised by an atypical and monotone intonation. The imitation of phonemes is limited and often occurs only in response to their own babbling played to them from a tape recorder (Dawson et al., 2000; Noterdaeme, 2005).

About 50% of autistic children fail to imitate the pre-speech sounds given to them by their mothers or other children in their first year of life, and prefer to hear their own babbling on tape recorder (Remschmidt, 2000). The development of receptive and expressive language in autistic children is delayed. According to parental reports, from the age of two, 25% of these children experience a halt or even a regression in the language ability attained to that stage (Taylor et al., 2002).

Apart from noticeable problems of social interaction in language and communication at an early stage, infants who were later diagnosed with ASD showed stereotypical behaviour and limited interests. From the age of 6 months, some children were over- or under-sensitive to certain sensory stimuli and had either no feeling for cold or were hypersensitive to pain (Dawson et al., 2000; Noterdaeme, 2005). They show no, or only a little, reaction in the case of bad burns. Some children find sensory stimuli unpleasant, for example, being lightly touched. In the case of acoustic stimuli, an over- or under-sensitive perception is to be observed. Autistic children can experience certain sounds more intensely and cover their ears with their hands in distress, or can be sensitive to sounds that are not readily discernible by others. Alternatively they can show little reaction to nearby loud sounds, like a fire-engine siren. It is particularly noticeable that there is seldom a reaction to direct verbal contact, and requests are ignored. During the course of development this reaction of the children can change, sometimes to the opposite, and the original irritating stimulus may later be preferred.

Higher or lower sensitivity can also be observed in the visual sphere: visual stimuli are partly ignored, which leads to autistic children walking into objects because they fail to avoid them in time. On the other hand, they show an uncertain and nervous manner when they notice that small changes have been made in their familiar environment (Noterdaeme, 2005). Many autistic children are preoccupied by experiencing feelings of the sensory system, i.e. vision, hearing, olfaction (smell) and somatic sensation (touch). These behaviours are seen, for example, in lengthy visual exploration of light and shadow reflections on a wall, intensive listening to the sound of a radiator, smelling an object/person, or touching, scratching and knocking on surfaces (Breakey, 2006; Wing, 1996).

Unusual motor actions, like rocking movements of the body, shaking of the head, grinding the teeth, snapping fingers or walking on tip-toes, can be apparent in young autistic children (Dawson et al., 2000). Some children show self-injurious behaviours (SIB) such as head banging, biting, scratching or the exploration of unpalatable objects, like pieces of metal or cigarette butts (Howlin, 1993). Risk factors are considered severe autism, related perinatal disorders or major difficulties in social skills. A study conducted with 222 children with infantile autism reveals high prevalence rates of self-injurious behaviours: 50% of the participants showed SIB with 14.6% displaying severe forms of SIB (Baghdadli, Pascal, Grisi, & Aussilloux, 2003).

Another component of early diagnosis, as well as an indication for later language outcomes in ASD, is the observation of play behaviour. The typical development of infant play behaviour can be divided into five consecutive phases: simple manipulating (first year of life), relational play (12 to 13 months), functional play (12 to 18 months), simple pretend play (18 to 24 months) and advanced pretend play (2 to 3 years) (Leslie, 1987; Noterdaeme, 2005).

Autistic children may only engage in functional play behaviour which is characterised by marginal diversity and curiosity, merely brief related play sequences and often limited to simple movements of objects, such as the prolonged turning of wheels (Chawarska & Volkmar, 2005). They mainly fail to “animate” a play object, such as a doll, e.g. by feeding, showing affection or talking to the object (Wing, 1996). These pretend play activities display a challenging stage for the majority of autistic children, because they require self-conscious intentions to develop a creative imaginary situation (Francke & Geist, 2003). During advanced pretend play typically developing children begin to imagine and simulate mental states, such as beliefs, feelings and desires, of themselves and others, and to understand that their own beliefs can differ from the beliefs of others. The marginal spontaneous play activities of autistic children are precursors of their lack of understanding of the beliefs and intentions of others, often referred to as the *Theory of Mind-Deficit* in autism (Baron-Cohen, 1994, 2000; Baron-Cohen, Leslie, & Frith, 1985; Leslie, 1987).

Even though research has shown Theory of Mind difficulties in autistic children, they are able to understand and perform “pretend actions”, such as pretending to drink out of an empty glass, but need further modeling and encouragement of an adult and generally more time to utilize pretend play (Kavanaugh & Harris, 1994).

The *Theory of Mind-Deficit* also explains the peculiarities in joint attention, given that autistic children have problems in interpreting a gaze shift of another person and hence face difficulties in understanding which object a person favors, if more than one object can be selected (Baron-Cohen, Campbell, Karmiloff-Smith, Grant, & Walker, 1995). It can be noted that adults show a deviant behaviour while interacting with autistic children compared to typically developing children distinguished by a higher amount of affection, active participation and assistance in constructing a play or joint attention action (Poustka, 2000).

Differences in the development of joint attention are among the earliest signs of young autistic children and therefore play a crucial role in early identification and treatment of children with ASD (Sullivan et al., 2007). Furthermore, the role of declarative joint attention as an early precursor for later language outcome and severity of autism has been highlighted in numerous studies (Carpenter, Nagell, & Tomasello, 1998; Charman, 2003; Mundy & Gomes, 1998; Ungerer & Sigman, 1984). Joint attention is explored in detail in Chapter 3.

Chapter 3
Joint Attention

3.1 Development of Joint Attention

Early in life joint attention is described as a dyadic interaction between the infant and another person, and later is seen in the ability to share attention with an adult as well as attend to the environmental surroundings (Leekam, Hunnisett, & Moore, 1998; Mundy & Crowson, 1997). Thus, a triadic coordination between the infant, another person and an object or event emerges (Dominey & Dodane, 2004; Leekam & Moore, 2001). This developmental milestone is subdivided into either responding to joint attention (RJA) or initiating joint attention (IJA) (Mundy, Sullivan & Mastergeorge, 2009; Murray et al., 2008). The former is characterised by a child's ability to react to the adult's focus of attention by following gestures, gaze or head positions (Mundy et al., 2009). At first, this is shown through visual attention and gaze contact (at 2 to 4 months of age) and later facial expressions and babbling (at 5 to 7 months of age) (Nadel & Tremblay-Leveau, 1999). RJA emerges first in typical development (Moore & Dunham, 1995) and between 6 and 12 months of age leads to an understanding of the adult as an "intentional agent" (Tomasello, 1995) who refers to an object with certain cues. Children start to understand the social function of joint attention and are motivated to share their interests in an object with an adult by correctly responding to behaviour requests (RBR), which are indicated by a caregiver through requesting gestures and the verbal statement "Give it to me!" (Mundy, 1995; Mundy et al., 2007; Mundy et al., 2003; Tomasello, 1995) By 12 months of age typically developing children start to initiate joint attention with gaze shift, vocalisation or bodily gestures, such as pointing, to imply their interest in an object or event and actively direct the adult's attention. This is referred to as initiate behaviour regulation/requests (IBR) (Liszkowski, 2005; Mundy et al., 2007).

By 18 months of age they are competent in exerting these skills outside their immediate visual field and able to turn their head to follow an eye gaze, head turn or a pointing gesture to a target which is located behind them (Butterworth & Nicholas, 1991).

Neuropsychological components appear to play a crucial role in the distinct developmental timeframe of RJA and IJA. It is suggested that the area of the parietal lobe, which is connected to the posterior attention system, is triggered during RJA activity and is mainly responsible for the perception and reaction to certain stimuli (Mundy, Card, & Fox, 2000; Rothbart, Posner, & Rosicky, 1994). The social aspects of following joint attention and hence orientating to others' focus of attention are regarded as primarily based on involuntary reflexive and imitative behavioural responses to provided stimuli (Mundy et al., 2007; Rothbart et al., 1994). The neuropsychological developmental time frame of reflexive responsiveness lies in the first 12 months of life, concurring with the developmental time frame of RJA (D'Entremont, Hains, & Muir, 1997). In contrast, studies assume that the frontal lobe is particularly involved in IJA activity. These cerebral areas are strongly connected to the anterior attention system. This system is regarded as mainly responsible for intentional behaviour following one's own desires with no association to imitative actions (Mundy, 2003; Mundy et al., 2007). The developmental time frame of the anterior system lags behind the development time frame of the reflexive system and could explain the later onset of IJA behaviour (Rothbart et al., 1994).

Some researchers refer to joint attention using other terms, such as *joint visual attention* (Morissette, Ricard, & Gouin-Décarie, 1995; Tremblay & Rovira, 2007), *commenting* (Warren, Yoder, Gazdag, Kim, & Jones, 1993), *coordinated joint engagement* (Adamson, Bakeman, & Deckner, 2004; Adamson, Bakeman, Deckner, & Romski, 2009; Striano & Bertin, 2005), *proto-imperatives and proto-declaratives* (Yoder & Warren, 1999). The latter applies to gestural bids which are used to share an object which another person, e.g. by pointing to a picture on the wall to attract the adult's attention towards it. On the other hand, proto-imperative gestural bids have a requesting function, e.g. by pointing to an object to imply "give this to me!" (Whalen & Schreibman, 2003).

3.2 Joint Attention in Autistic Children

3.2.1 Retrospective Video Analyses

Retrospective video analyses show that children who were later diagnosed with autism already have difficulties in social interaction by 12 months of age, using fewer joint attention behaviours such as looking, pointing, showing and reacting marginally to parental offers of joint attention or losing the shared focus rapidly (Baranek, 1999; Wing, 1996). Adrien et al. (1993) found impairments in social smile and facial expression, hypotonia, impairments in social interaction, and poor attention within the first year of life.

In the second year of life the peculiarities become more salient. Children then start to prefer being alone, ignore other people and show a lack of eye contact and gesture use (Adrien et al., 1993). However, the deficit in gesture is seen in a lack of indications of expressive joint attention, such as proto-declarative pointing (Baron-Cohen, 1989), and is not attributed to how fluent gestures are performed (Murray et al., 2008). Apart from showing difficulties in employing gestures, fewer gaze shifts of visual attention occur, not only compared to typically developing children but also to children with other developmental delays (Murray et al., 2008). In addition, autistic children orientate conspicuously less frequently to their names than children with other disabilities and show fewer behaviours of initiating joint attention, such as proto-declarative pointing or showing an object of interest during an interaction (Osterling & Dawson, 1994).

Werner, Dawson, Osterling and Dinno (2000) further analysed home videotapes and found that the timeframe to distinguish children later diagnosed with autism from typically developing children lies between eight and 10 months of age. Autistic children have peculiarities in orientating to their names as well as showing eye contact and social smile (Werner et al., 2000). Further studies emphasize difficulties in alternating and following eye gaze and showing of objects (Maestro, Casella, Milone, Muratori, & Palacio Espasa, 1999; Mars, Mauk, & Dowrick, 1998; Receveur et al., 2005).

A small number of video studies investigate the developmental abilities of autistic children in comparison to control groups, including children with language impairment, developmental delay, Down Syndrome, mental retardation (indicated by a Composite IQ score below 70) as well as typically developing children (Baranek, 1999; Clifford, Young, & Williamson, 2006; Osterling, Dawson, & Munson, 2002). These studies argue that social impairments in orientating to names and joint attention skills, such as gaze monitoring and the use of anticipatory gestures, are peculiar to autistic children. Given the significant concurrence of the existent data, it has to be noted that there are limitations to retrospective video analyses including the absence of a standardised measure, difficulties in identifying the child's exact age, and often small numbers of participants that limit the generalisability of the findings (Clifford & Dissanayake, 2008).

3.2.2 Parental Report

Another method of early infant observation is implemented through parental interrogation in interview or questionnaire form. The majority of parents with autistic children notice deficits in social interaction and joint attention skills, such as intensity and frequency of shared eye contact, use of proto-declarative gestures and response to joint attention bids (following a gaze or point), prior to their child's second birthday. Compared to matched developmentally delayed children, parents of autistic children report their children to play more independently without the need of encouragement or parental attendance. They seem less engaged while playing peek-a-boo or cuddling games (Vostanis et al., 1998). Retrospective parental reports provide significant information on early infant development prior to an ASD diagnosis. However, possible problems of reliability arise from retrospective reporting, particularly potential biased recall given the ASD diagnosis (Clifford & Dissanayake, 2008).

Despite the noted limitations of retrospective video analyses and parental reports, these methods are essential to document the early onset of joint attention impairments in young autistic children.

3.2.3 Studies of Autistic Children and Comparison Groups

Studies compared joint attention skills of autistic children with children who display differing language delays, such as the genetic disorders Down Syndrome and Williams Syndrome. Down Syndrome or Trisomy 21 is common genetic condition that involves symptoms such as congenital heart defects, distinctive facial features, respiratory problems and mental retardation (IQ: 35-70) (McDuffie, Leonard, & Schwartz, 2009). Williams Syndrome or Elfin Face Syndrome, is a rare genetic disorder, caused by a micro deletion of at least 16 genes on the chromosome 7q11.23 (Gilbert-Dussardier, 2006; Mervis & Klein-Tasman, 2000). Multiple symptoms have been reported including congenital heart defects, distinctive facial features, a mild to moderate mental retardation, short stature, kidney malformations and an overly sociable personality (Berthold & Seidel, 2002; Gilbert-Dussardier, 2006; Mervis & Klein-Tasman, 2000).

On comparison with Down Syndrome or Williams Syndrome, it is noticeable that the joint attention deficit is prevalent in autism (Adamson et al., 2009; Lincoln, Lai, & Jones, 2002; Lincoln, Searcy, Jones, & Lord, 2007; McArthur & Adamson, 1996). Unlike autistic children, children with Down Syndrome acquire joint attention skills, such as coordinated gaze shifting and pointing, and use these skills to interact with an adult (Sigman & Ruskin, 1999) but have difficulties in relating to symbols during an interaction (Adamson et al., 2009). Children with Williams Syndrome show similar deficits in joint attention to autistic children, e.g. using marginal proto-declarative pointing to initiate communication. However, they excel in their social aptitudes by initiating social offers and interacting more frequently with a caregiver than autistic children (Rose et al., 2007). Due to their advanced social skills, children with Williams Syndrome have fewer difficulties in understanding emotions or recognizing and differentiating faces than autistic children (Rose et al., 2007). Similarly to autistic children, children with Williams Syndrome show lexical and morphological delays, such as a later acquisition of first words (Mervis, Robinson, Rowe, Becerra, & Klein-Tasman, 2003).

However, despite a later onset of language development and underlying mental retardation, a better prognosis of later lexical and morphological skills is reported for children with Williams Syndrome (Clahsen & Almazan, 1998; Rice, Warren, & Betz, 2005).

Prospective studies prove a joint attention deficit, even in younger siblings of autistic children who show significant difficulties in responding to joint attention compared to siblings of typically developing children (Presmanes, Walden, Stone, & Yoder, 2007; Yirmiya et al., 2006).

Some researchers indicate a correlation between joint attention skills and mental age in ASD. Mundy, Sigman and Kasari (1994) report that children with high functioning autism have more difficulties in higher level joint attention skills, such as pointing or showing, whereas autistic children with severe mental retardation, i.e. a mental age of less than 20 months, show more difficulties in lower level joint attention skills, such as eye gaze. However, Leekam, Baron-Cohen, Perret, Milders and Brown (1997) could not find a relationship between the presentation of joint attention and mental age in ASD, stating that even children with a mental age of 8 years could not spontaneously hold eye contact.

3.2.4 Interaction of Adults with Autistic Children

While interacting with autistic children, adults use more ‘literal marking’ than ‘conventional marking’ compared to interactions with children with language delay (McArthur & Adamson, 1996). ‘Literal marking’ refers to distinct attention cues, such as shaking an object or holding it in front of the child’s face, rather than using verbal (“Look!”) or nonverbal cues, such as pointing (‘conventional marking’) (McArthur & Adamson, 1996). Furthermore, McArthur and Adamson (1996) report that adults show a wider variety of joint attention cues within ‘conventional marking’ while interacting with autistic children. This behaviour may function as a compensation strategy to promote joint attention in autistic children by offering a wider input range for a certain focus.

However, autistic children respond less frequently to joint attention offers by adults and have difficulties in following their gaze or pointing gestures compared to children with language delay (McArthur & Adamson, 1996).

3.3 Interpretation of Joint Attention Deficit

Previous studies often referred to a lack of understanding of intentionality in autism (Gallese, Eagle, & Migone, 2007), which may not suffice as an answer to explain the joint attention deficit since other studies show that autistic children outperform typically developing children in certain intentionality tasks (Aldridge, Stone, Sweeney, & Bower, 2000; Carpenter, Pennington, & Rogers, 2001) and are capable of understanding intentions underlying others' actions (Russel & Hill, 2001). Even though autistic children's attention is less perceptible, and may often be barely discernible to oberservers, e.g. by looking at an object from an angle or showing very short incidences of eye contact, this does not prove a lack of understanding of intentions. While the joint attention deficit is accepted as a core feature of autism in the literature, only a few researchers have taken a step further and tried to interpret the cause of the joint attention deficit. Three of the few existing approaches may help to explain the underlying cause of the deficit and the general nature of autism. Three theories, namely (1) the role of motivation; (2) the role of persistence, perception and gaze apraxia; and (3) the role of cerebral coherences: eye gaze and the brain, will now be introduced. Understanding the underlying mechanisms of joint attention in autistic children is essential for the design of future intervention programmes.

3.3.1 The Role of Motivation

In a single-participant reversal design by Vismara and Lyons (2007), three nonverbal autistic children, aged 26, 34, and 38 months, were given weekly home-based pivotal response training (PRT) for a total of 12 weeks. The results emphasize the role motivation plays for a joint attention intervention. They state that autistic children are indeed able to engage in joint attention. However, social interaction and sharing of interests and feelings are less significant for autistic children.

Whereas typically developing children experience the adults' attention as a rewarding motivator this is not necessarily the case for autistic children who prefer to engage with individually preferred objects.

Scientists show that a PRT, which allows for the child's choice of activities by employing his or her individual perseverative interests and allowing the child to express them gradually, enhances the motivation to engage in joint attention (Vismara & Lyons, 2007).

Following the definition of the Diagnostic and Statistical Manual for Mental Disorders (DSM-IV), perserverative interests are regarded as "encompassing preoccupations with one or more stereotyped and restricted patterns of interest that are abnormal either in intensity or focus" (American Psychiatric Association, 2000, p. 71). Individual perseverative interests include favourite toys, activities and games, such as playing twister using letters or numbers, making an ABC puzzle or using a magnetic letter board. In this approach these interests are encouraged by the caregiver without providing a controlled treatment condition. The caregiver constantly follows the child's lead, except for stereotypical behaviours or tantrums, and the child is thereby motivated and able to extend joint attention initiations to contexts where less preferred stimuli are provided. In general, the quality of adult-child-interaction improves significantly and children are reported to show increased levels of happiness (smiles, laughs, attention to adult, response to prompts, task engagement) and a reduction in social avoidance or withdrawal (Vismara & Lyons, 2007). Moreover, by following the child's interests and enhancing motivation, a mutual rewarding interaction is gained which reflects positively on the behaviour and emotions of the caregiver and in turn influences the child's overall behaviour. However, no follow-up data exists to confirm change over time.

3.3.2 The Role of Persistence, Perception and Gaze Apraxia

Despite the numerous studies that document how joint attention is impaired in autism, only one known study attempts to explain the cause of the deficit in a behaviour-scientific basic approach.

Gernsbacher et al. (2008a) assume that there are three major reasons that form the basis of the joint attention deficit: (1) an “atypical resistance to distraction”, (2) an “atypical skill at parallel perception”, and (3) an “atypical execution of volitional actions” (p. 38).

The first hypothesis of an “atypical resistance to distraction” is founded on studies suggesting that autistic children are persistent in their focus of attention and often resist shifting to another centre of attention. They are also less likely to be distracted by another stimulus while intensively engaged with an attractive object.

In a study by Landry and Bryson (2004) 5-year-old autistic children were matched to typically developing children and Down Syndrome children, with the same mental age. The children were given the instruction to focus on a computer screen in front of them displaying interesting coloured geometric forms. During the process, identical stimuli appeared on another screen next to the central screen. Autistic children were less likely to shift their centre of attention compared to typically developing children and children with Down Syndrome who were most easily distracted (Landry & Bryson, 2004). Moreover, autistic children outperformed mental age-matched typically developing children in remaining focused on a Continuous Performance Test of sustained attention. Typically developing children often lost their interest in the task while autistic children insisted on finishing the entire activity (Garretson, Fein, & Waterhouse, 1990).

The second conjecture of an “atypical skill at parallel perception” in autism is based on studies which demonstrate individuals with autism show outstanding performance on visual perception tasks. One study by O’Riordan (2004) compared a group of ten adults with high-functioning autism to IQ-matched typically developing adults. In three different visual experiments, autistic adults demonstrated a superior visual ability to locate certain stimuli and to distinguish them rapidly from distracting stimuli compared to the control participants. Specific visual target tasks included, for example, to press a key after detecting an ellipse which was presented on a monitor among circular distractors, as well as to locate a red X which was concealed behind a green X and a red C.

Further studies carried out with autistic children (O’Riordan, Plaisted, Driver, & Baron-Cohen, 2001; O’Riordan & Plaisted, 2001) suggest that the ability to correctly and quickly discriminate target objects from distractors is independent of developmental age and unique in autism, and might be explained by a distinct perception of stimuli and the method of seeking a target among multiple distractors in a parallel manner (Gernsbacher et al., 2008a). This capability is beneficial in visual detecting tasks, but may be obstructive in everyday life due to a lack of considering multiple stimuli and generalizing visual and social inputs, which is inter alia essential to categorize information (Plaisted, O’Riordan, & Baron-Cohen, 1998).

In their third assumption, Gernsbacher et al. (2008a) refer to an “atypical execution of volitional actions” in autism, also known as gaze and motor dyspraxia. Given that the use of gestures, such as head turn or gaze shifting, require an extensive interaction of different cerebral areas, which are possibly affected in autism, this may explain why autistic individuals’ gesture production lies far behind their gesture comprehension. Gernsbacher et al. (2008a) even point out that “autistics are considerably challenged by gesture production, which relies on action execution, but they are equivalent or even superior to nonautistics in gesture understanding” (p. 42).

In summary, Gernsbacher et al. (2008a) present a novel perspective to looking at the joint attention deficit in autistic children. In their conclusion they encourage researchers, therapists and parents to further investigate and engage in autistic ways of interaction rather than to impose and retain so-called typical ways of interaction. The novel hypotheses and optimistic perspective has also been acknowledged by Burack and Russo (2008). However, they expressed some criticism of the presentation of the thesis and interpretation of the studies underlying Gernsbacher et al.'s assumptions, which they suggested may be a little too confident bearing in mind that research in this area is still in progress. Further, they criticize a slightly one-sided inclusion of data and argue that the findings do not consider the complex picture of Autism Spectrum Disorder and different levels of development. Moreover, they argue that "rather disparate literature" was employed to explain the thesis (Burack & Russo, 2008, p. 47).

Even though a wide range of literature with diverse matching models and age groups was gathered, the results of the employed studies offer plausible support for the thesis which should be further verified in future studies. In a response to the critique, Gernsbacher et al. (2008b) underline their thesis by explaining some data, in particular, e.g. autistic individuals' visual attention focus, has proven to be longer for certain tasks with clearly outlined instructions compared to the visual attention span of children in control groups. Burack and Russo (2008) disagree with stressing how autistic individuals outperformed non-autistic individuals in certain tasks and hence should deserve more attention in regard to their unique form of expression.

They say that this argument is irrelevant and state that trying to better understand autistic individuals is in any case recommended (Burack & Russo, 2008). However, by emphasizing the skills and believing in the abilities of autistic individuals, a novel outlook is permitted. A shift in focus is therefore possible away from obvious and often-reviewed autistic difficulties towards an understanding of their skills, which in some aspects have proven to be superior. It is essential to acknowledge autistic individuals' attempts at joint attention interaction and to be aware of them even though they may sometimes remain unseen.

3.3.3 The Role of Cerebral Coherences: Eye Gaze and the Brain

At an early age typically developing infants show a higher amount of shared eye contact than it is the case for autistic infants. They are more attracted to the area of the eyes compared to autistic infants who prefer other facial features, such as the area around the mouth (Bormann-Kischkel et al., 1995; Langdell, 1981). Typically developing children can stare at the caregiver for prolonged period of times, whereas most autistic infants only hold eye contact for a few seconds and need special encouragement to do so. By the age of 10 weeks, typically developing infants improve their gaze behaviour and follow an eye gaze to actively share attention on an object of interest with an adult (Hood, Willen, & Driver, 1998). The deficits in early eye gaze are seen as first indicators for autism. Therefore it is essential to examine underlying cerebral coherences of eye gaze to achieve a better understanding of the early steps of joint attention and autism.

A closer look at studies that conducted various techniques of cerebral imaging, such as functional Magnetic Resonance Imaging (fMRI), Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT), reveal that particular cerebral areas are active during gaze contact, gaze monitoring, and gaze shifting. These include the amygdala, the fusiform face area (FFA), and the superior temporal sulcus (STS) (Allison, Puce, & McCarthy, 2000; Kanwisher, McDermott, & Chun, 1997; Kawashima et al., 1999).

The amygdala or amygdaloid body is a neuclei cerebral area of the medial temporal lobe and part of the limbic system (Amaral & Corbett, 2003; Prosiegel & Paulig, 2002). Amygdala activity has been reported during gaze contact and the interpretation of eye gaze in typically developing individuals. The role of the amygdala in joint attention skills is noted in studies that report of bilateral amygdala lesions which result in difficulties in correctly recognizing the direction of eye gaze (Young et al., 1995).

One fMRI study was carried out to compare the cerebral activity of autistic individuals with matched controls during a Theory of Mind and a social perception task (Baron-Cohen et al., 1999). During the Theory of Mind task participants were ask to give information on the feelings and beliefs of other persons by exclusively looking at images of their eyes.

Interestingly, the fMRI analysis revealed significantly higher amygdala activity during the task in the control group than in the autism group that consisted of individuals with high functioning autism or Asperger Syndrome. These findings concur with the study of Ashwin and colleagues (2001) that found decreased amygdala activation for recognizing faces in male autistic adults compared to matched controls. Brain images show that autistics cerebral activity was higher in other regions, namely the superior temporal gyrus and the anterior cingulate cortex (Ashwin et al., 2001). Pierce, Müller, Ambrose, Allen and Courchesne (2001) also report of cerebral differences between seven male autistic (aged 21-41 years) and eight non-autistic (aged 20-42 years) participants. They found a connection between the amygdala volume and the amygdala function of autistic individuals, who activated the left amygdala less frequently than the control group.

Apart from peculiar cerebral activity in autism the amygdala volume seems to differ from typically developing individuals and may explain joint attention deficits. In a study by Nacewicz and colleagues (2006), measures of the amygdala volume as well as the ability to judge facial expressions and the ability to follow an eye gaze (joint attention) were conducted on 54 males (aged 8 to 25 years). Of these participants 28 were autistic and 36 non-autistic. The findings demonstrate cerebral peculiarities in the autistic participants. First of all, the amygdala volume was reduced compared to the matched control group.

Participants with smaller amygdalae required the longest period of time to discriminate neutral from emotional facial expressions. Moreover, a connection between the amygdala volume and the amount of eye gaze has been reported: autistic individuals with the smallest amygdala volume showed the shortest eye contact fixation time and generally fewer attempts to hold eye gaze.

Additionally, a relation between social abilities in early infancy, measured with the Autism Diagnostic Interview-Revised (ADI-R) (Lord, Rutter, & Le Couteur, 1994; Rutter, Le Couteur, & Lord, 2003), and the amygdala volume in autistic individuals is suggested: autistic individuals with small amygdalae were more severely impaired in their social skills during early infancy compared to those with larger amygdalae and the control group (Nacewicz et al., 2006).

The findings of a reduced amygdala volume concur with previous MRI studies on autistic participants (Aylward et al., 1999; Pierce, Müller, Ambrose, Allen, & Courchesne, 2001). However, findings of other researchers contradict these results and suggest an enlarged amygdala volume in the left (Abell et al., 1999) and in both hemispheres (Howard et al., 2000) of autistic individuals. In a more recent study, Schumann et al. (2004) analysed MRI scans of ninety-eight male participants (71 autistic and 27 non-autistic) aged between 7.5 and 18.5 years.

The three most significant findings were: (1) the left and right amygdala volume of the autistic children and the right hippocampal volume of autistic children and adults was enlarged compared to the control group, (2) there was no significant difference between the amygdala volume of autistic adolescents (aged between 12.75-18.5 years) and the control group and (3) there was a significant amgydala growth of almost 40% between the age range of eight and 18 years in typically developing children that did not occur in autistic children.

In conclusion, studies provide conflicting findings regarding the volume of the amygdala in autistic children. Nevertheless, there is agreement on a deviant amygdala development in autism that consequently leads to functional differences, such as deficits in joint attention (Mosconi, 2009).

The study by Dalton, Nacewicz, Alexander and Davidson (2007) indicates a strong genetic component in autism. Siblings of autistic children, who themselves were non-autistic, showed cerebral peculiarities, including a decreased amygdala volume, comparable to that of the autism group and deviant to the control group, and a reduced cerebral activity of the FFA.

Moreover, abilities in joint attention, in particular the ability to hold eye gaze, were impaired in typically developing siblings of autistic children (Dalton et al., 2007).

Other cerebral components to play a pivotal role in joint attention are the superior temporal sulcus (STS) and the fusiform gyrus (Allison et al., 2000; Haxby, Hoffman, & Gobbini, 2000).

The STS appears to be responsible for the recognition of social perception, in particular eye gaze direction. This brain region is generally active in response to segments of the faces and shows exceptional activity during the interpretation of cues, such as gaze direction and movements of the mouth, as seen on functional MRI with humans (Puce, Allison, Bentin, Gore, & McCarthy, 1998). Consistent with these findings is the study of Campbell et al. (1990), which reports difficulties in judging the gaze direction of others for patients with lesions of the STS area.

Autistic individuals show hypoactivation of the STS area and the inferior occipital gyrus while looking at faces compared to the control group (Pierce, Müller et al., 2001). Moreover, cerebral imaging studies report reduced grey brain matter, deviant perfusion and different activation of the STS area during social perception tasks in autistic individuals (Zilbovicius et al., 2006).

The fusiform gyrus is part of the temporal lobes and is located lateral to the parahippocampal gyrus (Pierce, Müller, et al., 2001). It is involved in recognizing faces and differentiating familiar from unfamiliar faces. A cerebral lesion of this area results in a disorder called “prosopagnosia” whereby patients are suddenly unable to identify familiar faces, including sometimes even their own facial features (Duchaine & Garrido, 2008). Damage of the FFA and resulting problems in identifying faces contributes to difficulties in processing gaze but does not directly seem to involve the ability to judge the direction of gaze (Campbell et al., 1990).

Autistic individuals show less or even no activation of the FFA while looking at faces (Pierce, Müller et al., 2001). FMRI analyses reveal an activation of deviant neural areas in autism, such as the frontal cortex, primary visual cortex and the cerebellum or a combination of different areas. Interestingly, there is significant variation of activated areas within autism which seems to vary for each individual (Pierce, Müller et al., 2001).

In summary, cerebral imaging studies show that the cerebral areas which are active during gaze contact, gaze monitoring and gaze shifting differ between autistic and non-autistic individuals. Cerebral areas of the amygdala, FFA and STS that are typically activated for joint attention tasks, are hypoactive in autistic individuals. In some cases there is no activation of these areas and other cerebral areas take over monitoring, identifying and interpreting joint attention cues. In addition to functional differences, anatomical peculiarities are apparent in autism, such as deviant amygdala volume or reduced STS grey brain matter.

3.4 Early Intervention Studies

The crucial role of joint attention in autism has also been investigated through intervention approaches. Behavioural intervention and social skill studies have used joint attention as an outcome measure, but only some researchers have reported increases in joint attention. It is significant to note that these studies did not directly target joint attention skills or only focused on bids of joint attention as part of other social communicative skills.

Two effective intervention approaches for autistic children are Applied Behaviour Analysis (ABA) (Loovas, 1987; Rogers & Vismara, 2008; Smith, Eikeseth, Sallows, Graupner, 2009) and Picture Exchange Communication System (PECS) (Bondy & Frost, 2001a, 2001b, Frost & Bondy, 2002). ABA promotes certain areas of joint attention, such as eye contact and pointing, without directly focusing on teaching joint attention (Foxx, 2008; Leaf & McEachin, 1999; Lovaas, 1987). PECS helps autistic children with language delays to promote communication. Pictures are employed instead of words, e.g. to request a favourite object or to comment on the natural surroundings (Bondy & Frost, 1998).
The caregiver uses a verbal prompt, “What do you see?” to encourage the child to make a comment by means of a picture card. This intervention promotes general social interaction without teaching joint attention abilities in particular. Other intervention programs, implemented by peers or siblings of autistic children, focus on enhancing motivation during play interactions between the children using naturalistic principles. These include methods such as providing an intense play interaction and individualized play activities as well as a high amount of social stimuli and reinforcers. Results show positive impacts on joint attention alongside improvements in verbal and play abilities (Baker, 2000; Pierce & Schreibman, 1995).

The teaching approach of Rappaport (1996) promotes initiating joint attention through commenting. The caregiver is advised to lead the child’s index finger to an object of interest while saying, for example, “funny!” Rappaport assumes that creating novel or silly situations, such as putting a toy into the refrigerator, would promote the child’s commenting and pointing abilities.

This approach focuses on verbally initiating joint attention but does not address important aspects of nonverbal joint attention, such as gaze alternation. Further, it remains unclear as to how the child is expected to respond to these events and how to further motivate the child's interest in this social interaction (Jones, Carr, & Feeley, 2006).

Research addressing intervention programs which systematically train joint attention abilities has been neglected and mainly consists of small single case studies (Charman, 2003). In a study by Klinger and Dawson (1992) a 5-year-old autistic child was taught initiating and responding to joint attention. Prior to the intervention the child could use conventional gestures by showing the caregiver an object of interest. The joint attention abilities improved towards responding to joint attention bids by following a point and using gaze shift to initiate joint attention after 11 weeks of intervention (Klinger & Dawson, 1992). These results have to be noted with caution, bearing in mind that this child was verbal and only mild expressive language impairments were apparent prior to the intervention (Jones et al., 2006). Hwang and Hughes (2000) observed the effect of an approach teaching eye contact, motor imitation and joint attention on three nonverbal boys with autism, who were between 32 and 43 months of age and did not display these skills prior to the intervention. After intervention, all children significantly improved in their ability to hold eye contact, imitate motor activities (such as clapping their hands) and initiate joint attention via gaze shifting or pointing. Interestingly, the smallest improvement among these skills was seen in joint attention. Moreover, compared to the other skills, children had more difficulties in transferring their improvements in joint attention to other settings and persons, such as showing joint attention skills in an unfamiliar room with the experimenter and an unfamiliar person. This indicates that generalizations on joint attention improvements might be limited (Hwang & Hughes, 2000).

These results call for a highly intensive joint attention intervention which has the potential to establish long-term improvements continuing beyond a therapeutic setting.

In a study by Zercher, Hunt, Schuler and Webster (2001), autistic twin brothers, aged 6.3 years, were trained by three typically developing sisters, aged 5.5, 9.6 and 11.9 years, to use joint attention and symbolic play under supervision of an adult trainer who trained the sisters to be persistent and to overcome difficult situations, such as coping with resistance. The girls were experienced in interacting with children with disabilities and were asked to promote joint attention and play interactions, e.g. by giving and showing the boys toys and initiating play, pointing to mechanical objects, showing the boys symbolic play by making a doll “cry”, or talking to a toy phone and asking them to participate in a symbolic play interaction. The weekly 30-minutes interaction between the children took place for over 16 weeks. After the intervention, both boys showed a significant increase in joint attention, symbolic play and verbal utterances (Zercher et al., 2001). However, their joint attention directing behaviours only marginally improved. This might be due to the focus of this intervention, which is mainly play interaction rather than training to initiate joint attention. This study did not examine the long-term effects on vocabulary growth, social or cognitive skills, and it is not known how the boys interacted without trained peers several weeks after intervention.

In a more recent study by Whalen and Schreibman (2003), a joint attention intervention for five, 4-year-old autistic children was conducted three times a week, for 1.5 hours each sessions during a period of 10 weeks. Treatment was organized into two phases for responding to (phase 1) and initiating joint attention (phase 2). Phase 1 ranged from response to the child’s hand being placed on different objects (level 1), response to an object being tapped/shown (level 2, 3), response to eye contact (level 4) as well as following a point and a gaze (level 5 and 6). During phase 2, coordinated gaze shifting and proto-declarative pointing was trained. Results show that autistic children are highly impaired in initiating joint attention (IJA): only 2% or less of joint attention initiations were observed before treatment. After treatment, three participants improved in IJA and one child made large improvements. One child had to be excluded from the treatment program after ten consecutive days of intervention since no form of progress to initiate joint attention could be observed.

A decline in coordinated gaze shifting from post-treatment to three months follow-up measures could be observed in four out of five participants, implying that coordinated gaze shifting is especially challenging for autistic children. Long-term effects in this study particularly address responding to joint attention: four out of five children increased in their ability to respond to joint attention from post-treatment to follow-up.

Few researchers directly focus on teaching joint attention skills and examine long-term effects on other outcome variables. In one study by Kasari, Freeman and Paparella (2001), initiating of joint attention, i.e. pointing and showing, was successfully taught to a single child with autism using the principles of following the child's lead (milieu teaching), which allows flexibility while interacting with the child and meeting the individual child's need. Two studies by the same researchers directly compared two different precursors of later language in an intervention approach (Kasari, Freeman, & Paparella, 2006). In these randomized intervention studies, joint attention and symbolic play were directly taught to 3- to 4-year-old autistic children using principles of discrete trial training and naturalistic response training.

Training methods included establishing eye contact, sustaining immediate proximity to the child, providing a wide range of materials and activities in changing environmental play contexts, following the child's course of interests, commenting on the child's activities, and consistently responding to the child's play and communicative attempts.

The results indicate a significant enhancement in joint attention as well as symbolic play in both intervention groups compared to the control group. The autistic children who received a daily structured joint attention intervention of 30 minutes for five to six weeks significantly improved in their ability to initiate and to respond to joint attention, whereas the play intervention group showed more diverse types of symbolic play interaction and higher levels of play.

Results of the follow-up study (Kasari, Paparella, Freeman, & Jahromi, 2008) show that both the joint attention and symbolic play intervention had a positive impact on expressive language compared to the control group, and these results could only be attributed to this specific intervention program and not to other interventions the children were receiving. This indicates that even a short-term intervention period has an impact on developmental trajectories of autistic children which may also persist over time in different environmental contexts. These researchers emphasize the need for further research investigating intervention programs in both joint attention and play and the clinical significance for early intervention programs.

There were some limitations to these studies. The treatment goals were outlined broadly without explaining the objective and rationale of the treatment or providing an intervention approach. The authors state that the experimenters followed the interests and activities of the children by using principles of milieu teaching and systematic prompting and reinforcement (Kasari et al., 2008), without precisely explaining the events and actions. Further, the intervention was carried out by five graduate students, and it remains unclear whether they followed the same principles during treatment. The authors stated that they were trained in the intervention, but it can be assumed that they prompted in different ways, which might have had an impact on the behaviour of the children.

3.5 Joint Attention and Language Development

The association between joint attention and later language has been demonstrated in several studies with typically developing children (Morissette et al., 1995; Sigman & Kasari, 1995; Tomasello & Farrar, 1986). It is assumed that early eye gaze behaviour, such as visual coordination and visual joint attention, is important for the development of language and social skills (Murray et al., 2008). Tomasello (1995) assumes that a joint attentional focus between adult and child is necessary to comprehend and produce new words within an appropriate context. The children use social and pragmatic cues to learn new words within shared attention (Tomasello & Kruger, 1992; Tomasello, Strosberg, & Akhtar, 1996).

Given this, it has to be noted that the ability to direct others' attention develops within the same time frame as the development of first words (around 13 to 18 months) (Bates, Benigni, Bretherton, Camaiom, & Volterra, 1979). Hence, researchers have studied the influence joint attention has on the acquisition of vocabulary. Joint attention skills are seen as a predictor of later vocabulary size in typically developing children (Goldfield & Reznick, 1990; Kasari et al., 2001) and autistic children (Bono, Daley, & Sigman, 2004; Sigman & Ruskin, 1999; Siller & Sigman, 2002). Baron-Cohen, Baldwin and Crowson (1997) try to explain the connection between difficulties in joint attention and impaired language in autistic children. In their study they examined one facet of joint attention, gaze monitoring, and the ability to map word meanings. If children do not follow the adult's gaze while a new word is presented to them (following the speaker's direction of gaze), but look at a different object at the time (following the listener's direction of gaze), errors in word mapping will occur and children might learn the wrong word for the wrong object. Following gaze contact and correctly mapping to a novel word and object is especially difficult for autistic children. Baron-Cohen et al. (1997) report that only 29.4% of the autistic children in their study could do so, compared to 70.6% of children with mental disabilities.

The study by Siller and Sigman (2002) indicates that parental behaviours - in particular the number of joint attention initiations provided and undemanding utterances which are matched to the child's choice of attention - have a significant effect on the children's speech and language trajectories. According to the result of this study autistic children whose preferred activities are more frequently accompanied and underlined by parental speech and whose parents frequently offer joint attention initiations improve in their later language and communication compared to language-matched children who are given less parental input. The significant influence of the level of synchronization during early adult-child interaction on later language abilities can be verified in measures taken 10 and 16 years after the initial assessment. However, the authors state that the findings may also be influenced by a particular characteristic of the child which might already be superior initially compared to other children and positively influences the level of parental synchronization. In general, the findings show that parents of autistic children show equal levels of synchronization and social interaction skills compared to parents with language-matched typically developing children.

On closer examination, the clear relationship between the components of joint attention and later language remains a matter for debate (Thurm, Lord, Li-Ching, & Newschaffer, 2007). It is not yet clear whether either initiating (IJA) or responding to joint attention (RJA) is a better precursor for later expressive or receptive language ability.

Some studies suggest that there is a significant correlation between the child's ability to follow the direction of gaze and pointing gesture of the adult (RJA) and early receptive language skills (Mundy, Sigman, & Kasari, 1990). However, other studies provide evidence that more frequent IJA skills are associated with both expressive and receptive abilities (Mundy, Sigman, Ungerer, & Sherman, 1986; Sigman & Ungerer, 1984). A recent study by Murray et al. (2008) supports a positive correlation between the ability to respond to joint attention bids of others and both expressive and receptive language, but no significant connection between initiating joint attention and the selected language components.

On the other hand, Mundy and Gomes (1998) state that IJA is significantly connected with expressive language skills, whereas RJA is a predictor of receptive language. However, they found a relationship of RJA with both receptive and expressive language at follow-up testing. Luyster, Kadlec, Carter and Tager-Flusberg (2008) state only RJA as a precursor for later receptive language and found no significant correlation between IJA and subsequent language outcomes in young autistic children aged between 18 and 33 months. Bearing in mind that the processes of RJA and IJA are regarded as two separated developmental milestones of joint attention, and that RJA emerges first in typical development (Carpenter et al., 1998; Moore & Dunham, 1995; Murray et al., 2008), this may explain why some of the data could not find a connection between IJA and later language. Further, most of the studies did not use a battery of language assessments for a reliable speech and language analysis.

A detailed look at the components of joint attention and varied intervention approaches reveals that it remains unclear which of the different types of joint attention measures is the strongest predictor of later language skills. Mundy et al. (1990) and Sigman and Ruskin (1999) suggest that the ability to respond to the point of the experimenter is most predictive, whereas other studies favour the rate of communicative intents (requesting behaviours, imitations, and initiations of joint attention) (Charman et al., 2005), or the duration of the joint engagement between the adult and the child (Adamson et al., 2004) as the most salient indicator of later language development. However, the majority of studies only differ between RJA and IJA and do not further analyse different types of joint attention.

In summary, the development of joint attention is a crucial milestone during early infancy and follows certain developmental trajectories. Retrospective video analyses and parental interrogation show that joint attention is impaired in autistic children at an early age. Compared to children with other disabilities, such as Down Syndrome and Williams Syndrome, the joint attention deficit appears to be salient in autism. A strong connection between difficulties in joint attention and language outcome has been demonstrated in numerous studies with typically developing children and autistic children.

However, there is only marginal research of mainly single-case studies addressing early intervention programs for young autistic children. Specific intervention approaches which train autistic children in joint attention reveal remarkable improvements in joint attention. Further, a small number of studies investigate the effect of training joint attention on later language outcome and state that joint attention is a precursor for language ability. After receiving a joint attention intervention, autistic children improved in either their receptive or expressive language skills or in both language components. However, the clear connection between the different types of joint attention and later language remains a matter for debate. Further, intervention approaches are heterogeneous and no clear intervention guidelines are provided.

3.6 Current Study

Whilst there is consistent evidence that deficits in joint attention are a key feature of (early childhood) autism and a predictor of later development, few researchers have progressed beyond the theoretical investigation of joint attention to develop interventions for autistic children. Hence, the broad aim of the current study is to provide a detailed examination of an early intervention approach and the effects this intervention may have on pivotal skills of young autistic children. Only a small number of intervention studies involving young autistic children exist and these are primarily single-case studies. Further, intervention research has been mainly conducted with older autistic children (Luyster et al., 2008). In addition, research literature addressing the effect of promoting early nonverbal communicative skills on language outcomes is negligible. The small numbers of studies addressing later language outcomes have mainly focused on expressive language development after intervention (Luyster et al., 2008). The current study will fill these gaps in the literature by investigating the relationship between the training of joint attention and subsequent expressive and receptive language outcomes. The variety of quantitative measures employed in this study is exceptional in early intervention autism literature. This allows for widespread comparisons with robust results for in-depth interpretations. The intervention approach is specifically designed to consider the special needs of autistic children in the areas of joint attention and language.

Accordingly, the objectives of the proposed study are:

- To provide an intervention program that uses clear objectives and rationales based on developmental stages of joint attention in typically developing children.
- To evaluate the efficacy of directly teaching joint attention using an intervention approach that systematically trains young autistic children to respond to and to initiate joint attention.
- To provide recommendations for the design of future therapy programs for autistic children. Further, this particular intervention will be thoroughly described and enables future intervention studies to replicate this research.
- To determine the social validity of training joint attention in autistic children by showing changes in joint attention and language.
- To examine the developmental progress of each child after intervention, according to their language profile prior to the intervention. The children may start at different levels and reach different stages following individual progress.
- To collect follow-up data that will allow evaluation of the long-term outcomes.
- To demonstrate the effect of the intervention on different areas of language, such as vocabulary and syntax.

Specifically, this study seeks to answer the following research questions:

- Is it possible to develop joint attention behaviours in autistic children (who do not demonstrate such skills) through specific targeted intervention?
- Does joint attention intervention have an effect on expressive vocabulary growth after intervention and at 3 months follow-up?
- Does joint attention intervention have an effect on expressive syntactic growth after intervention and at 3 months follow-up?
- Does joint attention intervention have an effect on receptive language growth after intervention and at 3 months follow-up?

Chapter 4
Method

4.1 Ethical Considerations

Approval to conduct this research was obtained from Curtin University of Technology Human Research Ethics Committee (Approval Number HR 124/2008).

Informed consent was obtained for all participants (Appendix B) in accordance with the National Health and Medical Research Council of Australia (2007) guidelines. Parents were provided with a Participation Information Sheet (Appendix A) that outlined the purpose of the study, and what participation would involve, voluntary consent, and the right to withdraw from the study at any time without effects on other ongoing therapy. Parents were given the opportunity to ask any questions and were encouraged to communicate any special needs their child has that might require special consideration or support during participation (e.g. sensory sensitivity). Parents were provided with contact details of study supervisors, and the Curtin University of Technology Human Research Ethics Committee if they wished to receive further information.

The video tapes of interventions as well as records of measurements were coded for confidentiality purposes and stored in locked filing cabinets following transcription and analysis. Stored data was coded with identification numbers to ensure anonymity. Personal data on participants, such as name, phone number and address, were kept separately in a locked filing cabinet and accessible only to the researcher. Supervisors knew participants only by pseudonyms and code numbers. All data will be kept at Curtin University for a maximum period of five years after which it will be destroyed according to Curtin University protocols.

4.2 Participants

Children were recruited from service providers for autistic children in Western Australia. Advertising material was sent to service providers and volunteer parents contacted the researcher if they were interested in receiving further information. A total of four verbal children with childhood autism, diagnosed by an experienced multidisciplinary team based on DSM IV criteria (American Psychiatric Association, 2000), participated in this study.

4.2.1 Severity of Autism

For further identification and classification of the children the *Childhood Autism Rating Scale* (CARS) was administered (Schopler, Reichler, DeVellis, & Daly, 1980). It provided an indication of the severity of autism and is an important element in the systematic diagnosis of autism, as relations between the degree of the disorder and competencies in joint attention and language can be drawn (Schopler et al., 1980). The 15-item behaviour rating scale covered domains which are generally impaired in autism. These included: relationships with people, imitation, emotional response, body awareness, relation to objects, adaptation to environmental change, visual, auditory and taste-smell-touch response, anxiety reaction, verbal and nonverbal communication, activity level and intellectual functioning. Different features of autism were summarised in the domain “general impression”. CARS has an excellent validity and a high reliability of internal consistency (homogeneity between test items) with a coefficient alpha of .94 and a high average inter-rater reliability (agreement of different examiners) of .71 (Gillberg et al., 1996; Schopler, Reichler, & Renner, 1988). Behaviours of each participant were video-taped and observed by the researcher prior to the intervention. Fifteen categories were rated ranging from scores 1 to 4. Score 1 indicated a typical development for the child’s chronological age, score 2 a mildly atypical behaviour, score 3 moderate peculiarities and score 4 indicated severe impairment in a specific domain. Midpoint scores of 1.5, 2.5 and 3.5 were possible, ranging between typical, moderate and severe yielding a final score indicating non-autistic (15-30), mildly-moderately autistic (30-37), or severely autistic (37-60).

A summary of observation results is provided in table 2. Participants were classified as moderate (participant C, D) to severe (participant A, B) on the Autism Spectrum. Categories, directly related to the joint attention deficit, are further explicated in Appendix C.

Table 2.*Rating Scores on the CARS Subscales*

CARS item[1]	**Participant A**	**Participant B**	**Participant C**	**Participant D**
1) Relationships with people[2]	*2.5*	*3*	*2.5*	*2*
2) Imitation[2]	*3*	*3*	*2.5*	*3*
3) Emotional response	*2.5*	*2.5*	*2.5*	*2*
4) Body awareness	*2*	*3*	*1.5*	*2*
5) Object use[2]	*3*	*3.5*	*2.5*	*3*
6) Adaptation to change	*1.5*	*2.5*	*3.5*	*2*
7) Visual response[2]	*3*	*3.5*	*3*	*3*
8) Auditory response	*3*	*3*	*2.5*	*2*
9) Sensory awareness	*3*	*2*	*1.5*	*2*
10) Anxiety	*2*	*3.5*	*2.5*	*3*
11) Verbal communication[2]	*3*	*3.5*	*2.5*	*3*
12) Nonverbal communication[2]	*3*	*3.5*	*3*	*3*
13) Activity level	*2*	*2.5*	*2.5*	*2*
14) Intelligence	*2.5*	*3*	*1.5*	*1.5*
15) General impressions	*3*	*3.5*	*2.5*	*2*
Autism severity	*39 (severe)*	*45.5 (severe)*	*36.5 (moderate)*	*35.5 (moderate)*

[1] Moderate to severe impairments are marked as shaded areas
[2] Categories related to joint attention deficit (Appendix C)

4.2.2 Characteristics of Participants

Demographic and relevant history on the children was gathered during an interview with parents using the coding conventions for the CDI scoring program (Appendix D, E for scoring program sheet). The details are presented in Table 3.

The results indicate common features of autism during early infancy, such as a frequent occurrence of allergies, seizures or diseases as well as a regression of developmental milestones (Gurney, McPheeters, & Davis, 2006). In addition, all four participants had a family history of PDD or related disorders which is a common feature of autism (Bolton et al., 1994).

Apart from seeking an accurate diagnosis, the data collection on medical history is crucial for every clinician prior to starting any form of therapy program for autistic children, allowing an appropriate response to arising problems, such as seizures, self-injurious behaviours, allergies or asthma. Details of each participant are provided in Appendix F. All parents provided additional details on the children. Interview time varied from 45 to 60 minutes.

Table 3.*Demographic Information on Participants*

Characteristics	**Participant A**	**Participant B**	**Participant C**	**Participant D**
Age at intake	4:09	5:07	3:08	2:07
Gender	male	male	male	male
Birth	caesarian	caesarian	caesarian	complications
Birth order	2	2	2	1
Mothers' education	6-18 years school	college degree	graduate	high school
Fathers' education	6-18 years school	college degree	graduate	graduate
Hearing difficulties	ear infections	no	no	no
Diseases	major illness	major illness	major illness	good health
Family history	yes	yes	yes	yes
Bilingual code	no exposure	< 7 hrs/week	no exposure	no exposure
Ethnicity	Australian	Australian-Indian	Australian	Australian
Autism severity (CARS)	severe (39)	severe (45.5)	moderate (36.5)	moderate (35.5)

4.3 Study Design

A single participant multiple-baseline design across participants was employed in this study. This design is well-established in clinical settings to show changes within participant behaviours (Satake, Jagaroo, & Maxwell, 2008). Using this design, each child was involved in an initial baseline phase. During the initial baseline phase the researcher undertook sessions which involved interactions by following the child’s lead rather than specific joint attention intervention. The first child to enter the intervention phase completed a four session baseline and then changed to joint attention intervention. Subsequent children continued on the baseline phase until they entered the intervention phase (Jackson, 2006; Maxwell & Satake, 2006). That means there was a time interval between the children entering and finishing the intervention. Each child received a one and a half hours session, three times a week. Data were obtained during baseline, treatment, post-treatment and at three-month follow-up. This type of design has several advantages. First of all, developmental steps and changes could be controlled and the treatment could be adjusted accordingly to each child. Further, the effectiveness of the intervention could be determined by coding the target behaviour by means of a video analysis. In addition, unlike many group designs, all participants received the treatment and no child was excluded or later withdrawn from treatment to show treatment efficacy (Maxwell & Satake, 2006). Moreover, individual treatment outcomes were clear and treatment trends for each child could be easily identified and compared across participants. Finally, the baseline measure for each child, gained while the child was receiving individual attention (but not intervention) from the researcher, allowed for control of the effect of increasing “interaction time” with an additional person in the child’s life.

4.4 Intervention

Treatment consisted of a joint attention intervention which systematically trained autistic children to respond correctly to joint attention and initiate joint attention. This involved promoting skills such as eye gaze, pointing, showing, alternating and joint engagement. Treatment involved intensive home-based intervention, delivered by the researcher, consisting of three 90 minute sessions per week for eight weeks (total 36 hours). Due to the weekly available time for only one speech pathologist carrying out such a program, only a relatively small number of autistic children could participate. However, the number of participants in this approach and area is reasonable compared to other joint attention intervention studies with very young autistic children consisting mainly of single-case studies. Moreover, bearing in mind the challenges of early diagnosis (see chapter 2) it is exceptional to find a target group with autistic children at such a young age. In addition, prior to and after the in-depth assessments involved standardized tests, oral parent interview as well as transcripts of natural intervention.

4.4.1 Intervention Approach for Autistic Children

A general objective for the current joint attention intervention was the extension of joint attention skills. This included learning to engage with different objects and events and sharing a rewarding social interaction with an adult rather than showing withdrawn, repetitive behaviour.

Literature on pivotal skill training recommends a triad system of motivators to engage children in joint attention participation: (1) Child choice/preference, (2) natural consequences and (3) interspersed activities (Jones & Carr, 2004). These training methods were constantly followed in the current intervention. Further considerations included the developmental trajectories of joint attention in typically developing children and complementary activities which promote certain areas of joint attention. Moreover, behavioural strategies of prompting and reinforcement were employed.

4.4.1.1 Child Preference and Object Choice

One significant part of the current intervention was to constantly encourage the autistic children to respond to and initiate social interaction and motivate them to make their own choices of interest during the therapy process (Whalen & Schreibman, 2003). Therefore, a number of different activities and materials were provided and constant instructions of novel activities were offered to maintain the child's motivation to adopt and remain interested in target skills (Tomasello, 1995). Further, studies indicate that sensory-stimulating materials have proved of value for interacting with autistic children. Therefore, salient objects were selected which have the best potential to attract the child's attention by moving, lighting-up or making noise (Butterworth, 1995).

4.4.1.2 Salient Reinforcement

In a social interaction, typically developing children naturally engage with an object and share attention and events with an adult. As a response, the adult may express emotions and talk about the object. It is assumed that this behaviour reinforces typically developing children to show joint attention behaviours, whereas autistic children are not motivated by these natural consequences. They need a more idiosyncratic form of social reinforcement, such as loud interjections ("Wow!", "Look!"), intense show of emotion (exaggerated smiles, grimaces) or body contact (high-amplitude tickles) (Jones & Carr, 2004). Therefore, a strong emotional response was given to the child throughout the current intervention.

4.4.1.3 Varied Activities to Promote RJA and IJA

Activities were introduced which gave the child the opportunity to initiate joint attention and actively direct the adult's attention (Liszkowski, 2005) by using coordinated gaze shifting, vocalization or bodily gesture, such as proto-declarative pointing. To promote these skills a number of novel activities were provided, such as different pictures on the wall, various toys and picture books to initiate the use of pointing gestures.

Activities were mixed according to their level of difficulty, i.e. a difficult task was followed by an easier one, to ensure that the child kept motivated and experienced a sense of achievement (Whalen & Schreibman, 2003). Previous intervention studies say that this strategy helps to maintain the child’s interest in a task and a higher number of difficult tasks can be accomplished (Koegel, Koegel, Harrower, & Carter, 1999). For teaching initiating joint attention, different nuances of prompts were used by the researcher. These included verbal prompts (“Look, point!”), gestural prompts (by pointing to an object and encouraging the child to imitate) and physical prompts (by leading the child’s finger to an object) (Jones et al., 2006; Kasari et al., 2008; Wong, Kasari, Freeman, & Paparella, 2007). In training both initiating and responding to joint attention, behavioural methods, such as consequent direct and indirect reinforcement, were used to promote learning and maintain motivation. These included verbal praise, handing out a requested toy or giving the child a reward (Ingersoll & Schreibman, 2006; Kasari et al., 2008).

A selection of intervention goals, with descriptions of sample activities, designed by the researcher, is provided in Table 1. These activities are appropriate for interacting with very young children and aim to promote responding to and initiating joint attention.

Such tasks included activities to exercise maintaining eye-contact, using and understanding of referential gestures, sharing attention to an object and triadic coordination as well as increasing proto-declarative pointing, and later improving the promptness of pointing. The specific areas of joint attention that were targeted in the current teaching approach are: (1) shared eye gaze; (2) response to joint attention bids; (3) response to joint attention bids in ambiguous situations; (4) initiating joint attention; (5) complex joint attention behaviours; (6) increase in the promptness of initiating joint attention; (7) increase in the level of difficulty of joint engagement and (8) distal joint engagement. For teaching these specific skills behavioural shaping methods were followed which will now be explained for each objective.

The first objective was to promote shared eye gaze (1) which is important to increase eye-contact in social-communicative situations that is mainly challenging for autistic children who show a lack in eye gaze. By increasing eye contact it was assumed to promote the child's access to a shared focus for shared references which is essential for the development of pragmatic and vocabulary skills. The teaching approach to promote shared eye gaze allowed constant verbal encouragement (with simple and clear instructions e. g. "Eyes on!" "Look at me!"), and the presentation of specifically designed tasks. The children participated in tasks, such as *"Keep an eye on me"*, i.e. to hold eye contact through a one metre, colourful tube that attracts young children. Desired eye contact behaviour was encouraged by providing rewards. Throughout the training of shared eye gaze direct and indirect reinforcement was given. The task was repeated and trained until a routine was established and the child was able to hold eye contact for a longer period of time through the tube. Later a gradual expansion from the sample task *"Keep an eye on me"* to natural contexts was promoted, e.g. shared distal eye gaze was practiced without the tube.

The second objective was to increase responding to joint attention (2). The rationale for promoting this area of joint attention was to train social awareness, i.e. to gain the understanding that other people have social intentions and response is expected to show one's own desires. By training responding to joint attention and social awareness it was assumed to promote the development of pragmatic skills. To achieve an increase in responding to joint attention and social interaction (2) a high ratio of joint attention bids and an exploratory environment with a number of toys, pictures, books and tasks was necessary. Apart from direct and indirect reinforcement the behaviour was shaped with attractive interaction tasks, such as *"I shine, you point"*. This task was designed to attract the child's interest and attention. For that purpose, a number of novel pictures were provided on the wall around the room out of reach of the child. The pictures were varied and selected accordingly to the child's individual interest that was discovered from an interview with the caregiver prior to the intervention. Window shutters were closed to increase the focus of attention in a shaded room or left open if a child preferred light.

A torch light was employed to shine on one picture after the other and the child was asked to point to the highlighted items. This task was later used in role reversal to promote initiating joint attention (4). For that purpose, the torch was given to the child and the child was asked to highlight pictures on the wall to attract the adult's attention and achieve a response (verbal response/pointing to the item). Another designed task to initiate joint attention in young autistic children was *"Find, point, win a star"*. Firstly, the child was asked to leave the room to build on its natural curiosity. Secondly, attractive fairy stones were hidden before the child entered the room. Thirdly, the child was asked to find the stones and point them out to receive a star reward card after finding and pointing out at least five fairy stones (behavioural teaching). To further attract enthusiasm/interest and promoting joint engagement with objects, a magic wand was used to touch each fairy stone after the child has pointed them out and the examiner made them vanish in a magic bag. For some children less complex interactions were necessary to achieve novel joint attention skills, such as throwing and catching a flamboyant looking teddy or different coloured soft balls. The examiner held up the objects by asking "Where is the teddy/ball? Point to teddy/ball!" and threw the object back to the child after the pointing gesture was accomplished.

The examiner initially modelled the pointing gesture, as well as showing the child how to point. In addition, a folding device was employed to promote initiating and responding to joint attention. Various symbols could be pressed on a keyboard flashing up with sound at different positions on a mirror in front of the children. The children were first asked to press a symbol and point to the object on the mirror as well as holding eye contact with the examiner through the mirror.

In addition to these tasks the blocking and teasing task of Baron-Cohen (Charman et al., 2000; Phillips, Baron-Cohen, & Rutter, 1992; Warreyn, Roeyers, Oelbrandt, & De Groote, 2005) was employed to promote the response to joint attention bids in ambiguous situations. During the blocking task, the child was encouraged to play with a number of toys.

The examiner waited until the child was visually and manually engaged with a toy and then covered both hands of the child with his hands for 5 seconds, preventing the child from continuing his activity during this interval.

During the teasing task the examiner offered the child a toy only to withdraw it when the child started to reach out. During both the blocking and teasing task the examiner displayed a neutral facial expression and looked towards the face of the child. The objective of the tasks was to establish eye contact in ambiguous situations and to promote the initiating of joint attention, e.g. the child reached out or pointed to the blocked object to request it. The rationale of providing ambiguous situations was to improve the understanding of social-communicative interaction, i.e. to support the understanding that a response to joint attention is expected in communication to show others' intentions, such as gestural and verbal requests (e.g. "give me that toy back!") or emotions (e.g. surprise or anger after a withdrawal of the preferred object).

More complex joint attention tasks were gradually introduced to enhance the child's learning. These included the training of complex initiating joint attention behaviours (5) to challenge the child's requesting behaviour and promote sharing of attention and triadic communication between child, examiner and object a and b (coordinated gaze shifting). For this purpose, a shopping game was introduced promoting the child's use of gestures and requesting behaviours for desired objects.

In addition, the *"Get the key task"* was designed for supporting the child in making progress in initiating joint attention. For this task a wind-up toy was demonstrated to the child that was turned on with a key and moved with salient light effects. The examiner maintained the key which was clearly visible for the child and presented to be distracted. It was assumed that the child consequently would show joint attention behaviours by either looking at the noticeable object or pointing to the object or requesting the key. The rationale for presenting more complex joint attention tasks was to increase the understanding of mechanisms and coherences (e. g. turning of the key moves the wind-up toy) through shared attention and gaze following. Further, the child was challenged to show requesting behaviour.

In addition to these areas of joint attention the promptness of initiating joint attention (6) was specifically trained which is important to establish proto-declarative pointing. This was gained through direct and indirect reinforcement and specifically designed tasks such as the *"Where is busy bee"* and *the "Where is the duck"* task. For promoting the promptness of pointing a magnet of a bee/duck was placed on each second or third side of a big picture book. The book was shown to the child with the question "Where is the busy bee/duck?" and later "Who can point first?" which reinforced the child to point faster than the examiner.

A further objective was to promote the child's ability to engage with different objects and situations in every-day life. Therefore the level of difficulty in joint engagement tasks was gradually increased (7) by extending the number of objects and changing from one activity to another more rapidly. The rationale was to teach a constant focus of attention in various situations, i.e. to teach the child to focus on a certain object even though there were more distractions. For this purpose the task "*I shine, you point"* was modified by increasing the number of items on and changing them which is particularly challenging for autistic children who prefer routines.

The final objective was to promote distal joint engagement to enable the child to maintain joint attention outside the immediate visual field. Therefore, head-turning tasks and the "*Buzz for the elephant*" task were designed. During this task the child was shown an animal picture booklet within a distance of two metres and the child was asked to maintain attention and to use a buzzer if he identified an elephant. In addition, different pop-up toys with sound were frequently employed to attract the child's attention and promote distal joint attention skills.

Table 1 provides a summary of the particular areas of joint attention intervention and the objective and rationale associated with each area.

From the beginning of the intervention a constant repetition of play sequences was necessary until a routine was established (Rollins, Wambacq, Dowell, Mathews, & Reese, 1998; Tomasello, 1995).

Then, the material could be varied and the routine was enlarged to other contexts in a natural environment, i.e. at the beginning, the children were trained to hold eye-contact through a tube and later on look at a picture on the wall, a picture book and the examiner's face in a natural context.

During the activities visual support and a structured learning condition were provided to capitalize on the fact that autistic children tend to prefer visual and structured learning experiences (Aarons & Gittens, 1992). Visual support was ensured by the introduction of numerous symbols, which were repeated in each session and enabled the children to process information, organise their own thoughts and consequently encouraged communication. For that purpose, the pictographs of Mayer-Johnson (1994) were employed. These were introduced at the beginning of the session and remained visible and noticeable on the wall during the session. Structured learning was provided by a clear course of activities during the 90 minute intervention, such as an introduction with a welcoming game and an ending with a rewarding game to create a safe, predictable environment for the child. The course of activities of each session was introduced to each child prior to the intervention.

Apart from contingent reinforcement of desired joint attention behaviours during the whole session (e.g. "Great pointing! Good looking! Well done!"), joint attention behaviours were highlighted and rewarded after each session (e.g. "You did a great job pointing to the fairy stones today! Thanks for showing me! Have a sticker for pointing!").

4.4.1.4 Developmental Trajectories

The joint attention intervention followed developmental trajectories of joint attention in typically developing children. Considering these stages in development, the first days of therapy mainly addressed dyadic interaction (Leekam et al., 1998). Depending on the individual progress of each child, triadic coordination tasks were gradually introduced (Dominey & Dodane, 2004; Leekam & Moore, 2001). The different developmental time frame of RJA and IJA was considered.

As RJA emerges first in typical development (Moore & Dunham, 1995), it was addressed in the therapy process as the first step. Responding to joint attention training involved joint attention behaviours, such as response to a hand on an object, response to showing of an object, eye contact, following a point, and following the gaze of the experimenter. These skills were gradually extended outside the child's immediate visual field and head turns or a pointing gesture to a target that was located behind the child were taught (Butterworth & Nicholas, 1991).

In summary, a joint attention intervention for autistic children requires an approach which follows developmental trajectories of joint attention. This knowledge enables the creation of interspersed activities that range in their level of difficulty. The child's choice of materials and a variety of salient objects and events are required to maintain the motivation of the autistic child to master joint attention skills. Furthermore, different types of contingent prompting, direct and indirect reinforcement, as well as idiosyncratic social reinforcers, provide an optimal learning environment for the autistic child. The current study investigated the effect of an intervention targeting joint attention on the language development of autistic children.

The intervention systematically promoted joint attention abilities and the sessions are explained in detail by providing information on the general approach during intervention and specific sample tasks. The intervention objectives followed the developmental trajectories of typically developing children, and promoted specific joint attention skills. This made it possible to ensure that any change in joint attention and language is due to training joint attention during intervention.

Table 1.*Objective and Rationale for Different Areas of Joint Attention*

Objective	Rationale
1) Shared eye gaze	↑ access to shared focus for shared references
↑ eye gaze frequency within structured context	↑ vocabulary/pragmatic development
2) Response to JA bids	↑ social awareness
↑ responding to JA bids	↑ pragmatic development
3) Response to JA bids in ambiguous situations	↑ understanding of social communication
↑ response in ambiguous situations	↑ showing of intentions/emotions
	↑ gestural/verbal requests
4) Initiating JA	↑ understanding/meaning of initiating JA
↑ proto-declarative pointing	↑ communication
↑ coordinated gaze shifting	↑ turn-taking skills
↑ showing objects/events	↑ social skills: making choices/requesting
5) Complex initiating JA behaviours	↑ understanding of coherences
↑ sharing of attention	↑ shared attention
↑ triadic coordination	↑ gaze following
↑ coordinated gaze shifting	↑ requesting behaviour
6) Promptness of initiating JA	↑ gestural use to direct communication
↑ proto-declarative pointing	↑ frequency of pointing
↑ promptness of pointing	↑ speed of pointing
7) Level of difficulty in joint engagement	↑ constant attention focus in various situations
↑ ability to engage with different objects/events	↑ skill to neglect distractions
8) Distal joint engagement	↑ JA maintenance outside immediate visual field
↑ distal joint engagement	

↑ (establish/ increase/ promote)

4.5 Procedures

The study consisted of four consecutive phases (assessment, baseline/intervention, post-intervention and follow-up). Data collection took place for each phase.

4.5.1 Assessment Phase

A number of measures were completed during the assessment phase in order to specify the extent of language disorder evident, and quantify the diagnosis of autism. Prior to starting the intervention, an interview was conducted with the parents obtaining in-depth background information on family history (gender, birth, ethnicity, bilingualism, education of parents), living situation and medical history (birth, hearing, diseases, family medical history) (Appendix D, E, F).

The behaviours of each child were observed and rated for the *Childhood Autism Rating Scale* (CARS) to identify and classify the child's level of autism severity (DiLalla & Rogers, 1994; Schopler et al., 1980).

The language profile of the children was assessed prior to the intervention using the following tests: *Reynell Developmental Language Scales* (RDLS-III, Edwards et al., 1997); *Peabody Picture Vocabulary Test* (PPVT-IV, Dunn & Dunn, 1997, 2007) and the *Expressive Vocabulary Test* (EVT-II, Williams, 1997). Joint attention abilities were assessed, video-recorded and analysed using the *Early Social Communication Scales* (ESCS, Mundy et al., 2003).

4.5.2 Baseline/Intervention Phase

The multiple baseline design involved measurements taken from videos of each session of the intervention (coding of joint attention) and outcome variables (coding of language). During the baseline and intervention phase, joint attention was coded using an adaptation of Mundy's Early Social Communication Scales schema (Mundy et al., 2003).

This included the variables initiating joint attention (eye contact, alternate, point, point and eye contact, show) and responding to joint attention (correct follow proximal point/touch, correct follow line of regard). The variable Mean Length of Eye Contact (MLE) was added to Mundy's schema. Inter-rater reliability checks were completed on 78.6% of video samples for each single participant taken at seven different intervention sessions (randomized at completion), during three baseline sessions (randomized at completion) and during one follow-up.

Language was coded using the Systematic Analysis of Language Transcripts (SALT) software (Miller, 2008) until 55 entirely intelligible child-utterances were obtained. For this purpose, child-examiner conversations were transcribed for session 1, 10 and 20 providing data for analysing syntax, semantics and pragmatics.

These included the variables Mean Length of Utterances in words (MLUw) and morphemes (MLUm), Mean Turn Length, percentage of response to questions, verbal rate of words per minute and Type Token Ratio (TTR).

4.5.3 Post-Intervention and Follow-up Phase

The joint attention measure (ESCS) and the battery of language measures (RDLS-3/C, RDLS-3/E, PPVT-4/A, PPVT-4/B, EVT-2/A, EVT-2/B) were repeated after intervention and at 3 months follow-up in order to further examine language changes across the research period. A summary of the measures is provided in Table 4. The background and purpose of the specific measurements is further explained below.

Table 4.*Summary of Measures*

Assessment	Baseline/Intervention	Post-intervention	Follow-up
CDI Interview	ESCS (adaptation)		
CARS	Video observation		
RDLS-3/C	MLE Video	RDLS-3/C	RDLS-3/C
RDLS-3/E	SALT Video	RDLS-3/E	RDLS-3/E
PPVT-4/A		PPVT-4/A	PPVT-4/A
PPVT-4/B		PPVT-4/B	PPVT-4/B
EVT-2/A		EVT-2/A	EVT-2/A
EVT-2/B		EVT-2/B	EVT-2/B

4.6 Language Measures

4.6.1 Reynell Developmental Language Scales-3 (RDLS-3/C, RDLS-3/E)

The RDLS-3 is a standardised measure of receptive and expressive language employed with children between 1:06 and 7:06 years. For both areas of language a battery of standard toys and a picture book were applied. The Comprehension Scale (RDLS-3/C) consists of 62 items organised into ten sections, including comprehension of single words (e.g. *doll*), named objects (e.g. “Put the keys in the box”), agents and actions (e.g. “Make rabbit jump”), clausal constituents (e.g. “Make rabbit push the bed”), attributes (e.g. “Show me the sad cat”), and noun phrases (e.g. “Put the longest pencil in the box”).

In addition, the understanding of locative relations (*on top of, next to, under, behind, in front of*), thematic roles in sentences (e.g. “The boy is carrying an elephant”), as well as vocabulary and complex grammatical skills (e.g. “The girl who is wearing a hat is running”) were assessed. Furthermore, the ability to infer behaviours and situations from a picture (e.g. “Who’s been naughty? Who is feeling very upset?”) was examined. The Expressive Scale (RDLS-3/E) consists of 62 items organised into six sections. These sections covered simple object-, action- and attribute-words. Additionally, use of grammar, such as verbs in phrases, inflections (plurals, third person, past tense), clausal elements (e.g. “Teddy’s loading the bricks on the truck”), auxiliaries (negatives, questions) and complex structures (imitation, correction of errors, utterance completion) were examined. The test is useful to carry out with children who have language impairments. It monitors the individual progress of each child by showing strength and weaknesses in different areas of language (Edwards et al., 1997).

4.6.2 Peabody Picture Vocabulary Test-4 (PPVT-4/A, PPVT-4/B)

The PPVT is a well-established test to measure the receptive vocabulary of participants ranging in age from 2 through 90+ years. Dunn and Dunn (2007) collected data for the new version (PPVT-4) from 2005 to 2006 which consisted of an age norm sample of 3,540 cases, of 1,793 females and 1,747 males. The sample population of the age group 2 through 18 included representative proportions of individuals with speech and language impairments, Attention-Deficit Hyperactivity Disorder (ADHD), emotional disorder, developmental delay, specific learning disability and others. It is crucial to note that also autistic individuals were involved in this sample population.

The PPVT-4 measured single-word vocabulary for nouns, verbs and adjectives. For this purpose a picture booklet was shown to the participants consisting of four full-colour pictures on each page. The participants were presented with a spoken word by the examiner and asked to choose one of the four pictures.

Two parallel forms, Form 4/A and 4/B, each consisting of 4 training items and 228 test items, grouped into 19 sets of 12 items arranged in order of increasing difficulty, were employed. A basal and a ceiling set determined the basal item set in which the child made one or no errors and the ceiling item set in which the child made eight or more errors (Dunn & Dunn, 2007). A raw score was obtained by subtracting the total number of errors from the ceiling item. The raw score was converted into a standard score and provided deviation-type normative scores and developmental-type normative scores. Deviation-type normative scores included standard scores, percentiles, Normal Curve Equivalents (NCEs) and stanines. These scores based on the raw score and were compared to an age-matched sample. Developmental-type normative scores included age-equivalents and provided information on the developmental level of the examinee based on the raw score. Furthermore, the revised 4th version of the PPVT provided Growth Scale Values (GSVs), a metric to measure progress over time. Another advantage of the revised version was the larger number of stimulus words and enhanced illustrations. Word types across all levels of difficulty were measured and evaluated.

Internal consistency reliability checks indicated a split-half reliability of M = .94 for form A and B and a Standard Error of the Mean SEM of 3.6 respectively. The alternate-form reliability consisted of M = .89 and the Test-retest reliability of r = .93. Validity checks were inter alia obtained comparing the PPVT-4 with the EVT-2 (n = 3,540, average r = .82).

4.6.3 Expressive Vocabulary Test (EVT-2/A, EVT-2/B)

The EVT-2 is designed to assess expressive vocabulary of participants ranging in age from 2 through 90+ years (Williams, 1997). For this purpose, a picture booklet was shown to the participants displaying one full-colour picture on each page. The examiner provided certain stimulus questions such as “What is this?”, “What do you see?”, “What colour is this?”, “How many balls do you see?”, “What is she doing?”, “What shape is this?” or “Tell me another word for *steps*” and the child was prompted to provide specific vocabulary knowledge relating to the pictures. Two parallel forms, EVT-2/A and EVT-2/B, each with 190 items, were used in the current study. According to the PPVT-4, Growth Scale Values measured the progress of each child over time.

Since the PPVT-4 and the EVT-2 were standardised on the same population of 2,725 examinees, they were suitable for direct comparisons of receptive and expressive vocabulary by looking at growth score differences. Both measures have a high reliability and validity concerning early language and vocabulary (Morales et al., 2000).

4.6.4 Systematic Analysis of Language Transcripts (SALT)

Language video samples were transcribed for session 1, 10 and 20 for each participant using the Systematic Analysis of Language Transcripts (SALT) software (Miller, 2008). The language samples were compared to the New Zealand reference databases of approximately 255 randomly selected typically developing children from Auckland, Hamilton and Christchurch (Gillon, Miller, Schwarz, & Westerveld, 2002; Westerveld & Gillon, 2001, 2002).

Analysing spontaneous language during conversation had the advantage of collecting natural child's responses and reflecting a real-life situation rather than testing predetermined expressive vocabulary through standardized tests. In comparison to standardized tests, a higher ecological validity regarding evaluating language abilities and possible impairments of children is guaranteed (Hewitt, Hammer Scheffner, Yont, & Tomblin, 2005). Descriptive data is provided for a variety of linguistic characteristics. Results will be reported for syntax and morphology (Mean Length of Utterances in words and morphemes), semantics (Type Token Ratio), utterance formulation and pragmatics. Mean Length of Utterances (MLU) is a linguistic measure used to indicate verbal production and proficiency in young children providing information on the syntactic complexity of speech (Eisenberg, Fersko, & Lundgren, 2001). It is calculated by dividing the number of morphemes or words by the total number of oral utterances. In addition, the Type Token Ratio (TTR) was obtained to indicate the level of lexical variation and hence exploring vocabulary skills by dividing the number of different words (types) the participants expressed during conversation by the total number of words (tokens) (Hoerning, 2007; Richards, 1987).

Expressive language samples of each participant were transcribed until a total number of 55 selected, entirely intelligible, utterances were collected to measure MLU in words and morphemes as well as TTR. Hence, it was used for four coherent rationales: (1) to analyze expressive language, (2) to observe possible language delays, (3) to monitor areas of difficulties and (4) to measure possible progress of language at different stages of intervention.

Chapter 5
Results

This chapter contains the results of language and joint attention assessments. Language was analyzed using two different types of assessments: standardized measures and spontaneous language samples of child/examiner conversations.

5.1 Receptive Language

Receptive language performance was measured during three phases: (1) assessment, (2) post-intervention, and (3) follow-up. Two instruments, the *Peabody Picture Vocabulary Test* (PPVT-4) and the *Reynell Developmental Receptive Language Scales* (RDLS-3/C), were individually administered.

The PPVT-4 measured single-word vocabulary for nouns, verbs and adjectives. Five methods of analysis were used:

(1) General classification of receptive vocabulary. Percentile scores and test-age equivalents were compared to the normative sample.

(2) Growth Scale Value (GSV) interpretation. This measure is an equal-interval scale of vocabulary evaluating progress and possible change over time in relation to an age-matched sample. Standard scores of each administration were converted to GSV scores allowing interpretations of the intensity of vocabulary improvement prior to and after the intervention. In the end, the GSV difference at pre- and post-stages was calculated to analyze potential change in language performances, GSV > 8 indicated a significant change in receptive vocabulary (Dunn & Dunn, 2007).

(3) Graphical profile analyses. The graphical profile analyses allowed for conclusions regarding the receptive vocabulary performance of each participant prior to the intervention as well as providing evidence for possible change after the intervention (Dunn & Dunn, 2007). For a graphical profile analysis the age-based standard scores were plotted drawing a vertical line intersecting with the percentile, Normal Curve Equivalent (NCE), and stanine values and showing three sets of confidence intervals on the Gaussian distribution. Descriptive results in comparison to the age-matched sample were obtained including *extremely low* (-5SD to -2SD), *moderately low* (-2SD to -1SD) to *average* (-1SD to +1SD) for all participants comparing pre- and post-intervention data.

(4) Reliable change interpretation. For the next procedural step the reliable change index (RCI) was calculated. For this purpose, two parallel forms were administered and different forms were compared at pre- and post-test stages (A – B/B – A). For the analyses of clinical significance of change the standard error of the measurement (SEM), the standard error of the difference (SED) and the reliable change index (RCI) was computed. By obtaining the RCI score, conclusions on the efficacy of the intervention and possible progress from pre- to post-stages could be drawn (Jacobson & Truax, 1991). Assuming an internally valid research design, RC > 1.96 indicates a real change which can not be ascribed to measurement fluctuations or measurement error (Jacobson & Truax, 1991; Wise, 2004).

(5) Clinically significant change. The last procedural step was undertaken in order to determine if the change was clinically meaningful. The formula for clinically significant change which was first introduced by Jacobson, Follette, and Revenstorf (1984) was employed to measure change in autistic children (Jacobson, 1988; Jacobson, Follette, & Revenstorf, 1986; Jacobson & Revenstorf, 1988; Jacobson & Truax, 1991).

The RDLS-3/C was employed as a wide-range instrument that provided measures of comprehension of language at various levels of complexity. A receptive language classification was obtained in relation to the normative sample by looking at the percentile and age-equivalent scores. In addition, reliable change scores were calculated employing standard scores obtained prior to and after the intervention.

Results for the four participants will first be reported separately and then pooled in order to report on within-individual growth scores as well as reliable and clinical significance of change.

5.1.1 Participant A

Participant A was 4:09 years old during the initial assessment (phase 1), at age-equivalents of 2:04 (A) and 2:05 (B). Scores were compared against norms for children of the same chronological age. *Peabody Picture Vocabulary Test* (PPVT-4) standard scores of 61 (form A) and 64 (form B) were obtained. Confidence internals ranged between 57-67 (A) and 60-70 (B). There is a 90% chance that these scores included the child's true score. Percentiles scores indicated that the child scored as well as or better than 0.5 (A) / 1 (B) percent of age-matched peers. The *Reynell Developmental Comprehension Scale* (RDLS-3/C) was at an age-equivalent of 2:05 years and the first percentile. In summary, the examinee's receptive language functioning was in the extremely low range during phase 1 (see table 6).

Table 6.*Participant A: Score Summary of Receptive Language Skills*

Phase	*Test/Form*	*SS*	*Conf. Interval*	*Percentile*	*NCE*	*Stanine*	*CA*	*AE*	*Description*
	PPVT-4/A	61	57-67	0.5	<1	1		2:04	extremely low
1*	PPVT-4/B	64	60-70	1	<1	1	4:09	2:05	extremely low
	RDLS-3/C	0	-	1	-	-		2:05	-
	PPVT-4/A	79	75-84	8	21	2		3:06	moderately low
2**	PPVT-4/B	78	74-83	7	19	2	4:11	3:05	moderately low
	RDLS-3/C	17	-	1	-	-		3:03-3:06	-
	PPVT-4/A	78	73-85	7	19	2		3:06	moderately low
3***	PPVT-4/B	77	72-84	6	18	2	5:02	3:06	moderately low
	RDLS-3/C	14	-	1	-	-		3:03-3:06	-

** Assessment phase*
*** Post-intervention phase*
**** Follow-up phase*

Table 7 shows the administration phases, chronological ages, standard scores and converted GSV scores for participant A in relation to the normative sample (mean/range). The GSV is an equal-interval scale which allows measurement of within-individual vocabulary improvement as an effect of intervention programs (Dunn & Dunn, 2007). At all stages of assessment, GSV scores were below the normative sample which indicates a delay in receptive vocabulary growth. However, an increase in the GSV from pre- to post-intervention was noticeable which will further be analysed looking at the measure of significance of GSV differences (Dunn & Dunn, 2007).

Table 7.*Participant A: Summary of GSV scores*

Phase	*CA*	*Test/Form*	*SS*	*GSV*	*National GSV Scores*	
					Mean	*Range*
1*	4:09	PPVT-4/A	61	82	131	117-145
	4:09	PPVT-4/B	64	86	131	117-145
2**	4:11	PPVT-4/A	79	105	131	117-145
	4:11	PPVT-4/B	78	104	131	117-145
3***	5:02	PPVT-4/A	78	106	140	127-153
	5:02	PPVT-4/B	77	105	140	127-153

* *Assessment phase*
** *Post-intervention phase*
*** *Follow-up phase*

The graphical profile of deviation-type normative scores, i.e. raw score comparison with an age-matched sample, showed that participant A fell at the extremely low end of the average range prior to the intervention between -2SD to -3SD from the normal average range (see figure 1). After the intervention, the profile of deviation-type scores indicated an increase, falling at the moderately low end of the normal average range with a deviation between -1SD to -2SD (see figure 2).

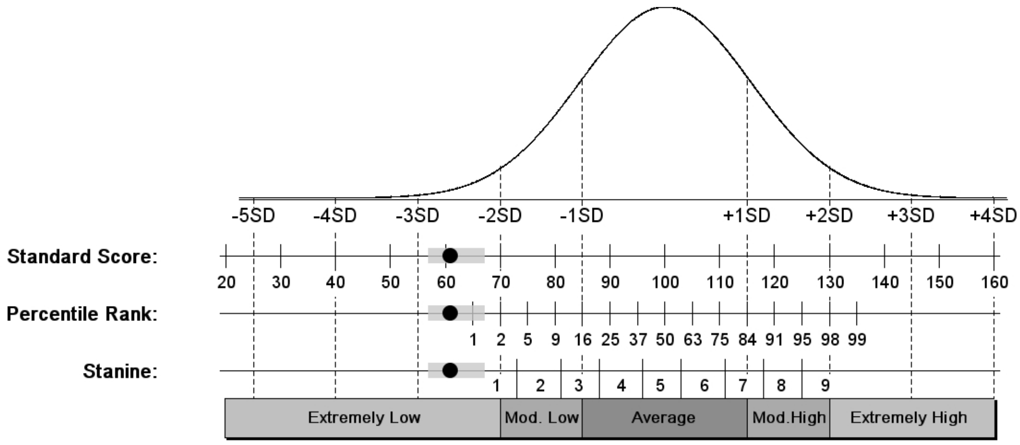


Figure 1.*Participant A: Receptive Vocabulary Skills during Phase 1 (form A)*

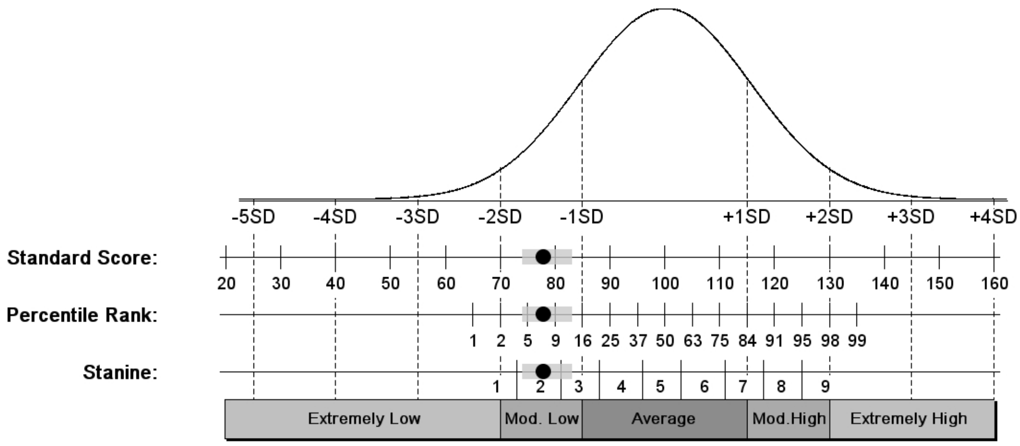


Figure 2.*Participant A: Receptive Vocabulary Skills during Phase 2 (form B)*

5.1.2 Participant B

Participant B had an initial chronological age of 5:07 years, at an age-equivalent of below 2 years. PPVT scores equal to or below 0.1 percent of age-matched peers were achieved. This represents the lowest possible percentile rank. The RDLS-3/C was at an age-equivalent of 1:09 and the first percentile. In summary, the level of receptive language functioning was extremely low during phase 1 (see table 8). Table 9 shows GSV scores obtained by participant B in relation to the normative sample. During all stages of testing, GSV scores deviated considerably from GSV mean scores of children at the same chronological age indicating a considerable delay in receptive vocabulary growth. Individual growth of GSV scores from pre- to post-intervention was noted which will be further analyzed later.

Table 8.*Participant B: Score Summary of Receptive Language Skills*

Phase	*Test/Form*	*SS*	*Conf. Interval*	*Percentile*	*NCE*	*Stanine*	*CA*	*AE*	*Description*
1*	PPVT-4/A	44	40-52	<0.1	<1	1	5:07	<2:00	extremely low
	PPVT-4/B	41	37-49	<0.1	<1	1		<2:00	extremely low
	RDLS-3/C	0	-	1	-	-		1:09	-
2**	PPVT-4/A	55	50-62	0.1	<1	1	5:10	2:06	extremely low
	PPVT-4/B	57	52-64	0.2	<1	1		2:06	extremely low
	RDLS-3/C	0	-	1	-	-		2:02	-
3***	PPVT-4/A	54	50-60	0.1	<1	1	6:01	2:05	extremely low
	PPVT-4/B	58	54-64	0.3	<1	1		2:07	extremely low
	RDLS-3/C	0	-	1	-	-		2:02	-

** Assessment phase*
*** Post-intervention phase*
**** Follow-up phase*

Table 9.*Participant B: Summary of GSV scores*

Phase	*CA*	*Test/Form*	*SS*	*GSV*	*National GSV Scores Mean*	*Range*
1*	5:07	PPVT-4/A	44	70	140	127-153
	5:07	PPVT-4/B	41	66	140	127-153
2**	5:10	PPVT-4/A	55	86	140	127-153
	5:10	PPVT-4/B	57	88	140	127-153
3***	6:01	PPVT-4/A	54	85	150	139-161
	6:01	PPVT-4/B	58	90	150	139-161

** Assessment phase*
*** Post-intervention phase*
**** Follow-up phase*

The graphical profile analysis illustrates results on form A (phase 1) and form B (phase 2) and indicates that participant B fell at the extremely low end of the average range prior to the intervention and between -3SD to -4SD from the normal average range (see figure 3). After the intervention, the profile of deviation-type scores showed an increase, however, still ranging at the extremely low end between -2SD to -3SD from the mean (see figure 4).

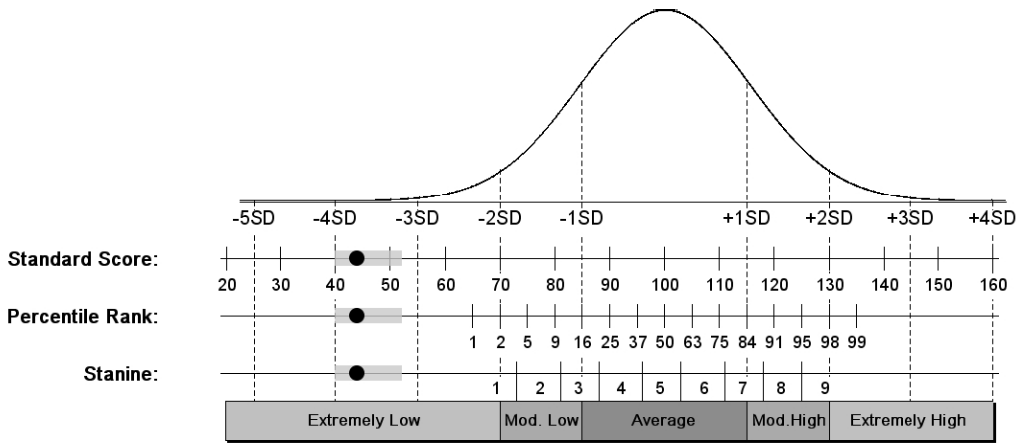


Figure 3.*Participant B: Receptive Vocabulary Skills during Phase 1 (form A)*

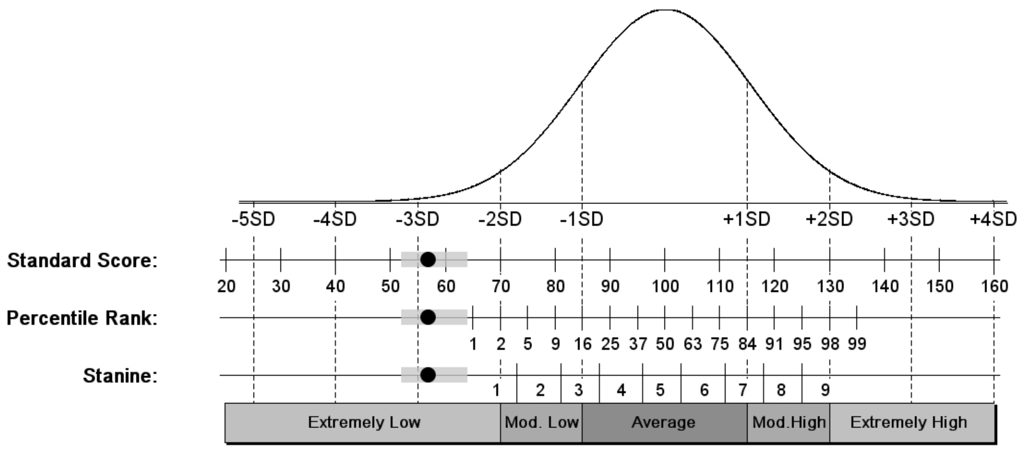


Figure 4.*Participant B: Receptive Vocabulary Skills during Phase 2 (form B)*

5.1.3 Participant C

Participant C had an initial chronological age of 3:08 years, at an age-equivalent of below 2 years. PPVT scores equal to or below 1 percent of age-matched peers were achieved. The RDLS-3/C was at an age-equivalent of 1:10 and at the first percentile. In summary, the examinee's receptive language was classified in the extremely low range during phase 1 (see table 10). Table 11 provides GSV scores during different phases of testing, and compared to mean scores of a normative sample. During all phases of assessment, participant C obtained GSV scores below the sample range indicating a delay in expressive vocabulary growth. Within-individual growth, comparing GSV scores from pre- to post-intervention will be further analyzed below.

Table 10.*Participant C: Score Summary of Receptive Language Skills*

Phase	*Test/Form*	*SS*	*Conf. Interval*	*Percentile*	*NCE*	*Stanine*	*CA*	*AE*	*Description*
1*	PPVT-4/A	57	52-65	0.2	<1	1	3:08	<2:00	extremely low
	PPVT-4/B	62	57-70	1	<1	1		<2:00	extremely low
	RDLS-3/C	0	-	1	-	-		1:10	-
2**	PPVT-4/A	81	75-88	10	23	2	3:10	2:10	moderately low
	PPVT-4/B	80	74-87	9	22	2		2:09	moderately low
	RDLS-3/C	22	-	1	-	-		2:06	-
3***	PPVT-4/A	77	72-84	6	18	2	4:01	2:09	moderately low
	PPVT-4/B	80	75-87	9	22	2		2:11	moderately low
	RDLS-3/C	13	-	1	-	-		2:05	-

** Assessment phase*
*** Post-intervention phase*
**** Follow-up phase*

Table 11.*Participant C: Summary of GSV scores*

Phase	*CA*	*Test/Form*	*SS*	*GSV*	*National GSV Scores Mean*	*Range*
1*	3:08	PPVT-4/A	57	62	116	100-132
	3:08	PPVT-4/B	62	68	116	100-132
2**	3:10	PPVT-4/A	81	94	116	100-132
	3:10	PPVT-4/B	80	93	116	100-132
3***	4:01	PPVT-4/A	77	92	131	117-145
	4:01	PPVT-4/B	80	96	131	117-145

** Assessment phase*
*** Post-intervention phase*
**** Follow-up phase*

The graphical profile analysis for participant C shows results during pre- and post-intervention. Prior to the intervention, participant C's scores were between -2SD to -3SD from the average range (see figure 5). After the intervention, scores improved to between -1SD to -2SD from the mean (see figure 6).

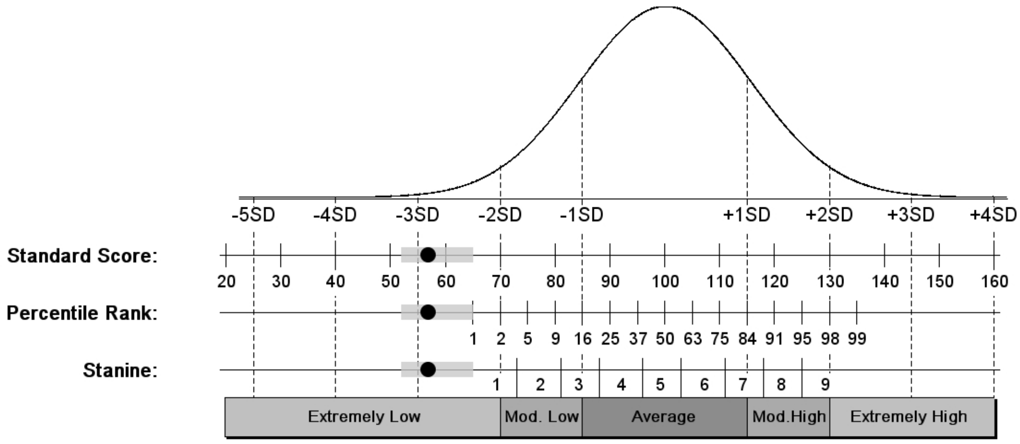


Figure 5.*Participant C: Receptive Vocabulary Skills during Phase 1 (form A)*

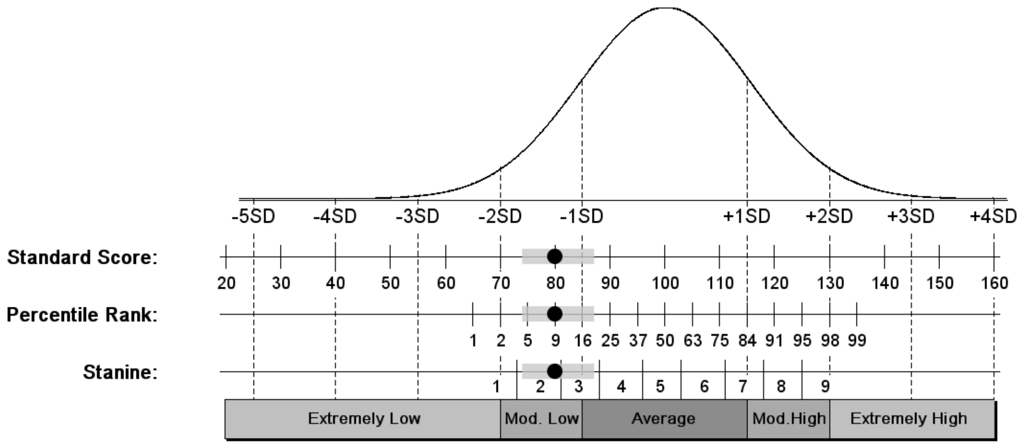


Figure 6.*Participant C: Receptive Vocabulary Skills during Phase 2 (form B)*

5.1.4 Participant D

Participant D, the youngest participant, was 2:07 years, at an age-equivalent of below 2 years. PPVT scores equal to or better than 3 (A) and 4 (B) percent of age-matched peers were achieved. The RDLS-3/C score was at an age-equivalent of below 1:09 years and a percentile rank of 1. Overall, the examinee's receptive language functioning was rated in the moderately low range during phase 1 (see table 12). Table 13 shows a considerable deviation of GSV scores from GSV mean scores for participant D. In comparison to children at the same chronological age, a delay in receptive vocabulary growth was noted. Individual growth will be analysed further below.

Table 12.*Participant D: Score Summary of Receptive Language Skills*

Phase	*Test/Form*	*SS*	*Conf. Interval*	*Percentile*	*NCE*	*Stanine*	*CA*	*AE*	*Description*
1*	PPVT-4/A	72	68-77	3	11	1	2:07	<2:00	moderately low
	PPVT-4/B	73	69-78	4	12	1		<2:00	moderately low
	RDLS-3/C	16	-	1	-	-		<1:09	-
2**	PPVT-4/A	87	83-92	19	32	3	2:09	2:01	average
	PPVT-4/B	85	81-90	16	29	3		2:00	average
	RDLS-3/C	26	-	1	-	-		2:01	-
3***	PPVT-4/A	82	77-88	12	25	3	3:00	2:02	moderately low
	PPVT-4/B	82	77-88	12	25	3		2:02	moderately low
	RDLS-3/C	19	-	1	-	-		2:01	-

** Assessment phase*
*** Post-intervention phase*
**** Follow-up phase*

Table 13.*Participant D: Summary of GSV scores*

Phase	*CA*	*Test/Form*	*SS*	*GSV*	*National GSV Scores Mean*	*Range*
1*	2:07	PPVT-4/A	72	53	103	86-120
	2:07	PPVT-4/B	73	54	103	86-120
2**	2:09	PPVT-4/A	87	77	103	86-120
	2:09	PPVT-4/B	85	74	103	86-120
3***	3:00	PPVT-4/A	82	78	116	100-132
	3:00	PPVT-4/B	82	78	116	100-132

** Assessment phase*
*** Post-intervention phase*
**** Follow-up phase*

Results for participant D on form A (phase 1) and form B (phase 2) are illustrated below (see figure 7, 8). The participant's performance fell at the moderately low end of the average range prior to the intervention and between -1SD to -2SD from the normal average range (see figure 7). After the intervention, the profile of deviation-type scores indicated that the participant's score increased to within the low average range (see figure 8).

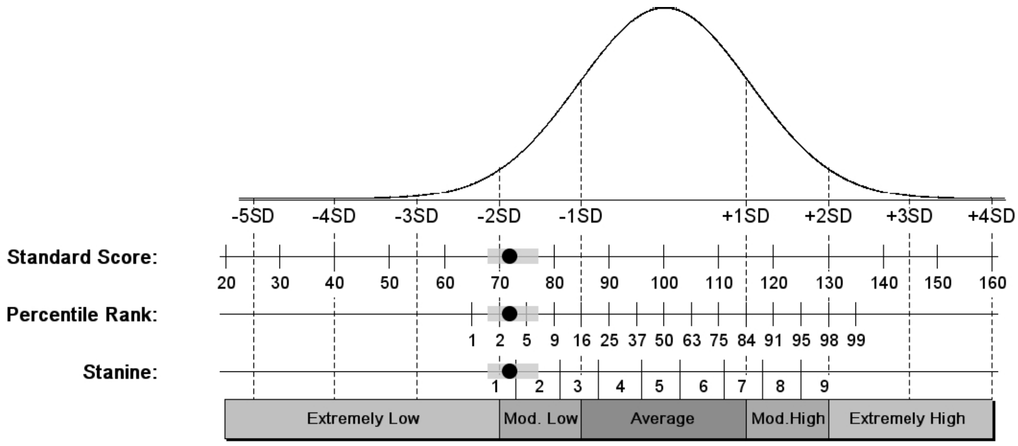


Figure 7.*Participant D: Receptive Vocabulary Skills during Phase 1 (form A)*

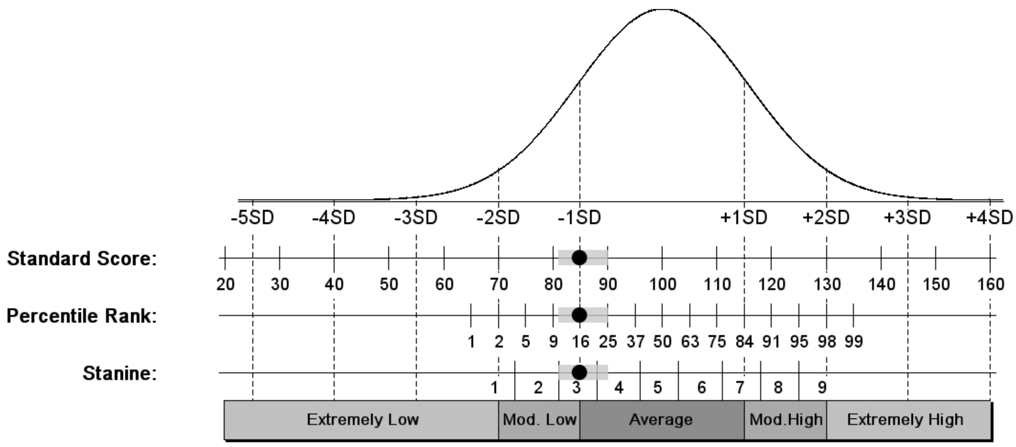


Figure 8.*Participant D: Receptive Vocabulary Skills during Phase 2 (form B)*

5.2 Expressive Language

Expressive language was measured during three phases: (1) assessment, (2) post-intervention, and (3) follow-up. Two instruments, the *Expressive Vocabulary Test* (EVT-2) and the *Reynell Developmental Expressive Language Scales* (RDLS-3/E) were individually administered.

The EVT-2 measured single-word vocabulary for nouns, verbs and adjectives. The following analyses were undertaken: (1) general classification of expressive vocabulary; (2) graphical profile analyses, (3) Growth Scale Value interpretation, (4) reliable change and (5) clinical significance interpretation.

The RDLS-3/E measured a wide-range of expressive language knowledge including single words, verbs, phrases, plurals, inflections (third person, past tense), clausal elements (e.g. "Rabbit is giving teddy a red brick, tell me what is happening"), expressive language imitation, correction of errors (e.g. "The lion attack_ the man") and auxiliaries (negatives, questions). For this purpose, a set of equipment was provided including various objects, a picture booklet and finger puppets. Data analysis involved a general expressive language classification as well as computing the reliable change index for each participant.

At first, results of the four cases will be reported separately and then pooled to look at vocabulary growth as well as reliable and clinically significance of change.

5.2.1 Participant A

Participant A obtained age-equivalent scores of 2:05 (A) and 2:07 (B). *Expressive Vocabulary Test* (EVT-2) scores equal to or below 1 percent of age-matched peers were achieved. The 90% confidence intervals ranged between 60-71 (A) and 62-74 (B). The *Reynell Developmental Expressive Scale* (RDLS-3/E) was at an age-equivalent of 2:05-2:06 and at the first percentile. Overall, the examinee's expressive language was categorized as extremely low during phase 1 (see table 14). Table 15 shows GSV score results obtained by participant A in relation to the normative sample (mean/range). During post-intervention, GSV scores ranged within national GSV norms.

Table 14.*Participant A: Score Summary of Expressive Language Skills*

Phase	*Test/Form*	*SS*	*Conf. Interval*	*Percentile*	*NCE*	*Stanine*	*CA*	*AE*	*Description*
1*	EVT-2/A	64	60-71	1	<1	1	4:09	2:05	extremely low
	EVT-2/B	67	62-74	1	4	1		2:07	extremely low
	RDLS-3/E	10	-	1	-	-		2:05-2:06	-
2**	EVT-2/A	77	72-84	6	18	2	4:11	3:04	moderately low
	EVT-2/B	78	73-85	7	19	2		3:05	moderately low
	RDLS-3/E	23	-	1	-	-		3:01	-
3***	EVT-2/A	75	69-82	5	15		5:02	3:05	moderately low
	EVT-2/B	75	69-82	5	15	2		3:05	moderately low
	RDLS-3/E	22	-	1	-	-		3:01	-

** Assessment phase*
*** Post-intervention phase*
**** Follow-up phase*

Table 15.*Participant A: Summary of GSV scores*

Phase	*CA*	*Test/Form*	*SS*	*GSV*	*National GSV Scores Mean*	*Range*
1*	4:09	EVT-2/A	64	101	122	107-137
	4:09	EVT-2/B	67	103	122	107-137
2**	4:11	EVT-2/A	77	115	122	107-137
	4:11	EVT-4/B	78	116	122	107-137
3***	5:02	EVT-4/A	75	117	134	119-149
	5:02	EVT-4/B	75	117	134	119-149

** Assessment phase*
*** Post-intervention phase*
**** Follow-up phase*

The graphical profile of deviation-type normative scores showed that the examinee's score fell at the extremely low end of the average range prior to the intervention and between -2SD to -3SD from the normal average range (see figure 9). After the intervention, the profile of deviation-type scores indicated that the examinee's score increased, falling at the moderately low end of the average range and deviated only between -2SD to -1SD from the normal average range (see figure 10).

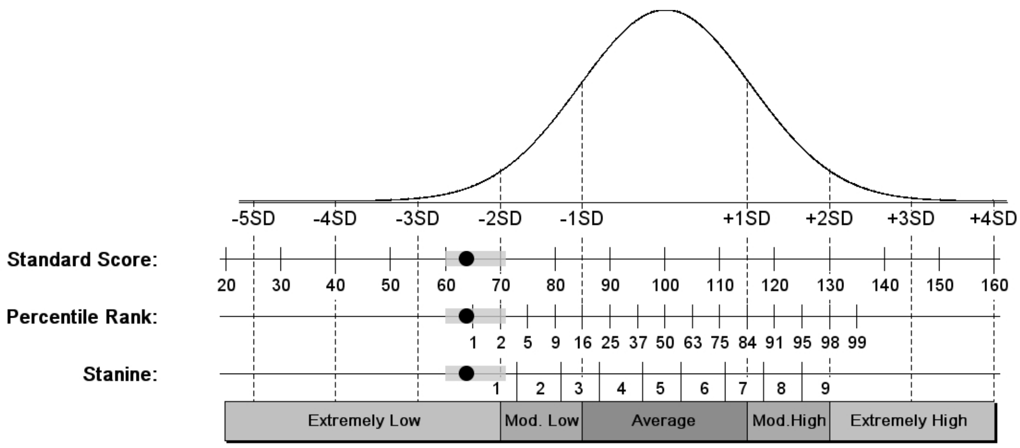


Figure 9.*Participant A: Expressive Vocabulary Skills during Phase 1 (form A)*

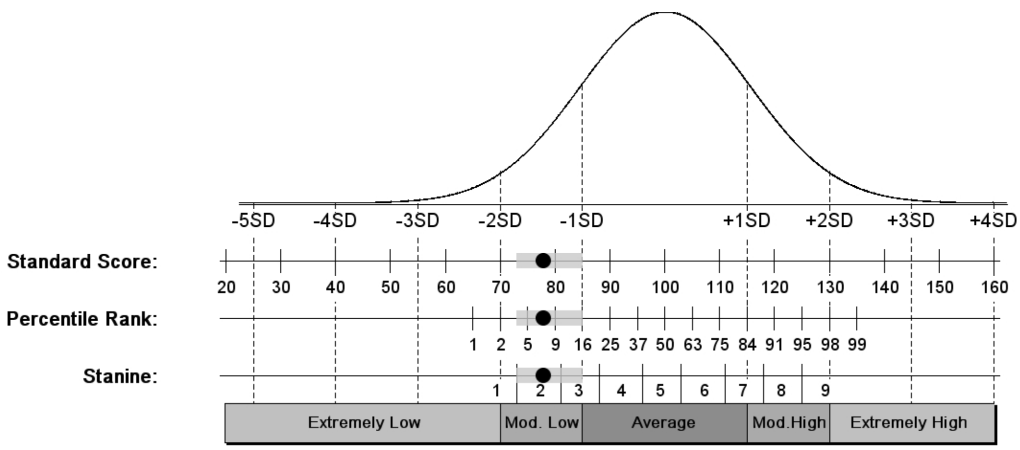


Figure 10.*Participant A: Expressive Vocabulary Skills during Phase 2 (form B)*

5.2.2 Participant B

Participant B achieved EVT-2 scores equal to or below 0.1 percent of age-matched peers, at age-equivalents of 2:04 (A) and 2:02 (B) years. The RDLS-3/E was at an age-equivalent of 2:02 years and at the first percentile. Altogether, an extremely low expressive language functioning was evident during phase 1 (see table 16). During all phases, GSV scores deviated considerably from the database mean and fell outside the GSV scores range (see table 17).

Table 16.*Participant B: Score Summary of Expressive Language Skills*

Phase	*Test/Form*	*SS*	*Conf. Interval*	*Percentile*	*NCE*	*Stanine*	*CA*	*AE*	*Description*
	EVT-2/A	51	47-58	<0.1	<1	1		2:04	extremely low
1*	EVT-2/B	49	45-56	<0.1	<1	1	5:7	2:02	extremely low
	RDLS-3/E	0	-	1	-	-		2:02	-
	EVT-2/A	60	55-67	1	<1	1		3:00	extremely low
2**	EVT-2/B	61	56-68	0.5	<1	1	5:10	3:00	extremely low
	RDLS-3/E	4	-	1	-	-		2:11	-
	EVT-2/A	59	54-68	0.3	<1	1		3:01	extremely low
3***	EVT-2/B	61	56-70	0.5	<1	1	6:1	3:02	extremely low
	RDLS-3/E	1	-	1	-	-		2:11	-

** Assessment phase*
*** Post-intervention phase*
**** Follow-up phase*

Table 17.*Participant B: Summary of GSV scores,*

Phase	*CA*	*Test/Form*	*SS*	*GSV*	*National GSV Scores Mean*	*Range*
1*	5:07	EVT-2/A	51	99	134	119-149
	5:07	EVT-2/B	49	97	134	119-149
2**	5:10	EVT-2/A	60	109	134	119-149
	5:10	EVT-2/B	61	110	134	119-149
3***	6:01	EVT-2/A	59	111	145	130-160
	6:01	EVT-2/B	61	113	145	130-160

** Assessment phase*
*** Post-intervention phase*
**** Follow-up phase*

The graphical profiles of pre-and post-test scores are presented below. Prior to the intervention, participant B fell between -3SD to -4SD from the average range (see figure 11). After the intervention, a shift towards ranging between -2SD to -3SD from the mean was apparent (see figure 12).

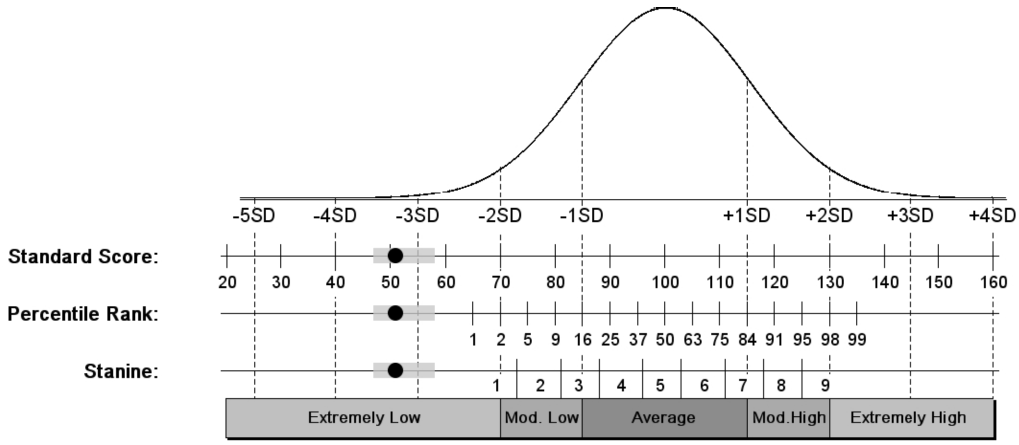


Figure 11.*Participant B: Expressive Vocabulary Skills during Phase 1 (form A)*

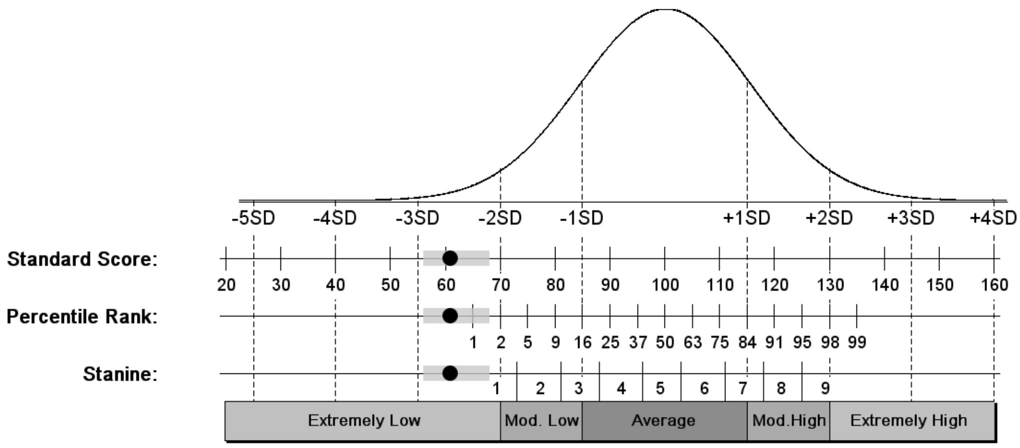


Figure 12.*Participant B: Expressive Vocabulary Skills during Phase 2 (form B)*

5.2.3 Participant C

Participant C achieved EVT-2 scores equal to or better than 7 (A) and 8 (B) percent of age-matched peers, at an age-equivalent of 2:04 years. The RDLS-3/E was at an age-equivalent below 1:09 years and at the first percentile. In summary, a moderately low expressive language functioning was apparent during phase 1 (see table 18). Table 19 shows the GSV scores of participant C in relation to the normative sample. During all phases, GSV scores ranged within national GSV norms.

Table 18.*Participant C: Score Summary of Expressive Language Skills*

Phase	*Test/Form*	*SS*	*Conf. Interval*	*Percentile*	*NCE*	*Stanine*	*CA*	*AE*	*Description*
	EVT-2/A	78	73-85	7	19	2		2:04	moderately low
1*	EVT-2/B	79	74-86	8	21	2	3:08	2:04	moderately low
	RDLS-3/E	0	-	1	-	-		<1:09	-
	EVT-2/A	86	81-92	18	30	3		3:00	average
2**	EVT-2/B	87	82-93	19	32	3	3:10	3:01	average
	RDLS-3/E	24	-	1	-	-		2:07-2:08	-
	EVT-2/A	83	78-89	13	26	3		3:01	average
3***	EVT-2/B	86	81-92	18	30	3	4:01	3:02	average
	RDLS-3/E	22	-	1	-	-		2:09	-

** Assessment phase*
*** Post-intervention phase*
**** Follow-up phase*

Table 19.*Participant C: Summary of GSV scores*

Phase	*CA*	*Test/Form*	*SS*	*GSV*	*National GSV Scores Mean*	*Range*
1*	3:08	EVT-2/A	78	99	105	89-121
	3:08	EVT-2/B	79	100	105	89-121
2**	3:10	EVT-2/A	86	110	105	89-121
	3:10	EVT-2/B	87	111	105	89-121
3***	4:01	EVT-2/A	83	111	122	107-137
	4:01	EVT-2/B	86	113	122	107-137

** Assessment phase*
*** Post-intervention phase*
**** Follow-up phase*

Graphical profiles of pre-and post-intervention phases are presented below showing a shift from moderately low to within the low end of the average (see figure 13, 14).

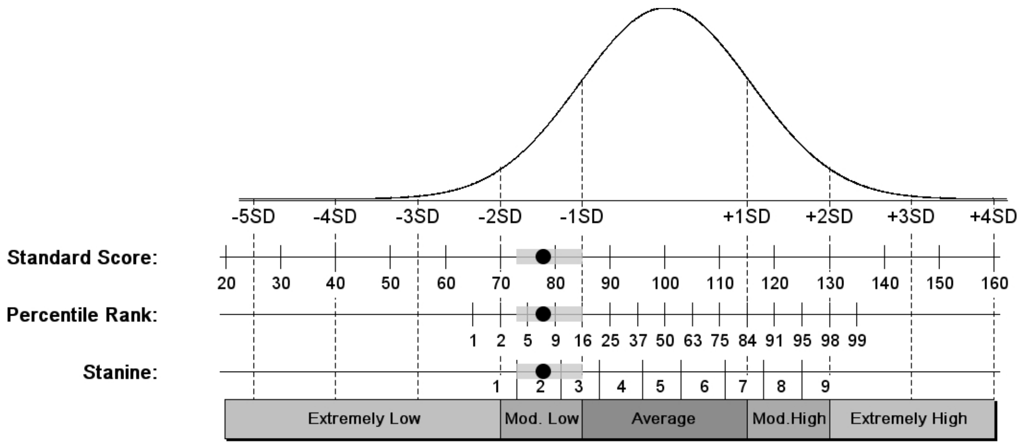


Figure 13.*Participant C: Expressive Vocabulary Skills during Phase 1 (form A)*

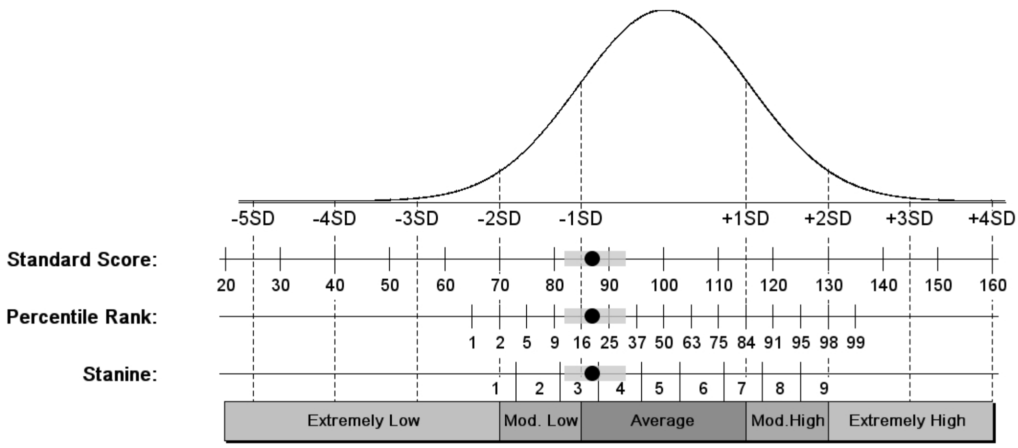


Figure 14.*Participant C: Expressive Vocabulary Skills during Phase 2 (form B)*

5.2.4 Participant D

Participant D achieved EVT-2 scores equal to or better than 3 (A) and 6 (B) percent of age-matched peers, at an age-equivalent of below 2 years. The RDLS-3/E was at an age-equivalent below 1:09 years and at the second percentile. In summary, a moderately low expressive language functioning was apparent during phase 1 (see table 20). Table 21 shows the GSV scores in relation to the normative sample. An increase of Growth Scale Value scores from pre- to post-assessment was noted.

Table 20.*Participant D: Score Summary of Expressive Language Skills*

Phase	*Test/Form*	*SS*	*Conf. Interval*	*Percentile*	*NCE*	*Stanine*	*CA*	*AE*	*Description*
1*	EVT-2/A	72	66-81	3	11	1	2:07	<2:00	moderately low
	EVT-2/B	77	70-86	6	18	2		<2:00	moderately low
	RDLS-3/E	27	-	2	-	-		<1:09	-
2**	EVT-2/A	88	81-96	21	33	3	2:09	<2:00	average
	EVT-2/B	82	75-90	12	25	3		<2:00	moderately low
	RDLS-3/E	39	-	14	-	-		2:03	-
3***	EVT-2/A	79	73-86	8	21	2	3:00	<2:00	moderately low
	EVT-2/B	81	75-88	10	23	2		<2:00	moderately low
	RDLS-3/E	37	-	11	-	-		2:05	-

** Assessment phase*
*** Post-intervention phase*
**** Follow-up phase*

Table 21.*Participant D: Summary of GSV scores*

Phase	*CA*	*Test/Form*	*SS*	*GSV*	*National GSV Scores Mean*	*Range*
1*	2:7	EVT-2/A	72	70	92	76-108
	2:7	EVT-2/B	77	76	92	76-108
2**	2:9	EVT-2/A	88	92	92	76-108
	2:9	EVT-2/B	82	83	92	76-108
3***	3:0	EVT-2/A	79	83	105	89-121
	3:0	EVT-2/B	81	85	105	89-121

** Assessment phase*
*** Post-intervention phase*
**** Follow-up phase*

Graphical profiles of pre- and post-intervention phases are presented below (see figure 15, 16). Prior to the intervention, participant D fell between -1SD to -2SD from the average range (see figure 15). After the intervention, participant D's score improved to within -1SD to -2SD of the mean (see figure 16).

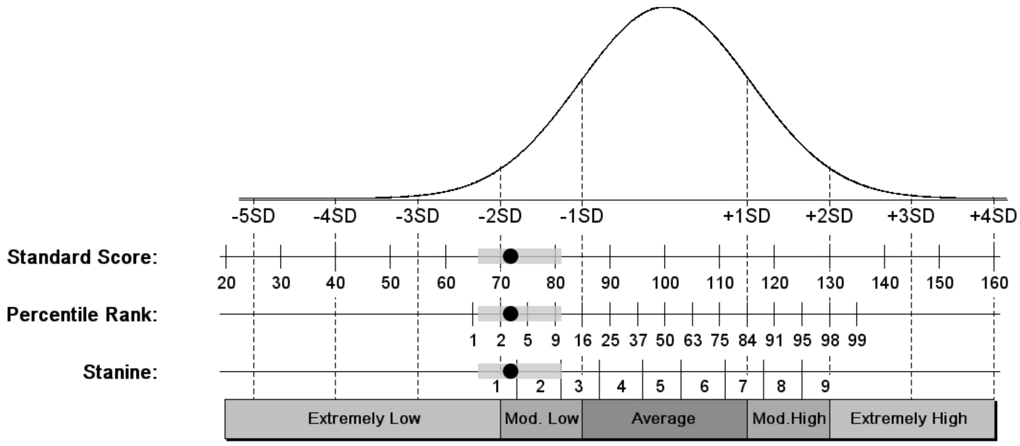


Figure 15.*Participant D: Expressive Vocabulary Skills during Phase 1 (form A)*

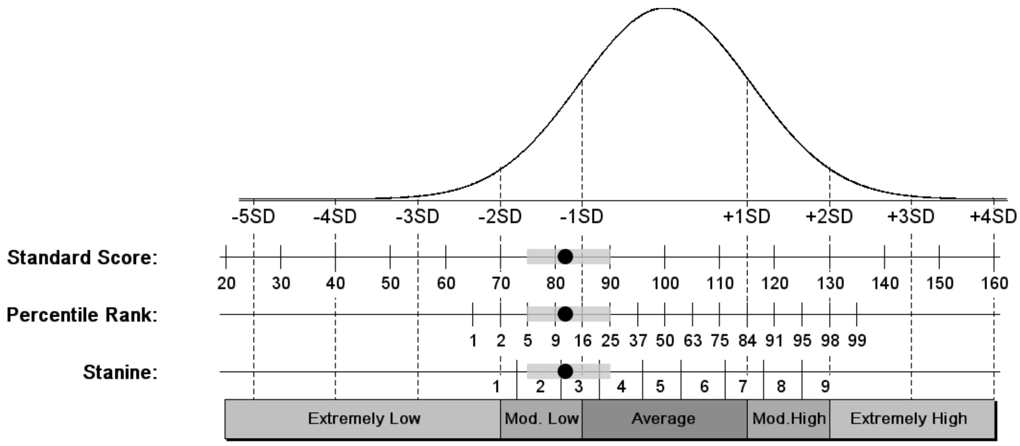


Figure 16.*Participant D: Expressive Vocabulary Skills during Phase 2 (form B)*

In summary, graphical profile analyses documented progress on receptive and expressive vocabulary shifting from extremely low to moderately low (participant A) and moderately low to average (participant C, D). Participant B remained in the extremely low functioning prior to and after the intervention for both receptive and expressive vocabulary skills. However, it has to be noted, that participant B started at a lower level than his peers falling between -3SD to -4SD from the average range for both receptive and expressive vocabulary skills prior to intervention. A considerable within-individual change was measured, shifting towards ranging between -2SD to -3SD from the mean for both receptive and expressive vocabulary skills.

5.3 Analyses of Significance of Change in Language Performances

5.3.1 Growth Scale Value Interpretation

For the measure of significance of GSV differences, within-individual GSV scores from pre-intervention (X_1) to post-intervention (X_2) were employed, with GSV differences ≥ 8 indicating a statistically significant difference (p<.10) (Dunn & Dunn, 2007), i.e. a receptive or expressive vocabulary growth that is unlikely to occur coincidentally or be explained by measurement error, using the following formula: $8 \leq (X_2 - X_1)$. Results for each of the participants are presented in table 22. Significant within-individual GSV differences were calculated from pre- to post-intervention for all participants for both receptive and expressive vocabulary scores. Overall, higher GSV score differences were measured for receptive vocabulary (PPVT-4) for all participants.

Table 22.*Comparison of Growth Scale Value Scores*

Participant	Test	GSV (X_1)	GSV (X_2)	GSV difference (A-B)	GSV difference (B-A)
A	PPVT-4	82 (A)	104 (B)	22*	
		86 (B)	105 (A)		19*
	EVT-2	101 (A)	116 (B)	15*	
		103 (B)	115 (A)		12*
B	PPVT-4	70 (A)	88 (B)	18*	
		66 (B)	86 (A)		20*
	EVT-2	99 (A)	110 (B)	11*	
		97 (B)	109 (A)		12*
C	PPVT-4	62 (A)	93 (B)	31*	
		68 (B)	94 (A)		26*
	EVT-2	99 (A)	111 (B)	12*	
		100 (B)	110 (A)		10*
D	PPVT-4	53 (A)	74 (B)	21*	
		54 (B)	77 (A)		23*
	EVT	70 (A)	83 (B)	13*	
		76 (B)	92 (A)		16*

** Significant growth*

5.3.2 Reliable change

Reliable changes, i.e. real changes which could not be ascribed to measurement fluctuations or measurement error, were analysed using within-individual change scores from pre- and post-intervention. Reliable change index (RCI) scores below 1.96 were labelled as "no reliable change" and above 1.96 indicated that "reliable change" has occurred (Jacobson et al., 1986; Wise, 2004). Figures for the determination of reliable changes are presented in table 23. Calculations are provided in Appendix G. Reliable change index scores were computed participant by participant for each of the tests employing the pre-test score (X_1), post-test score (X_2), standard deviation (SD) and reliability of the outcome measure (rel), i.e. test-retest reliability, and using the following formula of the Jacobson and Truax classification (Jacobson & Truax, 1991) calculating the standard error of the measurement (SEM) and the standard error of the difference (SED):

$$RCI = (X_2 - X_1)/(SED)$$

$$1.96 < (X_2 - X_1)/(SED)$$

where

$$SED = \sqrt{2}(SEM)^2$$

$$SEM = SD\,\sqrt{(1 - rel)}$$

Reliable change was determined for participant A and D from pre- to post-intervention on all measures. Participant B and C showed reliable change from pre- to post-intervention on some of the measures. Reliable change was determined for participant B on vocabulary measures and for participant C on receptive vocabulary and language measures (see table 23).

Table 23.*Classification of Reliable Change*

Participant	Test	Form	X_1	X_2	SD	rel	SEM	SED	RCI
A	PPVT-4	(A – B)	61	78	14.4	.91	4.32	6.1094	2.78*
	PPVT-4	(B – A)	64	79	14.4	.91	4.32	6.1094	2.46*
	RDLS-3	(C – C)	0	17	4.43	.5	2.215	3.1324	5.43*
	EVT-2	(A – B)	64	78	15.75	.95	3.5218	4.9805	2.81*
	EVT-2	(B – A)	67	77	15.75	.95	3.5218	4.9805	2.01*
	RDLS-3	(E – E)	10	23	6.21	.86	2.3235	3.2859	3.95*[1]
B	PPVT-4	(A – B)	44	57	17.75	.94	4.3478	6.1487	2.11*
	PPVT-4	(B – A)	41	55	17.75	.94	4.3478	6.1487	2.28*
	RDLS-3	(C – C)	0	0	4.43	.75	2.215	3.1324	0
	EVT-2	(A – B)	51	61	16.65	.96	3.33	4.7093	2.12*
	EVT-2	(B – A)	49	60	16.65	.96	3.33	4.7093	2.34*
	RDLS-3	(E – E)	0	4	6.21	.86	2.3235	3.2859	1.22[2]
C	PPVT-4	(A – B)	57	80	14.4	.91	4.32	6.1094	3.76*
	PPVT-4	(B – A)	62	81	14.4	.91	4.32	6.1094	3.11*
	RDLS-3	(C – C)	0	22	4.43	.75	2.215	3.1324	7.02*
	EVT-2	(A – B)	78	87	15.75	.95	3.5218	4.9805	1.81
	EVT-2	(B – A)	79	86	15.75	.95	3.5218	4.9805	1.41
	RDLS-3	(E – E)	0	24	6.21	.86	2.3235	3.2859	7.30*[3]
D	PPVT-4	(A – B)	72	85	14.4	.91	4.32	6.1094	2.13*
	PPVT-4	(B – A)	73	87	14.4	.91	4.32	6.1094	2.29*
	RDLS-3	(C – C)	16	26	4.43	.75	2.215	3.1324	3.19*
	EVT-2	(A – B)	72	82	15.75	.95	3.5218	4.9805	2.01*
	EVT-2	(B – A)	77	88	15.75	.95	3.5218	4.9805	2.21*
	RDLS-3	(E – E)	27	39	6.21	.86	2.3235	3.2859	3.65*[1]

**Reliable change*
[1]Reliable change on all measures (participant A and D)
[2]Reliable change on vocabulary measures (participant B)
[3]Reliable change on receptive vocabulary and language measures (participant C)

5.3.3 Clinically Significant Change

The second criteria (method B) of the formula introduced by Jacobson et al. (1984), with the following definition of clinically significant change was applied: “The level of functioning subsequent to therapy should fall within the range of the functional or normal population, where range is defined as within two standard deviations of the mean of that population” (Jacobson & Truax, 1991) (p. 13). Three out of four single participants showed clinically significant change from pre- to post-intervention moving into the “normal” range within -2SD from the mean which was determined on the graphical profile analyses for both PPVT-4 and EVT-2 measures. Clinically significant change could not be attributed to participant B.

5.4 Analysis of Spontaneous Language

Language interactions were recorded during child/examiner conversation in sessions 1, 10 and 20. Descriptive data is provided for a variety of linguistic characteristics. Results are reported for syntax and morphology (Mean Length of Utterances (MLU) in words and morphemes), semantics (Type Token Ratio), utterance formulation and pragmatics. For the analysis of MLU, a one-way repeated measures ANOVA was first employed on each single participant in order to determine whether there was any effect for time. If there was an effect for time, then a paired samples t-test was employed, to determine whether there was a significant increase of Mean Length of Utterances for words (MLUw) or morphemes (MLUm) across time (see Appendix J). In addition, the Type Token Ratio (TTR) was obtained to indicate the level of lexical variation and hence exploring vocabulary skills by dividing the number of different words (types) the participants expressed during conversation by the total number of words (tokens) (Hoerning, 2007; Richards, 1987). Developmental language delays are indicated by deviating at least 1SD (^{1}) or 2SD (^{2}) from the database mean.

5.4.1 Participant A

Table 24 shows the expressive language analysis summary for participant A. For the first transcript an interaction time of 18:17 minutes was transcribed and compared to a language sample of 32 females and 24 males with an age range of 4:05 to 5:04 years. In total, 96 child utterances and 203 examiner utterances were transcribed until 55 entirely intelligible child utterances were collected. The second and third transcript consisted of 95 (94) child and 217 (157) examiner utterances.

Expressive language mainly consisted of three word phrases and was characterized by a frequent initiation of verbal interaction with the examiner. Participant A was able to label a wide range of items correctly. However, echolalia, jargon speech and syntactic errors occasionally occurred. The first transcript documents language delays in syntax, morphology, discourse as well as verbal facility and rate at the first session. Measurements of MLU in words and morphemes deviated significantly from the age-matched sample. In addition, a poor Mean Turn Length was apparent and questions were only occasionally answered. The examinee's speech was characterized by a low word rate per minute and frequent pauses within utterances which specifically affected phrases following questions.

The second and third transcripts indicated a higher level of language proficiency in syntax and morphology with increased MLU in words and morphemes. A one-way repeated measures ANOVA demonstrated a significant effect of time for MLU in words and morphemes $F(2,108) = 244.933$, $F(2,108) = 193.992$, $p = .000$. Paired samples t-tests indicated a significant increase of MLU in words across time $t(54) = -12.050$, $t(54) = -11.850$, $t(54) = -19.588$, $p = .000$. Paired-samples t-tests also showed a change in the number of utterances for morphemes across time $t(54) = -9.939$, $t(54) = 8.124$, $t(54) = -24.759$, $p = .000$ (see Appendix J). Moreover, the discourse summary showed progress in responding to questions, Mean Turn Length of words and verbal rate, i.e. the number of spoken words per minute (see table 24).

Table 24.*Participant A: Spontaneous Language Profile*

	Participant A	Transcript 1	Transcript 2	Transcript 3
Descriptive data	Child Utterances	96	95	94
	Examiner Utterances	203	217	157
	Transcript Length (min)	18:17	21:42	18:22
Language measures	MLU in Words (55 utterances)	2.73[1]	3.49[1]	4.36[1]*
	MLU in Morphemes (55 utterances)	2.93[1]	3.91[1]	4.71[1]*
	Type Token Ratio (55 utterances)	0.46	0.43	0.43
	Responses to Questions (%)	39.0[2]	55.0[2]	63.0[1]
	Mean Turn Length (words)	3.72[1]	4.17[1]	5.33[1]
	Verbal Rate (words/min)	14.86[2]	9.25[2]	13.23[2]

** Significant change from transcript 1 through transcript 3*
[1]*At least 1SD from the database mean*
[2]*At least 2SD from the database mean*

5.4.2 Participant B

The expressive language analysis summary for Participant B is provided in Table 25. For the first language transcript an interaction time of 44:42 minutes was transcribed and compared to a language sample of 42 females and 43 males with an age range of 5:05 to 6:05 years. In total, 177 child utterances and 320 examiner utterances were transcribed until 55 child utterances were entirely intelligible. The second and third transcript consisted of 175 (188) child and 318 (299) examiner utterances.

Expressive language skills were dominated by echolalia, phrase repetitions and jargon speech. The participant made high frequency screaming sounds accompanied by repetitive eye and finger movements. During the major part of the interaction the examinee remained mute, which is shown in the low word rate per minute. He only answered questions after at least four repetitions and in response to rewards. No eye contact was made. Expressive language was not used as a mean to communicate and to direct interaction. The major part of the conversation was led by the examiner without any verbal or nonverbal response from the child. Measurements of MLU in words and in morphemes showed highly significant deviations from the age-matched sample indicating difficulties in syntax and morphology. In addition, the discourse summary showed difficulties in answering questions and interacting with the examiner. These also included 'yes or no' questions.

Overall, the performance in answering questions and conversational turn-taking skills deviated significantly from the age-matched sample and the majority of questions were not answered. In general, the participant needed a lot of time for responding to and verbally interacting with the examiner and made frequent utterance pauses which is noticeable in the excessive transcript length. The majority of utterances consisted of single-word phrases and severe language delays were evident during interaction.

During the course of intervention, improvement was noticed in syntax and morphology with increased MLU in words and morphemes. Despite the improvement, language proficiency in MLU remained 2SD from the database mean. A one-way repeated measures ANOVA demonstrated a significant effect of time for MLU in words and MLU in morphemes $F(2,108) = 61.816$, $F(2,108) = 63.906$, $p = .000$. Paired samples t-tests showed a significant increase of MLU in words $t(54) = -6.122$, $t(54) = -6.000$, $t(54) = -9.686$, $p = .000$ as well as MLU in morphemes across time $t(54) = -6.230$, $t(54) = -5.899$, $t(54) = -10.115$, $p = .000$ (see Appendix J). The discourse summary showed progress in responding to questions and Mean Turn Length of words. No positive trend could be observed for the verbal rate per minute. Overall, a significant expressive language delay was apparent during all stages of interaction.

Table 25.*Participant B: Spontaneous Language Profile*

	Participant B	**Transcript 1**	**Transcript 2**	**Transcript 3**
Descriptive data	Child Utterances	177	175	188
	Examiner Utterances	320	318	299
	Transcript Length (min)	44:42^2	42:39^2	39:57^2
Language measures	MLU in Words (55 utterances)	1.87^2	2.35^2	2.75^{2}*
	MLU in Morphemes (55 utterances)	1.98^2	2.40^2	2.85^{2}*
	Type Token Ratio (55 utterances)	0.41	0.57^2	0.46
	Responses to Questions (%)	27.0^2	35.0^2	48.0^2
	Mean Turn Length (words)	1.97^1	2.59^1	3.87
	Verbal Rate (words/min)	4.07^2	2.58^2	3.89^2

** Significant change from transcript 1 through transcript 3*
[1]At least 1SD from the database mean
[2] At least 2SD from the database mean

5.4.3 Participant C

For the three language samples 66, 70 and 69 child utterances as well as 105, 110 and 102 examiner utterances were transcribed. In comparison to the other participants, the transcript length was short indicating a constant communication flow without cut-offs or frequent pauses during conversation (see table 26). This participant produced co-ordinated sentences with occasional irregular past tense and plural errors. His conversation was characterized by relaying stories repeatedly, for example, stories involving characters from Thomas the Tank Engine. A frequent failure to respond to questions and follow the rules of conversational turn-taking could be noticed. Moreover, phrases frequently consisted of repetitions. MLU in words and morphemes was slightly impaired at the start but eventually ranged within age appropriate norms.

A one-way repeated measures ANOVA showed a significant effect of time for MLU in words $F(2,108) = 59.083$, $p = .000$ and MLU in morphemes $F(2,108) = 51.949$, $p = .000$. Paired samples t-tests indicated a change in the number of utterances for words $t(54) = -8.964$, $t(54) = -4.401$, $t(54) = -8.364$, p = .000 as well as morphemes across time $t(54) = -10.509$, $t(54) = -8.518$, $p = .000$, $t(54) = -2.984$, $p = .004$ (see Appendix J). After the joint attention intervention, the participant's ability to respond to questions and interact with the examiner improved. He was able to verbally draw the examiner's attention towards an activity by saying: 'Look!' or 'Your turn!', and by asking the examiner questions. Moreover, the Mean Turn Length of words and the verbal rate per minute increased.

Table 26.*Participant C: Spontaneous Language Profile*

	Participant C	Transcript 1	Transcript 2	Transcript 3
Descriptive data	Child Utterances	66	70	69
	Examiner Utterances	105	110	102
	Transcript Length (min)	10:02	9.23	8.32
Language measures	MLU in Words (55 utterances)	3.05[1]	3.96	4.47*
	MLU in Morphemes (55 utterances)	3.24[1]	4.13	4.56*
	Type Token Ratio (55 utterances)	0.49	0.46	0.46
	Responses to Questions (%)	39.0[2]	52.0[2]	69.0
	Mean Turn Length (words)	4.07	6.61	7.86
	Verbal Rate (words/min)	17.10[1]	20.09[1]	23.94[1]

** Significant change from transcript 1 through transcript 3*
[1]At least 1SD from the database mean
[2] At least 2SD from the database mean

5.4.4 Participant D

In total, 92 child utterances and 211 examiner utterances were transcribed for the first language sample until 55 entirely intelligible child utterances were collected to analyse MLU. Subsequent transcripts consisted of 85 (87) child and 199 (217) examiner utterances.

Expressive language was characterized by a high number of single-word phrases and repetitions. However, unlike the second participant, there was a frequent social interaction between the child and the examiner and the child was constantly engaged in shared activities. The child was able to lead play which was accompanied by frequent babbling and directed the examiner's attention using mainly single-or two-word phrases such as "bubbles" or "chips yummy" for indicating a desired object or event. Difficulties in syntax and morphology were apparent in the highly significantly deviations of MLU scores in both words and morphemes from the database mean (see table 27). Moreover, the Mean Turn Length of words as well as the verbal rate per minute significantly deviated from the age-matched sample.

Over the course of intervention, an improvement in syntax, turn-taking abilities and pragmatics was evident in an increase in MLU, responses to questions, Mean Turn Length and verbal rate (number of word production per minute). A one-way repeated measures ANOVA showed a significant effect for time looking at MLU in words $F(2,108) = 284.396$, $p = .000$ and MLU in morphemes $F(2,108) = 300.460$, $p = .000$. Paired samples t-tests indicated no change in the number of utterances for morphemes across time comparing the first and second transcript $t(54) = -1.765$, $p = .083$ (see Appendix J). For MLU in words the correlation and t could not be computed pairing transcript one and two because the standard error of the difference was 0. However, a significant increase was measured across time pairing transcript one and three as well as transcript two and three for MLU of words $t(54) = -16.864$, $t = -16.864$, p = .000 and MLU of Morphemes $t(54) = -18.453$, $t(54) = -18.055$, $p = .000$ (see Appendix J).

Table 27.*Participant D: Spontaneous Language Profile*

	Participant D	Transcript 1	Transcript 2	Transcript 3
Descriptive data	Child Utterances	92	85	87
	Examiner Utterances	211	199	217
	Transcript Length (min)	26:83[1]	13:55	14:52
Language measures	MLU in Words (55 utterances)	1.40[2]	1.40[2]	2.65[2]*
	MLU in Morphemes (55 utterances)	1.44[2]	1.49[2]	2.67[2]*
	Type Token Ratio (55 utterances)	0.61[2]	0.52[1]	0.55[1]
	Responses to Questions (%)	18.0[2]	28.0[2]	37.0[2]
	Mean Turn Length (words)	2.21[1]	2.02[1]	3.88
	Verbal Rate (words/min)	3.65[1]	6.64[1]	8.89[1]

** Significant change from transcript 1 to transcript 3/ no significant change from transcript 1 to transcript 2*
[1]At least 1SD from the database mean
[2] At least 2SD from the database mean

In summary, all participants showed improvements in syntax, turn-taking abilities and pragmatics during the course of interaction measured by an increase of responses to questions, Mean Turn Length and verbal rate. No increase could be noted for lexical variety measured by Type Token Ratio. Statistically significant increases in MLU measured by both words and morphemes were evident in all participants.

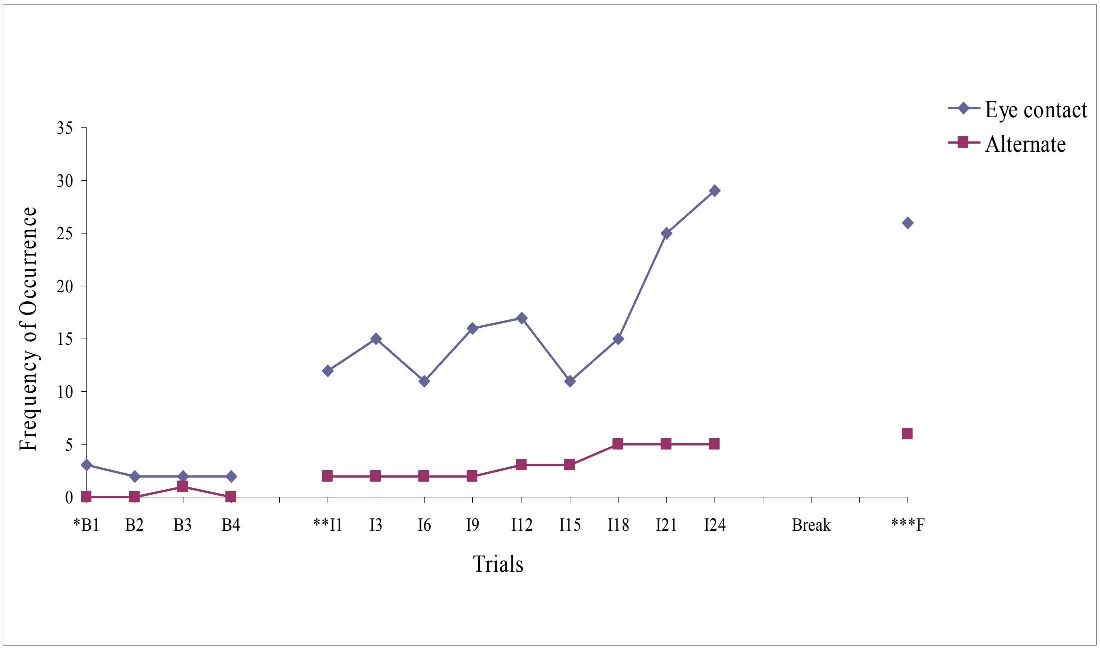
5.5 Assessment of Joint Attention

5.5.1 Rating of Initiating and Responding to Joint Attention

The researcher spent two to three weeks recording baseline data for each child. After establishing baseline data, the joint attention intervention was introduced. Intervention videos were analysed and data compared to baseline results. The follow-up data was recorded after a 3-month break. Follow-up data included spontaneous occurrences of joint attention behaviours. Data is reported in Tables 28, 29, 30 and 31 (see Appendix H). Graphical illustrations of frequencies of occurrence of target behaviours (measured over a 15 minute period) of each participant during baseline, intervention and follow-up are presented below (see figure 17-28). Results are organized separately showing distinctive skills, including lower level IJA (eye contact, alternate), higher level IJA (point, point and eye contact, show), and RJA (correct following proximal point/touch and correct following line of regard) (Mundy et al., 2003). In order to assess inter-rater agreement, 78.6% (44 out of 56 videos) of all video-tapes were coded by an independent examiner (speech pathologist) who was blind to the rating of the first examiner. Inter-rater agreement was approximately 91. Any disagreement between the two raters was resolved by discussion.

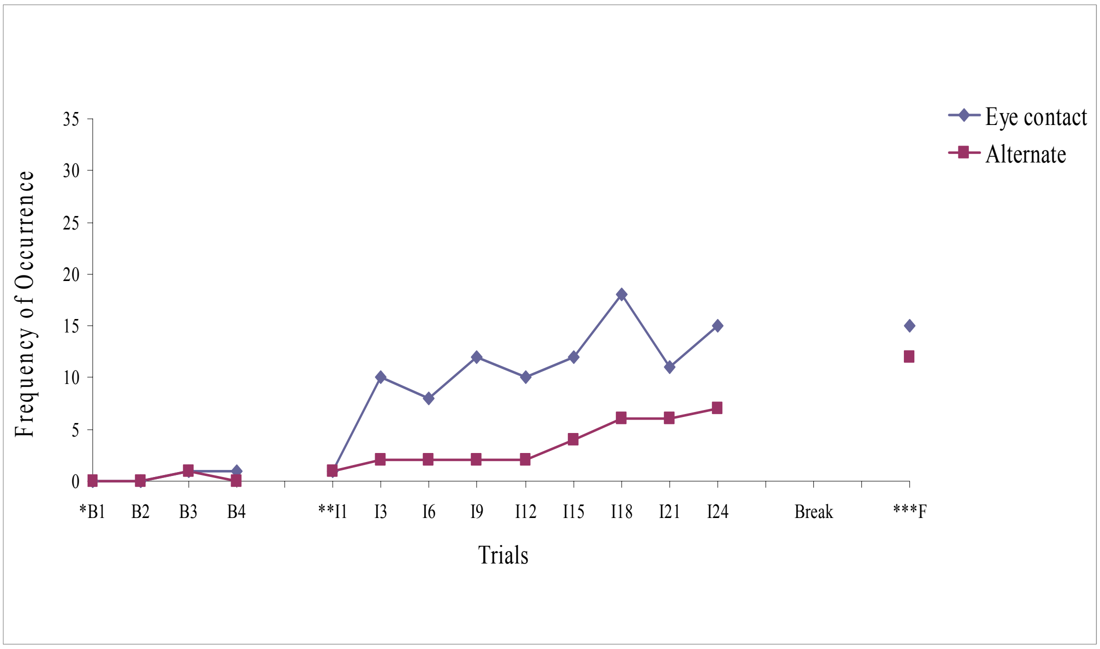
5.5.1.1 Lower level IJA skills

Figure 17.*Participant A: Frequency of lower level IJA skills*



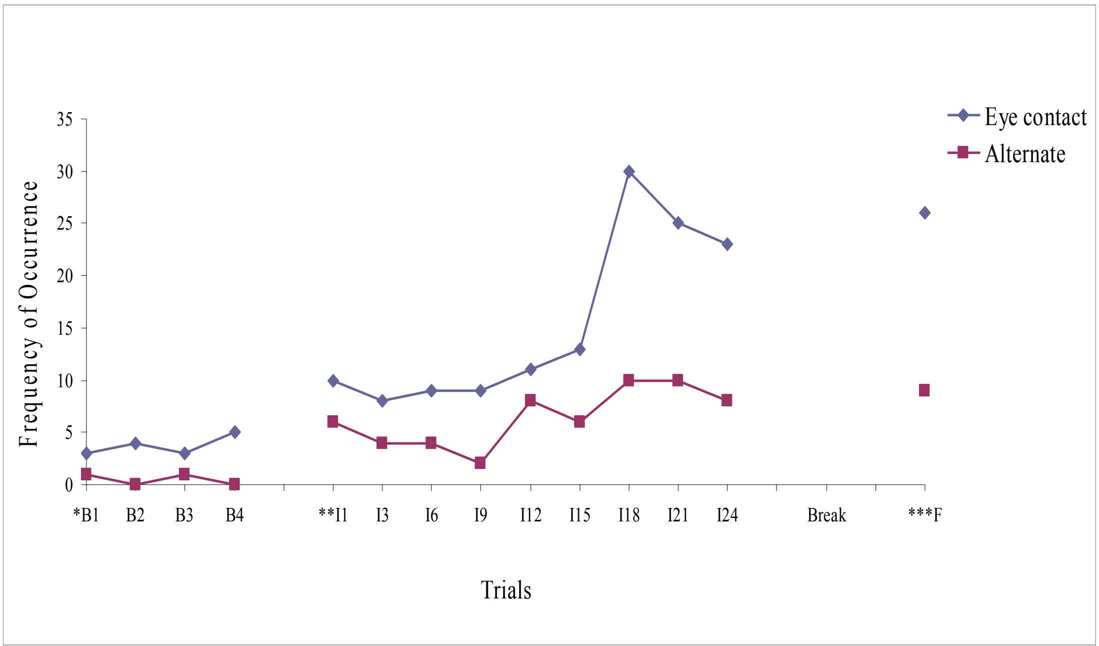
* B1-B4= Baseline one to four ** I1-I24= Intervention sessions Break= Three months *** F= Follow-up

Figure 18.*Participant B: Frequency of lower level IJA skills*



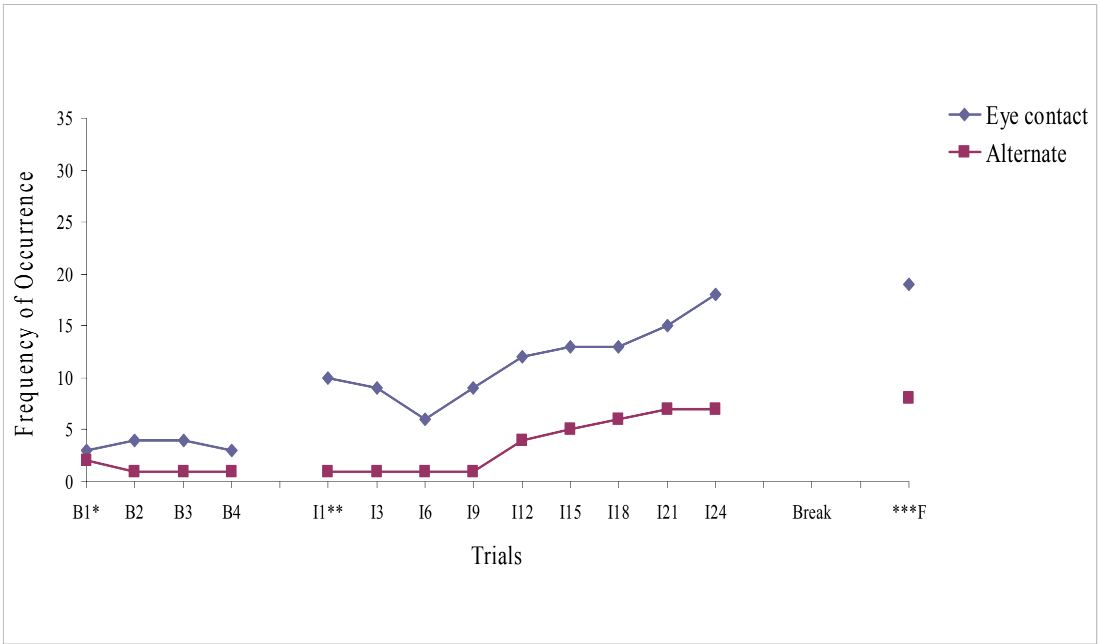
* B1-B4= Baseline one to four ** I1-I24= Intervention sessions Break= Three months *** F= Follow-up

Figure 19.*Participant C: Frequency of lower level IJA skills*



* B1-B4= Baseline one to four ** I1-I24= Intervention sessions Break= Three months *** F= Follow-up

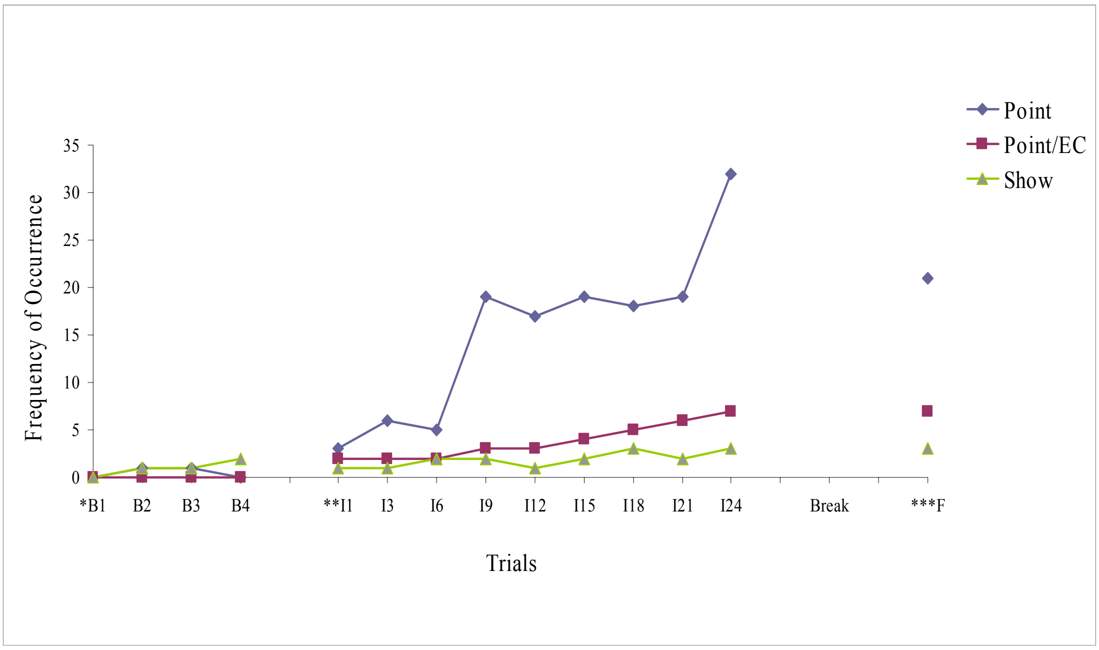
Figure 20.*Participant D: Frequency of lower level IJA skills*



* B1-B4= Baseline one to four ** I1-I24= Intervention sessions Break= Three months *** F= Follow-up

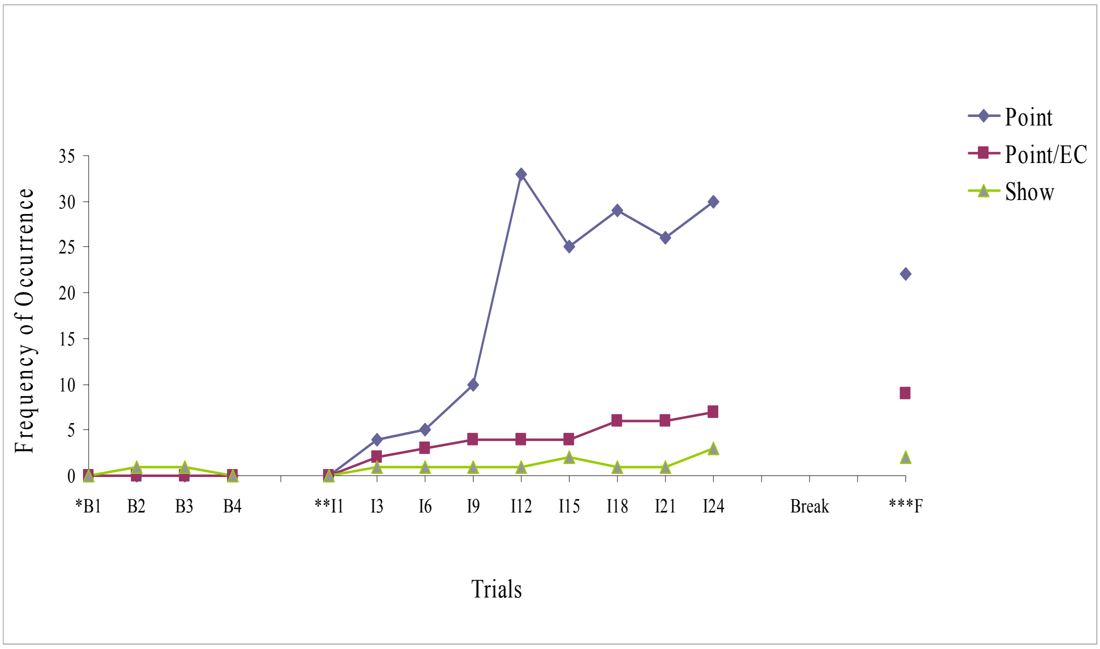
5.5.1.2 Higher level IJA skills

Figure 21.*Participant A: Frequency of higher level IJA skills*



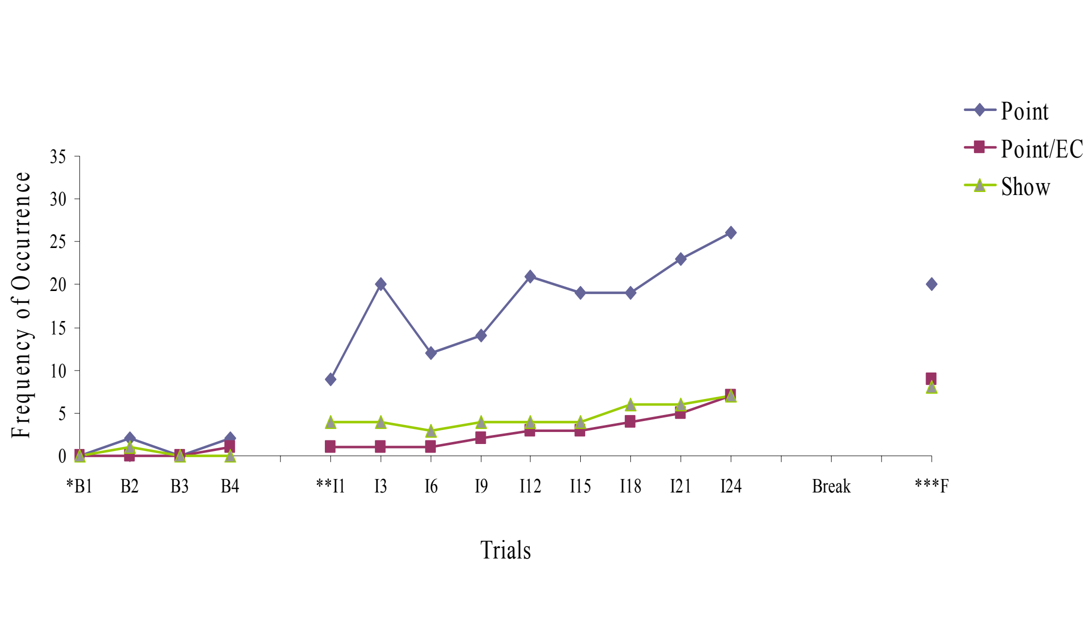
* B1-B4= Baseline one to four ** I1-I24= Intervention sessions Break= Three months *** F= Follow-up

Figure 22.*Participant B: Frequency of higher level IJA skills*



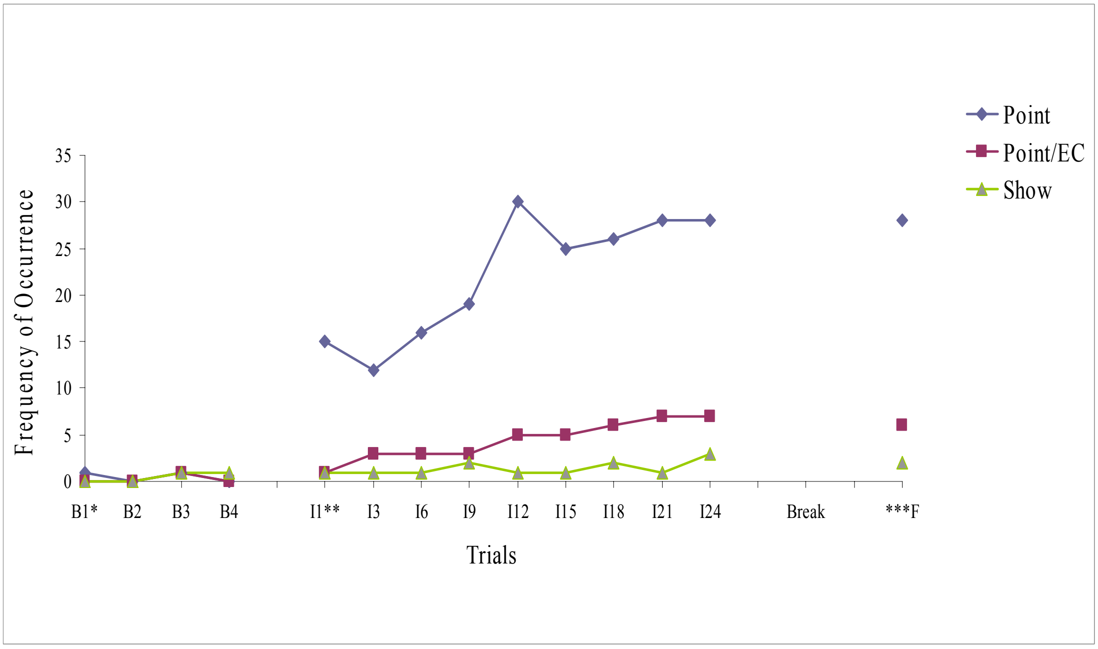
* B1-B4= Baseline one to four ** I1-I24= Intervention sessions Break= Three months *** F= Follow-up

Figure 23.*Participant C: Frequency of higher level IJA skills*



* B1-B4= Baseline one to four ** I1-I24= Intervention sessions Break= Three months *** F= Follow-up

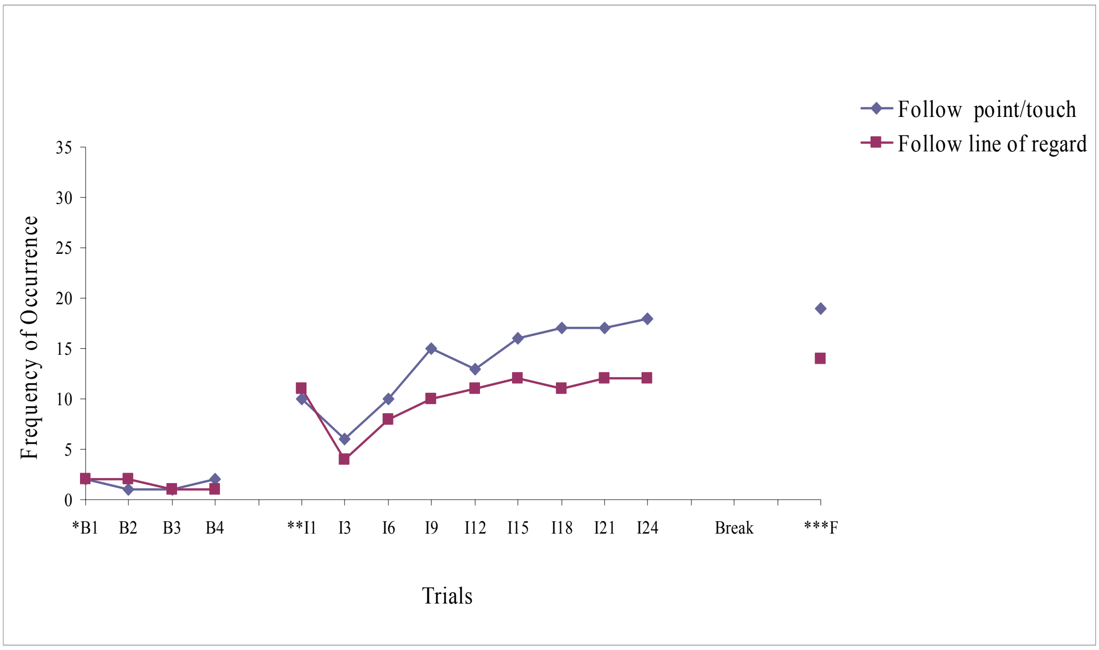
Figure 24.*Participant D: Frequency of higher level IJA skills*



* B1-B4= Baseline one to four ** I1-I24= Intervention sessions Break= Three months *** F= Follow-up

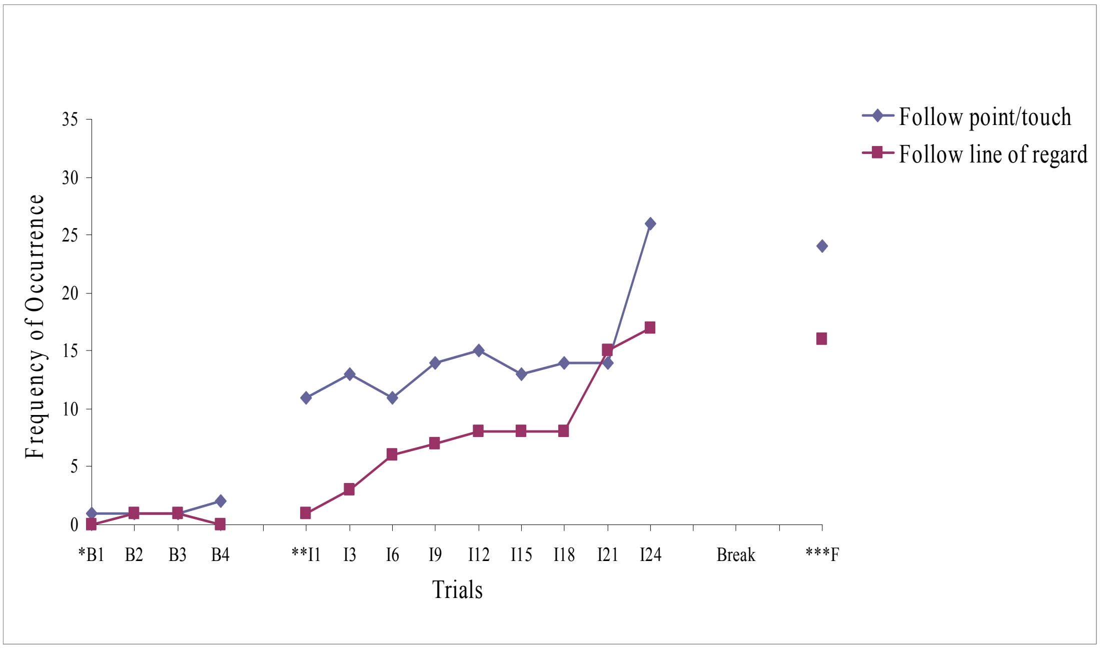
5.5.1.3 RJA skills

Figure 25.*Participant A: Frequency of RJA skills*



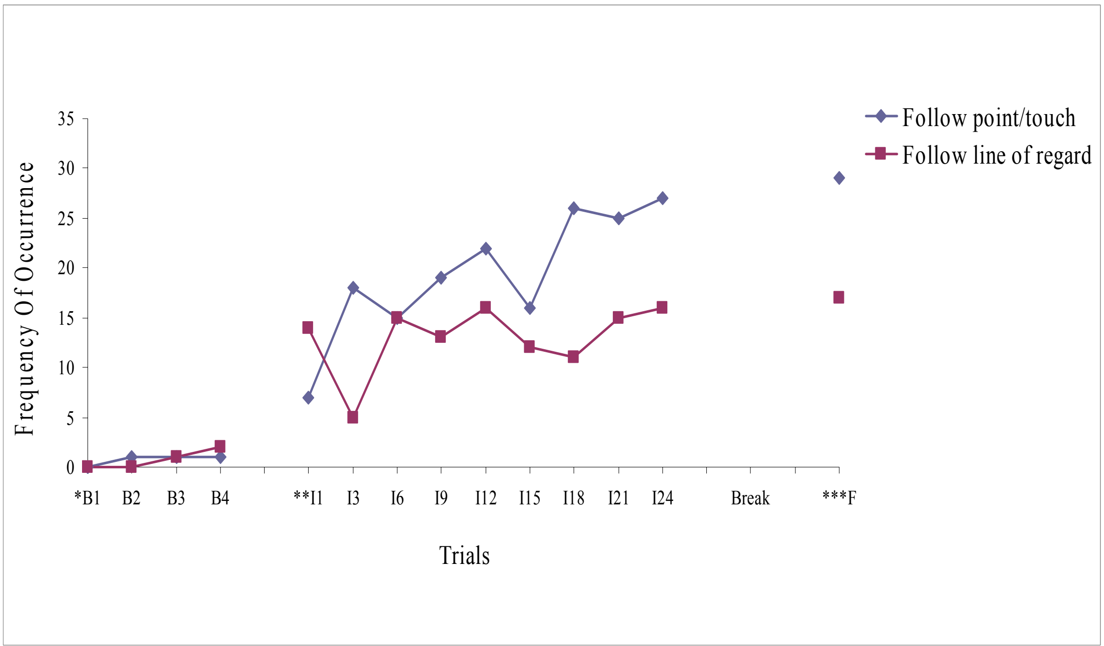
* B1-B4= Baseline one to four ** I1-I24= Intervention sessions Break= Three months *** F= Follow-up

Figure 26.*Participant B: Frequency of RJA skills*



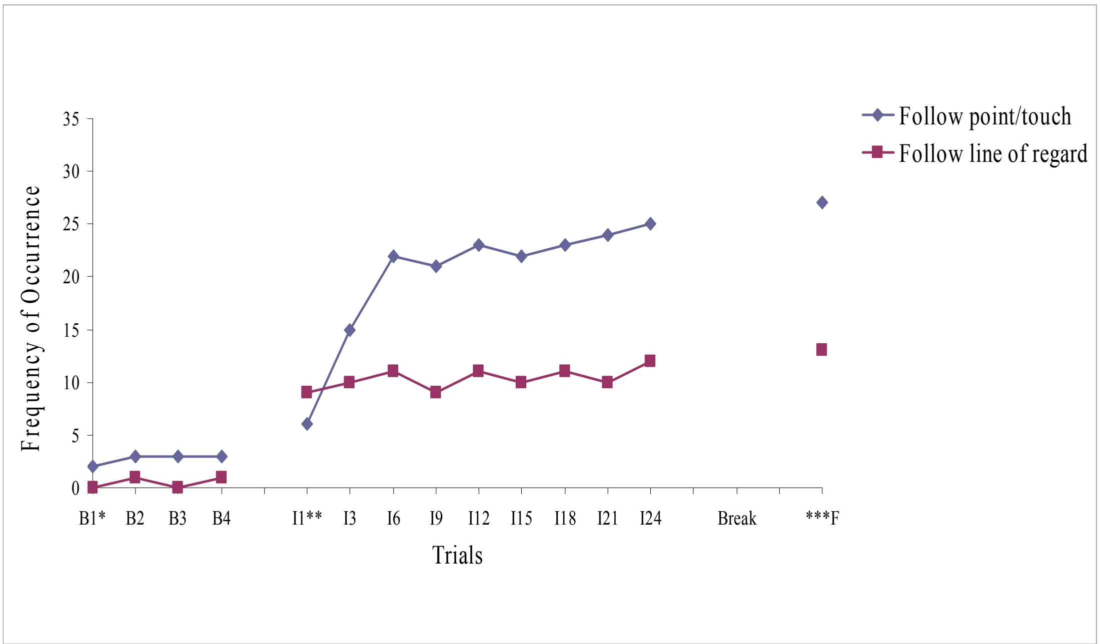
* B1-B4= Baseline one to four ** I1-I24= Intervention sessions Break= Three months *** F= Follow-up

Figure 27.*Participant C: Frequency of RJA skills*



* B1-B4= Baseline one to four ** I1-I24= Intervention sessions Break= Three months *** F= Follow-up

Figure 28.*Participant D: Frequency of RJA skills*



* B1-B4= Baseline one to four ** I1-I24= Intervention sessions Break= Three months *** F= Follow-up

For analyzing the data of initiating and responding to joint attention, the *Two Standard Deviation Band Method,* an established statistical method for single-participant designs, was employed (Gottman & Leiblum, 1974; Ottenbacher, 1986; Portney & Watkins, 2000). It provides information on whether significant performance changes have occurred between baseline and intervention phases. For this purpose, a horizontal line was marked through the mean of the data points in the baseline phase. Thereupon, the standard deviation of the baseline data point was computed and two horizontal lines were plotted: (1) deviating 2SD above and (2) deviating 2SD below the mean line. Finally, the number of consecutive data points in the intervention phase ranging outside these two horizontal lines was verified. A significant behavioural change between baseline and intervention phases was indicated if two or more consecutive data points fell outside the two horizontal lines. Table 32 shows mean scores of the baseline phase, standard deviations, calculations of ±2SD and intervention effects.

In summary, a clear indication of progress in initiating and responding to joint attention was noticeable in all four boys. Follow-up data included spontaneous occurrences of joint attention behaviours. Established behaviours remained stable after the break. Results of follow-up data were similar to results of intervention. Intervention effects could be measured for all behaviours of participant C. No significant change was measured for the variable “show” of participants A, B and D. However, significant change was evident for all other behaviours. Two examples of the method are provided in Appendix I (see figure 31, 32).

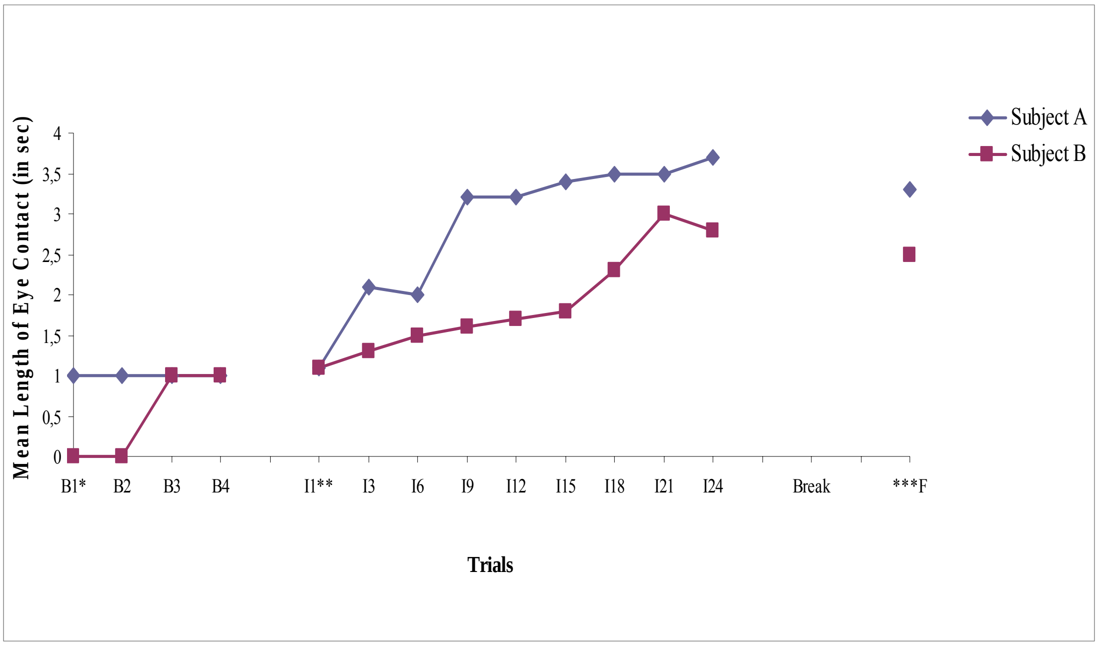
Table 32.Significant Changes determined by the Two SD Band Method

Participant	Behaviours	Baseline Means	Std. Deviation	+2SD	-2SD	Significance
A	Eye Contact	2.25	.50	3.25	1.25	significant
	Alternate	.25	.50	1.25	-0.75	significant
	Point	.50	.58	1.65	-0.65	significant
	Point/Eye Contact	.00	.00	.00	.00	significant
	Show	1.00	.82	2.63	-0.63	not significant
	Follow point/touch	1.50	.58	2.65	0.35	significant
	Follow line of regard	1.50	.58	2.65	0.35	significant
B	Eye Contact	.50	.58	1.65	-0.65	significant
	Alternate	.25	.50	1.25	-0.75	significant
	Point	.00	.00	.00	.00	Significant
	Point/Eye Contact	.00	.00	.00	.00	Significant
	Show	.50	.58	1.65	-0.65	not significant
	Follow point/touch	1.25	.50	2.25	0.25	significant
	Follow line of regard	.50	.58	1.65	-0.65	significant
C	Eye Contact	3.75	.96	5.66	1.84	significant
	Alternate	.50	.58	1.65	-0.65	significant
	Point	1.00	1.15	3.31	-1.31	significant
	Point/Eye Contact	.25	.50	1.25	-0.75	significant
	Show	.25	.50	1.25	-0.75	significant
	Follow point/touch	.75	.50	1.75	-0.25	significant
	Follow line of regard	.75	.96	2.66	-1.16	significant
D	Eye Contact	3.50	.58	4.65	2.35	significant
	Alternate	1.25	.50	2.25	0.25	significant
	Point	.50	.58	1.65	-0.65	significant
	Point/Eye Contact	.25	.50	1.25	-0.75	significant
	Show	.50	.58	1.65	-0.65	not significant
	Follow point/touch	.00	.00	.00	.00	significant
	Follow line of regard	.50	.58	1.65	-0.65	significant

5.6 Mean Length of Eye Contact

Fourteen video recordings at different time phases were analyzed and duration of eye contact was measured for each participant by stopwatch in order to calculate the Mean Length of Eye Contact (MLE). During baseline phase, MLE was ≤ 1 sec for participants. After establishing baseline data, the joint attention intervention program was introduced. During the intervention, the children were constantly prompted to hold eye contact and rewarded when holding eye contact for >2 sec. A clear indication of progress in the duration of maintaining eye contact was noticeable in all four participants. The follow-up data was recorded after a 3-month break. Established behaviours remained stable after the break. Results of follow-up data were similar to results of intervention. Data for MLE is provided in Tables 33, 34, 35 and 36 (see Appendix H). Graphical illustrations of MLE of each of the participants during baseline, intervention and follow-up are presented below (see figure 29, 30).

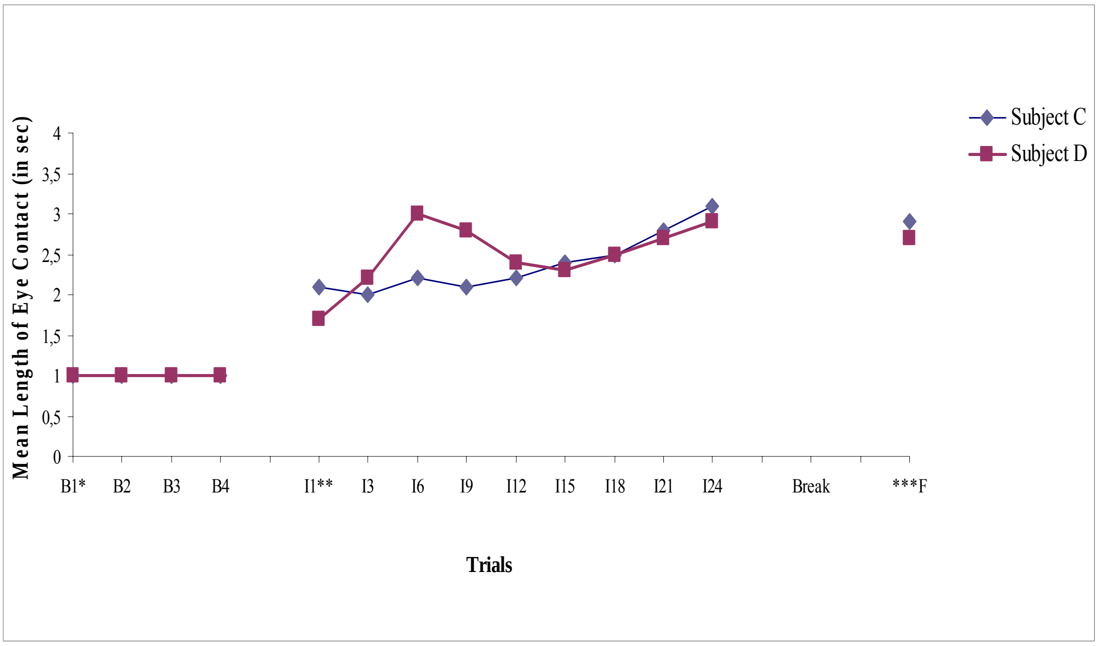
Figure 29. *Mean Length of Eye Contact for participant A and B*



* B1-B4= Baseline one to four [1] ** I1-I24= Intervention sessions Break= Three months *** F= Follow-up

[1] MLE overlap for participant A and B during B3 and B4

Figure 30. *Mean Length of Eye Contact for participant C and D*



* B1-B4= Baseline one to four [2] ** I1-I24= Intervention sessions Break= Three months *** F= Follow-up

[2] MLE overlap for participant C and D from B1 through B4

Chapter 6
Discussion

This study investigated the development of joint attention in verbal autistic children. A single-participant research design was used to investigate whether joint attention skills could be taught through a short term targeted intervention. The relationship between improvements in joint attention and language development, in particular (a) expressive vocabulary growth, (b) expressive syntactic growth and (c) receptive language growth after the intervention and at 3 months follow-up was also investigated.

The findings on joint attention will be discussed, followed by the findings on language development. The limitations of the current research and suggestions for future research will also be considered.

6.1 Joint Attention

Despite theoretical and empirical evidence underlining the importance of training joint attention in autistic children, to date only a small number of intervention research studies have been carried out (Charman et al., 2005; Yoder & McDuffie, 2006). The term “joint attention” was used in this study as an umbrella term for various components of joint engagement. Previous studies have looked more generally at joint attention in autism (Baranek, 1999; Lincoln et al., 2007; Maestro et al., 1999; Mars et al., 1998; Receveur et al., 2005; Werner et al., 2000) and have only, if at all, distinguished between RJA and IJA (Adamson et al., 2004; Charman et al., 2005; Luyster et al., 2008; Murray et al., 2008).

The processes of RJA and IJA are regarded as two separate developmental milestones of joint attention which are based on differing cerebral processes. The ability to respond to joint attention emerges first in typical development (Carpenter et al., 1998; Moore & Dunham, 1995; Murray et al., 2008) and is associated with parietal and temporal cortical activity (Frieschen, Bayliss & Tipper, 2007; Materna, Dicke & Thern, 2008; Mundy, Card & Fox, 2000), while IJA is linked to frontal cortical processes (Henderson, Yoder, Yale & McDuffie, 2002; Mundy et al., 2000; Torkildsen et al., 2008).

It is assumed that the dissociation of these behaviours is meaningful for early learning and teaching approaches for autistic children (Mundy et al., 2009). This theory is significant for intervention research and influenced the current approach. No similar intervention study is known which provides an in-depth analysis of different components and patterns of joint attention, when looking at specific areas within RJA and IJA. Mundy et al. (2003) distinguished between lower and higher levels of initiating and responding to joint attention skills providing a diagnostic measurement for joint attention (Early Social Communication Scale). Eye contact and the ability to alternate gaze from an object to a person were considered as lower level IJA skills, whereas show, point and point with eye contact were combined as higher level IJA skills. The ability to correctly follow a proximal point or touch was classified as lower level RJA, while a correct follow of line of regard was rated as higher level RJA. The classifications of lower and higher levels for IJA and RJA were adapted in the current intervention study to categorize target behaviours and to develop a treatment approach that promoted different components of joint attention.

Consistent with previous studies (e.g. Hwang & Hughes, 2000; Kasari et al., 2001; Mac Donald et al., 2006; Taylor & Hoch, 2008; Whalen & Schreibman, 2003), results show that joint attention skills were highly impaired in all four participants prior to the intervention and no improvement during the baseline period could be measured. Participants rarely established eye contact with the researcher, rarely followed a pointing gesture and rarely commented on objects during an interaction.

Moreover, they did not initiate joint attention such as showing an object to the researcher or pointing to an object of interest to direct attention. After the intervention, significant improvement was noted for all participants in lower level IJA skills (i.e. eye contact and alternate gaze), as well as RJA skills (i.e. following a point or touch and following a line of regard). Significant progress was also noted in higher level IJA skills in all participants (i.e. pointing with and without eye contact).

Consistent with the Mundy et al. (2003) classification schema, participants in the current study showed a higher frequency of occurrence for lower level RJA skills in comparison to higher level RJA skills. It is interesting to note that the children employed eye contact more frequently than pointing at the beginning of the intervention. However, once pointing was reliably established, all participants employed it more frequently than eye contact. This was not only noticeable rating the video material but also during observations before and after video recordings and through parental report. This suggests that the children realized the importance of directing adults' focus of attention via pointing gestures and experienced these recently acquired skills as rewarding but were not aware of using eye gaze as a successful alternative. After learning how to point, all participants frequently initiated pointing gestures or said "point!", when seeing the researcher prior to starting a therapy session. This was rarely accompanied by eye contact or any of the other target behaviours they were learning. The child who was most severely autistic (participant B), over-generalized what he had learned during the intervention within the first weeks of the program and started to use the pointing gesture not only to show objects to another person but also to point to people when seeing them for the first time. This was possibly his way of engaging with them, showing joint attention and his awareness of the other person's presence.

The results showed that it was more challenging for all participants to accomplish a combination of two joint attention skills, such as pointing with eye contact. Furthermore, consistent with results of previous studies (Taylor & Hoch, 2008), it was challenging to teach participants to alternate gaze. This ability, also known as gaze shifting, refers to the ability to look from an object back to the adult.

In response to an activity or event, participants frequently looked *either* to the object *or* to the researcher, but needed social reinforcement to alternate gaze.

Interestingly, three out of four participants did not demonstrate any progress in the ability to show objects to the researcher even though this ability was promoted during the intervention. This higher level IJA skill seems to be particularly challenging for autistic children, given that showing cannot be modeled in the same manner as other joint attention skills, such as pointing. This finding is consistent with the few existing intervention studies reporting that directing behaviours did not improve, or only marginally improved, in autistic children (Hwang & Hughes, 2000; Zercher et al., 2001). In a joint attention intervention approach by Whalen and Schreibman (2003) significant improvement in IJA skills was reported for one participant. However, only marginal improvements in initiating joint attention were noted for three further participants and one participant was excluded from the study after ten days of therapy as no improvement could be observed (Whalen & Schreibman, 2003). This was also the case in the current study. One participant (E) did not acquire any joint attention skills after two and a half weeks of intervention. This was attributed to an extremely low mental age (below one year) and an extremely low language-age (the participant failed to complete any of the standardized language tests). Bearing in mind that typically developing children learn to initiate joint attention by 12 months of age (Liszkowski, 2005; Mundy et al., 2007), it is assumed that participant E had not yet completed certain developmental and cognitive stages to be capable of acquiring joint attention skills (Mundy et al., 2009; Whalen & Schreibman, 2003).

This is the first known study which examined not only frequency of eye contact in autistic children but also the duration of eye contact initiations (Mean Length of Eye Contact: MLE). Autistic children show difficulties not only in establishing eye contact but also in holding eye contact for longer periods of time. All participants showed very low MLE results during the baseline phase. During the intervention, the children were specifically prompted to hold eye gaze for longer periods of time. There was a clear increase in eye contact and duration of eye contact from the baseline to the intervention phase in all participants.

During the follow-up phase, frequency of spontaneous eye contact and MLE were measured showing that these skills were successfully established and remained consistent after a three month break. During the break, three participants did not receive any other intervention and one participant received weekly social skills training in his school.

In summary, MLE scores did not exceed 2.4 seconds on average even though the participants were specifically trained to hold eye contact for longer periods of time. However, this is a strong result bearing in mind that the average length of eye contact in the typical developing population was reported to be 2.95 seconds (Wang & Hui, 2007). Participant A reached the highest MLE average score (2.9 sec) while participant B, most severely autistic, achieved the lowest MLE average score (1.9 sec). However, no conclusions can be drawn on MLE scores outside the therapeutic setting and with another person since the participants were specifically trained to look at the researcher for longer periods of time and parents were not involved in this intervention approach. Future research with a larger sample group is needed to identify MLE scores in autistic children during an intervention and outside the therapeutic setting.

In summary, there are several important findings of the current study regarding joint attention. First of all, moderate to severe autistic children with very low language ages, who did not show joint attention skills during the baseline phase, showed progress in their joint attention skills after an intensive intervention program. These included lower level IJA skills as well as RJA skills. Specifically, findings suggest that certain joint attention behaviours were more complex to learn for autistic children than others.

Higher level IJA skills, such as showing and in doing so directing the attention of another person to a certain objects, were particularly difficult for the majority of participants. In addition, the ability to alternate gaze from an object back to the researcher and the combination of two joint attention skills, such as pointing with eye contact, were a challenge.

On the other hand, findings suggest that learning how to point seemed to be more salient for participants than other skills: pointing skills were frequently employed by all participants to initiate joint attention after they were established. Spontaneous pointing gestures were initiated by all participants during the follow-up video. Unlike typically developing children, participants frequently verbally accompanied pointing gestures by saying “point”. Another finding is that the duration of eye contact can be increased in autistic children through specific targeted intervention. All participants showed improved MLE scores from baseline to follow-up.

A final important finding is that the type of intervention may provide the greatest benefit to a certain population, i.e. autistic children who have a mental age above one year. This may be due to the developmental time frame in which typically developing children master IJA skills (Liszkowski, 2005; Mundy et al., 2007).

6.2 Joint Attention and Language Development

Numerous studies have explained in theory how the development of joint attention and language are connected (Carpenter, Nagell, & Tomasello, 1998; Charman, 2003; Morissette et al., 1995; Mundy & Gomes, 1998; Murray et al., 2008; Sigman & Kasari, 1995; Tomasello & Farrar, 1986; Ungerer & Sigman, 1984). Joint attention skills have been identified as “pivotal skills” (Charman, 2003) needed by autistic children to master triadic interaction (Baron-Cohen, 1995, 1997), to understand the intentions of others, and to comprehend/produce novel words (Tomasello, 1995). Baron-Cohen et al. (1997) explained how difficulties in joint attention such as gaze monitoring and errors in word mapping are connected in autism.

To date, the clear relationship between the components of joint attention and later language remains a matter for debate (Thurm, Lord, Li-Ching, & Newschaffer, 2007). Some studies suggest a significant correlation between RJA skills and later receptive language (Luyster et al., 2008; Mundy, Sigman, & Kasari, 1990) while other studies found an association between IJA skills and both expressive and receptive language (Mundy, Sigman, Ungerer, & Sherman, 1986; Sigman & Ungerer, 1984). Mundy and Gomes (1998) state that IJA is significantly connected with expressive language skills, whereas RJA is a predictor of receptive language.

At follow-up testing the same researchers found a relation of RJA with both receptive and expressive language (Mundy & Gomes, 1998). As noted earlier, the processes of RJA and IJA are regarded as two separate developmental milestones of joint attention. RJA emerges first in typical development (Carpenter et al., 1998; Moore & Dunham, 1995; Murray et al., 2008), which may explain why some of the studies could not find a connection between IJA and later language. Apart from studies based on theories, only a very limited number of intervention studies have been carried out to show effects of joint attention on later language in autistic children (Kasari, Freeman, & Paparella, 2006; Kasari, Paparella, Freeman, & Jahromi, 2008).

In general, findings of the current study show impairments in both receptive and expressive vocabulary and language skills in participants prior to and after the intervention. These delays in speech and language are considered a cardinal feature of early childhood autism (American Psychiatric Association, 2000). Specifically, participants showed delays in vocabulary, syntax, pragmatics and morphology. All participants of the current study started at an extremely low receptive language level. In comparison to receptive skills, expressive language functioning was higher at the start of the intervention for all participants ranging at the extremely low (participant A, B) or moderately low (participant C, D) level. However, no significant difference between receptive and expressive abilities could be measured prior to the intervention (Dunn & Dunn, 2007). These results are consistent with previous studies that report both expressive and receptive language impairments in autistic children (Kjelgaard & Tager-Flusberg, 2001).

The majority of previous intervention studies did not use a battery of language assessments for a thorough speech and language analysis. It is important to classify expressive and receptive language skills with various language assessments at different timeframes to (1) discuss language development more specifically and (2) formulate more reliable hypotheses on relations between joint attention and expressive/receptive language. There is no known joint attention intervention study which employed three different types of language assessments to analyze language skills in autistic children.

Language measurements of the current study included standardized testing and spontaneous language samples. By combining these measurements, vulnerability of measures, caused by factors such as the need for motivation and compliance for standardized testing, could be decreased (Charman, 2004; Koegel et al., 1997; Tomasello and Mervis, 1994). The results of different language measures will first be discussed separately and then jointly to summarize findings.

6.2.1 Language Skills measured by Standardized Tests

The first important finding is that significant growth could be determined for all participants comparing Growth Scale Value scores from pre- to post-intervention for both receptive and expressive vocabulary (Dunn & Dunn, 2007). This result is consistent with previous studies stating joint attention skills as a predictor of later vocabulary size in typically developing children (Goldfield & Reznick, 1990; Kasari et al., 2001) and autistic children (Bono, Daley, & Sigman, 2004; Sigman & Ruskin, 1999; Siller & Sigman, 2002). Results suggest a connection of joint attention with both receptive and expressive vocabulary growth (Murray et al., 2008). The second finding is that higher GSV score differences were found for receptive vocabulary for all participants. This result may imply that, as previously assumed by some researchers (Luyster et al., 2008; Mundy et al., 1990), there is a stronger relation between joint attention skills and receptive vocabulary development. Further intervention studies with a larger sample group are required to support this hypothesis.

The third finding is that reliable change in receptive and expressive vocabulary skills could not be attributed to all participants on all language measures after the intervention. According to the criteria for reliable change (Jacobson et al., 1986; Jacobson & Truax, 1991; Wise, 2004) only two participants (participant A, D) achieved reliable change on all (receptive and expressive) language measures. Results of the other two participants will now be further examined.

Participant B showed reliable change for receptive and expressive vocabulary employing the PPVT-4 and EVT-2 measures, but no reliable change on the RDLS-3. Participant B was observed to experience difficulties relating to the various test materials of the RDLS and was unable to follow instructions. He also exhibited repetitive behaviours and anxiety responses due to difficulties coping with frequent shifts of activities. Participant B seemed to relate to pictures more easily (PPVT-4, EVT-2) which could have influenced the overall test results.

Reliable change could be determined for participant C on both receptive and expressive skills employing the PPVT-4 and the RDLS-3. However, no reliable change could be attributed using another expressive language measure (EVT-2). Participant C was observed to rapidly lose interest in labelling the pictures of the EVT-2 test material which could have influenced the overall test results.

An important finding is that all participants showed reliable change for receptive vocabulary skills using the PPVT-4. These results are consistent with previous studies suggesting an influence of joint attention on the acquisition of vocabulary size in autistic children (Bono et al., 2004; Sigman & Ruskin, 1999; Siller & Sigman, 2002).

Three out of four single participants showed clinically significant change from pre- to post-intervention moving into the “normal” range within -2SD from the mean. Clinically significant change could not be attributed to participant B. However, Growth Scale Value scores and reliable change scores indicated improvement for participant B. The movement into the “normal” range may be unrealistic for some autistic children and may be influenced by the severity of autism and the developmental language age prior to the intervention. Participant B was severely autistic and had a very low developmental language age.

In summary, two participants (participant A, D) showed substantial benefits from the intervention, showing change in Growth Scale Value scores as well as reliable and clinically significant change.

After discussing the results of the standardized tests, it is of interest to look closely at the joint attention intervention and try to determine which element of the intervention caused changes in language. For this purpose, we need to examine which component of joint attention influenced language improvements. Some studies closely observed preverbal gestures, such as showing, giving and pointing, in relation to language. The abilities to initiate pointing (Bates et al., 1979) and to respond to pointing (Mundy et al., 1990; Sigman & Ruskin, 1999) were identified as strongest predictors for later language development.

Other studies favour the rate of communicative intents (requesting behaviours, imitations, and initiations of joint attention) (Charman et al., 2005) and the duration of joint engagement (Adamson et al., 2004) as the strongest predictor for later language development. The current intervention study does not allow for clear conclusions on this question. It can be noted that once pointing gestures were established, all participants used them more frequently than other joint attention skills during observations and outside the therapeutic setting. The use of this acquired skill, i.e. interacting with an adult and referring to objects, may have influenced novel word learning and language development. In addition, the durations of joint engagement between the adult and the child (Adamson et al., 2004), i.e. an intensive training of joint attention, and an early onset of intervention (Gerenser, 2009), seems to be essential to establish these skills. Alongside the role of joint attention as a predictor for later language development, previous studies have emphasized the relation of imitation and later language (Charman et al., 2000; Charman et al., 2005; Ingersoll & Schreibman, 2006). There seems to be strong relation between joint attention and imitative skills (Roeyers et al., 1998). In one of the few existent intervention studies, teaching imitation caused an increase in other social behaviour skills, including joint attention, language and pretend play (Ingersoll & Schreibman, 2006).

Imitation was not specifically trained in the current intervention approach; however participants imitated the researcher to some extent to learn novel behaviour skills. Future intervention research could place a stronger emphasis on imitation. It is of interest to find out whether intervention approaches that teach both joint attention and imitation are more effective than intervention approaches that focus on either joint attention or imitation.

Another important finding is that one variable of joint attention skills, i.e. show, did not improve significantly. This result states that participants of the current study did not achieve language gains through improvement in showing, which is one component of higher level IJA.

6.2.2 Spontaneous Language during Conversation

Spontaneous language was analyzed to address the question of whether joint attention intervention has an effect on expressive syntactic growth after intervention. In addition, semantic and pragmatic skills were examined. Language delays in morpho-syntax, discourse and pragmatics have been reported as general characteristic of autism (Happé, 1994; Kelley et al., 2006). However, as criticized earlier by Perkins et al. (2006), only a very limited number of studies have been carried out to analyze spontaneous language and to identify specific linguistic patterns in autism. Condouris, Meyer and Tager-Flusberg (2003) analyzed the relationship between standardized tests and spontaneous language transcripts as two different measurements to assess language in autism. They argue that both measures are valuable to identify language impairments and recommend the use of both measures simultaneously based on the diverse language profile in autism (Condouris et al., 2003).

Spontaneous language transcripts revealed language delays in morpho-syntax, discourse and pragmatics in all participants. These language impairments are a central feature of early childhood autism (Gerenser, 2009; Kelley, Paul, Fein, & Naigles, 2006; Ritvo, 2006) and have been identified in previous studies that analyzed spontaneous speech in autism (Dobbinson, Perkins, & Boucher, 1997, 1998). Results showed that MLU in words and morphemes deviated at least -1SD to -2SD from the database mean during the first assessment. Three participants (A, B, C) showed a significant change in the number of utterances in words and morphemes across time. No change in the number of utterances for words and morphemes across time could be measured comparing the first and second transcript for participant D. However, a significant increase of Mean Length of Morphemes across time could be determined from transcript one to three as well as transcript two and three. As participant D was the youngest participant in this study, this might suggest that more time was required to show change given the low developmental age throughout the assessment.

Apart from enhanced MLU scores across time, there was a positive trend for the Mean Turn Length of words and an increased verbal rate for words per minute for all participants. Increasing the frequency of eye gaze as well as responding to joint attention bids, has resulted in an improvement in vocabulary development (Bono et al., 2004).

Moreover, participants gradually learned how to use gestures during interaction which led to improved pragmatic skills (i.e. turn taking, use of gestures to support communication, response to questions). During the intervention the ability to share the same focus and respond to joint attention was promoted to improve social awareness and support the understanding of social communication.

The Type Token Ratio (TTR) of the spontaneous language profile did not show improvement in semantic skills for any of the four participants. During the course of intervention, there was no noticeable increase in the level of lexical variation, implying that the intervention had a positive effect on social-communicative skills and pragmatic development but not on lexical knowledge.

The results imply that there was an improvement regarding the verbal rate (the number of words per minute which were used during conversation), but not in the number of different word types used. Possible reasons could have been (1) the type of intervention or the (2) duration of intervention. A study by Hirotani et al. (2009) showed that the social context is important for early word learning. Typically developing infants showed better results in novel word learning if it was embedded in a joint attention condition (eye contact, positive tone of voice) versus a non-joint attention condition (no eye contact, neutral tone of voice). In the current study, the focus was on a joint attention intervention without providing specific speech and language therapy. Accordingly, the aim was to teach and improve joint attention but not primarily to teach novel vocabulary. Secondly, the researcher suggests that the duration of interaction was too short to show statistical change in the area of lexical knowledge as demonstrated in spontaneous interaction.

In summary, the spontaneous language transcripts proved to be a sensitive measure to track language development and change in autistic children and have a higher ecological validity compared to standardized tests (Hewitt et al., 2005). They are more likely to reflect real life functioning rather than being responses in a clinical testing situation. The children did not need to be motivated to give answers and could be observed in a natural play situation. Results show improvements in morpho-syntax, pragmatic and social-communicative skills and an increase of the verbal rate. No improvements in semantic skills or lexical knowledge were observed. Future research should gather language samples of a larger target group following joint attention intervention. Longitudinal studies could be conducted video-taping autistic children during play interaction with their parents in their homes.

6.3 Contribution of the Current Study

In summary, the current study contributes to our understanding of joint attention by looking at very specific components of joint attention. Unlike previous studies, the intervention was provided by the researcher and clear objective and rationales directly related to specific areas of joint attention were presented. After the intervention, improvements in particular areas of joint attention skills could be identified, and assumptions of learning patterns made. Results of this approach suggest that the current joint attention intervention improved social interaction skills as well as language trajectories in autistic children. Findings are consistent with theoretically based studies stating that labeling and understanding the meaning of objects emerges by monitoring them via eye gaze and other joint attention skills (Baron-Cohen et al., 1997). It is assumed that developmental coherences within joint attention skills exist and should be considered in designing interventions: once lower level joint attention behaviours are mastered higher level skills can be achieved more easily. Activities were developed accordingly to specific target areas of joint attention and aimed to directly increase IJA and RJA skills as well as to promote triadic coordination, coordinated gaze shifting, distal joint engagement, promptness of proto-declarative pointing, and the duration of eye gaze.

These objectives were inter alia connected with facilitating social awareness, a shared focus for shared references, vocabulary and pragmatic development as well as turn-taking and conversational skills. Apart from the necessity of an intensive, area-focused program, flexibility in adjusting a thorough prepared approach to each individual child with a different level of severity of autism and developmental age was necessary.

Teaching joint attention can mean that rather complex training sequences such as pointing to objects and events can be accomplished rapidly with a very young child (participant D) but seem out of reach for an older child (participant B) in the first sessions. In this case, the activities need to be simplified accordingly to the child's developmental age and should be based on skills (such as throwing an object) that the child is already mastering.

Autistic participants who were less impaired enjoyed more complex games and rapid variations of activities which required the performance of fine motor skills, coordination and complex turn-taking.

6.4 Limitations and Implications for Future Research

Due to the target group (autistic children diagnosed prior to their sixth birthday), and the type of intervention (an intensive program carried out by one researcher), the number of participants was restricted, limiting the extent to which the findings can be generalised. Future studies, carried out by a team of researchers and clinicians, could include a larger number of participants and employ within group designs. In addition, a matched control group of autistic children who do not receive the intervention and a control group of typically developing children matched by developmental age would be beneficial. Furthermore, this study does not allow conclusions on the type of learning environment that is best to show improvements in autistic children in joint attention and language. The current approach tried to provide a positive learning environment for the autistic child by presenting varied activities ranging in their level of difficulty; ensuring motivation with salient objects; child choice of activities; the use of behavioural methods of prompting and reinforcement and a natural environment in the child’s home (Butterworth, 1995; Jones & Carr, 2004; Jones et al., 2006; Tomasello, 1995; Vismara & Lyons, 2007, Whalen & Schreibman, 2003; Wong et al., 2007). Future research could evaluate differing learning programs and compare their efficacy in a group design.

Moreover, the target group consisted of autistic children, who had significant developmental language delays in expressive and receptive vocabulary yet were at least partly able to use verbal speech prior to the intervention. Since the participants of the current study were verbal autistic children, no conclusions can be drawn on the development of joint attention of non-verbal autistic children. Future research needs to address this population. It may be that a joint attention intervention for non-verbal autistic children needs to be even more intensive than for verbal autistic children to show change in joint attention. Non-verbal language tests could be carried out to see if these children show improvement in their receptive language skills.

The current study does not allow general conclusions on the question whether the ability to initiate or respond to joint attention is a better precursor for later language growth. Consequently, it would be interesting to identify how training of IJA or RJA influences later language trajectories.

Future research is required to identify characteristics which allow autistic children to successfully participate in an early intervention program and how to promote the development of children who might not yet be ready to participate. It is crucial to note that progress in joint attention was achieved in the current study, despite the low language age and severity of autism of all participants. Participants all demonstrated extremely or moderately low expressive and receptive language skills prior to starting the intervention program and were classified as ranging between moderate to severe on the Autism Spectrum. It has to be noted that one participant had to be excluded from the study based on an extremely low developmental language age and severe autism. Even though previous intervention studies provided general characteristics of participants, further details on the target group, including a diagnosis of autism severity was frequently missing (Kasari et al., 2008; Taylor & Hoch, 2008) and only provided by some researchers (Whalen, Schreibman, & Ingersoll, 2006).
Bearing in mind the small number of intervention studies, future research would benefit from a clear description of participants and could investigate how severity of autism might influence treatment outcomes.

Future research should focus on therapeutic interventions for young autistic children, in particular on the main constituents of successful intervention approaches. Hitherto, studies have mainly addressed the theoretical background of joint attention. It is assumed that this has three major reasons: (1) there are only a very limited number of joint intervention studies with autistic children that can be replicated; (2) there are time and financial constraints based on the intensity of intervention autistic children require to show change in their behaviour; and (3) the field of joint attention is recent and specific and intervention requires trained professionals.

To date, intervention guidelines for both researchers and clinicians are rare. Mundy et al (2003) provided the first published measure of joint attention. This is a crucial component in the diagnosis of joint attention.

In the future, the emphasis could lie on early treatment. As noted earlier, the number of intervention studies is very limited (Charman, 2003) and often lacks a clear description of the concrete treatment program (Kasari et al., 2008). A thorough explanation of the actual intervention is necessary to replicate previous research and further develop effective intervention programs. Future research, ideally a union of researchers and clinicians, also needs to identify and compare the effectiveness of different approaches.

Research is needed to further study joint attention skills in typically developing and autistic children in natural settings, such as at home and in school (Hwang & Hughes, 2000, Jones et al., 2006). Previous studies have mainly consisted of intervention programs carried out in clinical contexts (Taylor & Hoch, 2008; Whalen & Schreibman, 2003). In this study, a home-based program was chosen, assuming that autistic children may learn more efficiently in a comfortable, familiar environment outside a clinic given other underlying problems such as coping with change and anxiety. In this context, further intervention studies are required to investigate the effectiveness of training parents to promote joint attention. Previous studies have shown positive trends in training parents (Rocha et al., 2007), siblings (Ling-Ling & Odom, 2006) and peers (Zercher et al., 2001). Rocha et al. (2007) showed improvements of RJA and IJA in three parent-child pairs. Further studies are required to replicate findings and to gather longitudinal data with a larger participant group. Behaviour training could further be accomplished by providing videos modelling joint attention for autistic children (Whalen & Schreibman, 2003).

To date, intervention studies with siblings of autistic children focused on social interaction rather than specifically trained joint attention, and joint attention was not considered as the main outcome variable (Ling-Ling & Odom, 2006). Future research is needed to further study the effectiveness of parent, sibling or peer training for autistic children.

One of the few intervention studies with siblings of autistic children focused on promoting play behaviour (Celiberti & Harris, 1993). Results show that siblings of autistic children can successfully teach social interaction skills to an extent, that autistic children are able to generalize acquired skills to novel objects (Celiberti & Harris, 1993). The advantage of a sibling related intervention is that it can be generalized into a natural setting and employed in everyday play situations.

Apart from concentrating on the importance of parent, peer and sibling training, group intervention studies could be carried out. Children may learn efficiently in a group environment modeling the behaviours of their peers and may experience the group situation as motivating and rewarding. Providing group therapy for autistic children could include participation of their parents which would simultaneously show target behaviours to parents they can model to their children at home. Social skill groups are often employed in private practices to enhance the ability of autistic children to understand another person's feelings and mental states. One established program, that also provides social skills training in a group setting, is "Treatment and Education of Autistic and related Communication handicapped Children" (TEACCH) (Häussler, 2005). Consequently, future research could focus on training joint attention in a group environment.

In general, early intervention programs for autistic children ideally need to be multidimensional and carried out at various settings (home, school and clinic) by involving families, teachers, peers and professionals.

Based on findings of the current study, it seems to be crucial for future research to further analyze learning patterns of autistic children and identify levels of difficulty for establishing and showing certain behaviours. This includes analyzing different components of joint attention, such as showing and pointing, comparing their learning curves and searching for answers on how they may be related.
The ability to point may be a more essential behaviour skill for the development of joint attention and learning of other components of joint engagement than other skills, such as showing objects.

Nevertheless, shedding light on this question in an intervention study may be challenging. It seems difficult to separate IJA and RJA in an intervention approach for autistic children by teaching one matched target group only IJA skills and the other matched target group only RJA skills. It is necessary to model joint attention to autistic children so they can respond to an interaction, before they are able to initiate joint attention independently.

Even though it appears to be important to teach both IJA and RJA skills, it seems possible to focus on lower level IJA skills (i.e. eye contact and alternate) in one group and higher level IJA skills in another group (i.e. pointing with and without eye contact) and later compare the development of joint attention.

Finally, future research needs to further examine the correlation between joint attention and later language development as well as play behaviour. Intervention studies with a larger participant group to replicate previous findings are necessary. In addition, the connection between joint attention and possible long-term effects on social interaction between autistic children and their parents is a matter of interest. It is assumed that an improved social interaction has positive psychological side effects on both parent and child and influences their mutual relationship, but this assumption remains to be tested.

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Appendices

APPENDIX A

Participation Information Sheet

Dear parents,

Autistic children have difficulties in social interaction, such as holding eye gaze, showing objects to parents or following their gestures. These skills are called joint attention behaviours. A research project is being carried out to find out whether an intervention program which promotes these skills will also improve the development of language.

This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number HR 124/2008). The Committee is comprised of members of the public, academics, lawyers, doctors and pastoral carers. Its main role is to protect participants. If needed, verification of approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/- Office of Research and Development, Curtin University of Technology, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784 or by emailing hrec@curtin.edu.au.

If you give permission for your child to take part in this study a speech pathologist will give a joint attention intervention program to your child in your home for three times a week for approximately 90 minutes each. The time will be arranged to suit your family.

The intervention will promote social interaction skills such as following a pointing gesture, holding eye gaze and shifting attention from an object to an adult and back. Before the intervention starts the therapist will have a look at the general developmental stage of your child as well as his / her joint attention and language ability. The joint attention and language measures will be repeated three months after the intervention. You will be asked to fill in a questionnaire about the development of your child. A speech pathologist might ask you some additional details about your answers to the questions.

The results of the research may be published, but your child's name will not be used. Intervention sessions will be video-taped but video tapes of interventions as well as records of measurements will be coded for confidentiality purposes and stored in locked filing cabinets. Stored data will be coded with ID numbers to ensure anonymity. Personal data on you and your child, such as name, phone number and address, will be kept separately in a locked filing cabinet. All data will be kept at Curtin University for a maximum period of five years and eventually be destroyed using a shredder.

You do not have to give permission for your child to take part in this research. If you do give your permission, you can change your mind at any time. If you withdraw your child from the study, all the information that has been collected about your child will be destroyed.

If you have any questions or concerns about this project, please do not hesitate to contact either myself or my research supervisors, Dr. Kathy Ziatas (Ph. ____________) or Dr. Cori Williams (Ph. ____________).

Yours sincerely,

Clarissa Lindsay

(Ph. ____________or mob____________)

APPENDIX B

Consent Form

Project title:	Early Intervention to Improve Later Speech and Language Trajectories in Young Autistic Children
Institution:	Curtin University of Technology, Faculty of Health Sciences
Approval Number:	HR 124/2008
Researcher:	Clarissa Lindsay
Contact:	Ph. 9266 xxxx or mob. 04xxxxxxxx

I have read the information above and any questions I have asked have been answered to my satisfaction. I know that I may withdraw my permission at any time.

- ☐ I give permission for my child to participate in the research.
- ☐ I agree to fill in the questionnaire and to answer questions about this information.
- ☐ I understand that the research data gathered for this study may be published but my child and I will not be identified.
- ☐ I give permission for the use of videotapes during presentations or training programs by the researcher.

____
Child's name

____
Parent's name

____________________________________ ____________________
Parent or authorized representative's signature Date

____________________________________ ____________________
Investigator Date

APPENDIX C

Data Collection: Severity of Autism

"Relationships with people"

During play observations it was noticed that all participants frequently avoided eye contact with the researcher and could not respond to joint attention bids. Timid and withdrawn behaviour was observed during various interactions.

"Imitation"

Joint attention and imitative skills are strongly connected milestones considering that typically developing children engage in interaction and imitate gestures by the age of 9 months (Roeyers, Van Oost, & Bothuyne, 1998). Participants were asked to imitate actions, such as clapping hands, but only could do so after an enormous amount of repetition, reinforcement, persistence and support by the researcher. Thereupon, actions of imitation only rarely took place and were characterized by a delay and very short appearance. More complex imitative actions, like standing on one foot or clenching and opening of the fist, were not possible.

"Object Use"

All participants were preoccupied with specific objects, such as cars, and did not show much interest in novel objects. In addition, three participants were occasionally observed in using objects in a non-functional manner, such as turning the wheels of a car. Moreover, all single participants were fascinated with light reflects or sounds made by objects. During the initial observation phase, participant B could rarely be distracted from switching on and off the head light repetitively.

"Visual response"

Visual exploration and response was peculiar for all single participants and characterized by staring into space, looking at objects from an angle or occasionally holding objects very close in front of the eyes. In addition, rapid eye movements were observed for three out of four participants.

All children frequently and rapidly moved their heads and eyes seeking for objects around the room having difficulty locating them. One child was able to explicitly express the inability to locate objects by saying “Help me, I can’t see!” or “Show me!” and was leading the index finger of the researcher, as closely as one centimeter distance, towards the target object. Moreover, a lack of visual awareness was noticeable in three out of four participants. They were frequently visually unaware of surrounding obstacles and collided with them which improved during the course of intervention learning to relate to objects and people.

“Verbal Communication”

As explicated earlier, joint attention also seems to play a crucial role in later language development (Bono et al., 2004; Siller & Sigman, 2002). Significant speech and language impairments were noticed prior to carrying out the language tests in all single participants. Verbal communication was characterized by frequent jargon speech, echolalia, pronoun reversal or repetitive speech.

“Nonverbal Communication”

Nonverbal communication skills, such as pointing, showing or giving objects, were clearly impaired before starting the intervention. The inability to initiate joint attention and direct an adult’s attention towards an object was observed by the researcher and consistent with parental report stating a lack of pointing gestures.

APPENDIX D

CDI Scoring Program Questionnaire

BASIC INFORMATION FORM

Child's Birth date____________________________ Date________________________

Child's Name _______________________________Sex _________
FIRST MIDDLE LAST

Address ____Ph. __________
STREET CITY POSTCODE

Child's birth order: ☐ 1st ☐ 2nd ☐ Other ______ (specify)
Number of children in family_____

Is child adopted? ☐ Yes ☐ No Child's birth weight: _______

Name of
Mother/Guardian:____
FIRST LAST

Name of
Father/Guardian:____
FIRST LAST

CONTACT INFORMATION

The best **TIME** to contact me is: _____________________________________

The best **PLACE** to contact me is: HOME ☐ Ph. #______________________

WORK ☐ Ph. #___________________

EXPOSURE TO OTHER LANGUAGES

Is your child regularly exposed to a language other than English? **YES □ NO □**

If YES: What Language? ________________ By whom?________________________________

Days per week? _______# Hours per day?______ Since what age (in months)?

HEALTH

Did you experience any major pregnancy or birth complications? **YES □ NO □**

If YES: Please describe: ____

Was your child born prematurely (i.e., before the due date)? **YES □ NO □**

If YES: How many weeks early? ___________

Does your child experience chronic ear infections (5 or more)? **YES □ NO □**
If so, has your child undergone intervention (e.g., tubes)? **YES □ NO □**

If YES: Please describe:

____
____
____
____
____
____
____
____
____
____
____

Is there some reason to suspect that your child may have a hearing loss? **YES □ NO □**

Has your child had major illnesses, hospitalizations, diagnosed disabilities? **YES □ NO □**

If YES: Please describe:

Have you or any member of your extended family (e.g., child's siblings, grandmother, father, etc.) been diagnosed with any type of behavioural impairment, neurological impairment, language disability and/or learning disability? **YES □ NO □**

If YES: Please specify:

CAREGIVER INFORMATION

With whom does your child live?

 One parent Both biological parents Biological parent + step-parent
 Adopted parent(s) Other, please explain ________________________________

Who participates in the day-to-day care of your child? (check all that apply)

 Mother/Guardian Day Care Centre (hrs/week __________)
 Father/Guardian Non-parent caregiver (e.g., grandparent, "nanny") in your home (hrs/week ___________)

 Outside-the-home caregiver (e.g., "family provider" in their home) (hrs/week _______)
 Other, please explain _____________________________________(hrs/week _______)

ETHNIC BACKGROUND

For example, Asian, Native Australian, Black, White, Hispanic, or other appropriate category.

______________________ Mother/Guardian

_________________________ Father/Guardian

EDUCATION

Circle highest grade completed. (12 = high school graduate, 16 = college graduate, 18 = advanced degree).

Mother/Guardian	6	7	8	9	10	11	12	13	14	15	16	17	18
Father/Guardian	6	7	8	9	10	11	12	13	14	15	16	17	18

OCCUPATION

Please provide a brief description of your occupation using specific terms (e.g., computer technician, accountant, dental assistant)

Mother/Guardian:____

Father/Guardian:____

THANK YOU VERY MUCH

FOR TAKING THE TIME TO ANSWER OUR QUESTIONS!

Reference: Language and Communication Database Project, School of Human Development, University of Texas at Dallas P.O. Box 830699, GR 41, Richardson, TX 75083-0688, USA

APPENDIX E

CDI Scoring Program Sheet

FAMILY HISTORY

Birth Order:	1 to 9, or NR
Ethnicity Code:	NR = not reported A = Asian B = Black H = Hispanic I = Indian W = White 1 = Native Australian 2 = other
Bilingual Code:	NR = not reported 0 = no exposure 1 = less than 7 hours/week 2 = 8-35 hours/week 3 = 35+ hours/week
Mother's Education: **Father's Education:**	6-18 years, or NR 6-18 years, or NR 12 = finished high school 16 = college degree 18 = graduate degree

MEDICAL HISTORY

Medical Code:	NR = not reported
Birth:	P = Premature (< 1500g, < 38 weeks gestation) BC = Birth complications
Hear:	E = Ear infections (more than 5) EI = Ear infections with intervention (e.g. tubes) HL = Child is thought to have a hearing loss
Diseases:	MI = Major illness DD=Developmental disability
Family history:	FD = Family history of developmental disability

LIVING SITUATION

Lives with (all that apply):	NR = not reported 1P = One parent 2P = both biological parents AP = Adopted parents 1S = One biological, one step-parent O = Other
Daily care (all that apply):	NR = not reported MG = mother/guardian FG = father/guardian NP = non-parent caregiver in home (e.g. nanny) DC = Day care centre OH = outside-the-home provider (e.g. family) O = Other

APPENDIX F

Data Collection: Medical History

Participant A

There were no complications during gestation. Delivery took place through elective caesarean section. Weight at birth was 3200gram and bottle feeding was by maternal preference. At approximately six weeks of age, serious skin difficulties occurred which resulted in a treatment with topical steroids (corticosteroid creams). By the age of 30 months, the participant had an anaphylactic reaction in response to hazelnut digestion and has ongoing difficulties with allergies and eczema, including allergic reactions to milk and nuts which also occurred during an intervention session showing erythrism at face and neck. One intervention session was cancelled due to stomach pains which were probably connected to food intolerance. By the age of 43 months, a mild intellectual impairment was diagnosed by a multidisciplinary team on behalf of the *Wechsler Preschool and Primary Scale of Intelligence-Third Edition Australian Standardised Edition* (WPPSI-III Australian) (Wechsler, 2002) and the *Vineland Adaptive Behaviour Scales-Second Edition* (Vineland-II) (Sparrow, Cicchetti, & Balla, 2005). The family medical history shows no form of PDD, language disorder, epilepsy or ADHD. However, the grandfather on the father's side has Schizophrenia which coincides with family studies reporting of a genetic association between autism and schizophrenia (Rapoport, Chavez, Greenstein, Addington, & Gogtay, 2009). The aunt on the mothers' side is reported to have congenital deafness.

Participant B

There were no complications during gestation and the child was born at 38 weeks via elective caesarean section. Weight at birth was 3360gram. After stopping breast feeding at the age of 12 months, the boy refused to drink via bottle feeding. He spat out milk and water he was given and his mother tried to provide fluid intake by feeding him yoghurt and watermelon. Eventually, he dehydrated and had a one-time hospital stay. He completed all important developmental milestones: sitting at 7 months, expressing first words at 12 months and walking at 15 months. The mother reported of a developmental regression especially on behalf of his verbal skills. A video-tape proves that he could play hide and seek at the age of 18 months but lost this ability at the age of approximately 50 months. Difficulties in play, speech and language as well as social skills became more and more apparent at the age of approximately 24 months which later lead to the diagnosis of childhood autism. Previous assessments included the *Bayley Scales of Infant and Toddler Development* (Bayley-III) (Bayley, 2006) reaching extremely low performance levels in all five different domains including cognition, receptive and expressive language as well as fine and gross motor skills. In addition, results of the *Bayley-III Social-Emotional and Adaptive Behaviour Questionnaire* (Bayley, 2006) showed difficulties in social interaction, sensory-tactile processing and particularly in using gestures. At approximately 63 months of age, he developed a small amount of facial eczema which resulted in a treatment with topical steroids. However, no food allergies could be diagnosed. He was first diagnosed with a viral respiratory infection including shortness of breath and coughing followed by difficulty to perform motor activities such as jumping and running. At the age of approximately 65 months, he was diagnosed with asthma. Regarding family medical history both grandfathers, on the mothers' and on the fathers' side, were described as being "loners", showing impairments in their social abilities and meeting the criteria for Asperger Syndrome.

Participant C

The mother of the child was diagnosed with gestational diabetes mellitus (GDM) showing increased blood glucose levels up to 5-10 per cent during pregnancy (Metzger et al., 2007). GDM could be controlled by diet, however an increased risk of developing diabetes type 2 persisted (Wah Cheung & Byth, 2003). The prevalence rates for GDM in Australia, currently ranges between 5.2–8.8 per cent according to the Mercy and the Australasian Diabetes in Pregnancy (ADIPS) criteria (Wah Cheung & Byth, 2003). The mother was diagnosed with the genetic disorder Factor V R506Q (Leiden) and treated with Clexane injections containing the active ingredient enoxaparin to prevent blood clotting. Delivery took place via elective caesarean section. Weight at birth was 3345 gram. The baby was described as being very quiet and rarely cried. Food intake was exclusively by breast feeding until 6 months of age and then partly continued until 14 months of age. By the age of 2:09 years, the boy was diagnosed with giardiasis and developed symptoms of constant diarrhea, cramps and fever. During this timeframe the parents reported of a regression regarding skills and milestones he had established until then, such as toilet training. By the age of 3:09 years, he was administered the WPPSI-III Australian reaching an overall IQ scale within the normal range. Furthermore, the *Child Behaviour Checklist* for age 1.5-5 years was completed showing peculiarities in particular areas such as emotional response (strong emotional reactions, rapid shifting between sadness and excitement), social skills (aggressive behaviour towards other children such as hitting them or destroying their toys; demanding and aggressive behaviour towards adults especially after change of routine or activity) and attention (hyperactive and restless behaviour). Furthermore, difficulties in play behaviours were reported, such as a lack of understanding how to interact with other children and little social imaginative play. In addition, a lack of eye contact, empathy as well as the ability to express own emotions was noticed. Regarding family medical history the maternal grandfather had Asperger Syndrome and the boy's first cousin on the mother's side was diagnosed with PDD.

Participant D

Vacuum extraction was required in an otherwise unremarkable delivery following a healthy, full-term pregnancy. Weight at birth was 3400gram. The mother reported of problems with breast feeding resulting in the child being underweight and she continued with bottle feeding. Prior the child's second birthday, the mother had concerns about his overall development. She reported of difficulties in book sharing activities, following routine instructions, pretend play, language development and sleep. Moreover, she noticed reduced eye contact and difficulties to shift eye gaze between a desired object and an adult. By the age of 2 years, the boy was diagnosed with autism on DSM-IV criteria by a paediatrician, a speech pathologist and a psychologist. He was administered the *Vineland II Adaptive Behaviour Scales* (Interview Edition - Survey Form) obtaining an overall adaptive behaviour score falling within the mild disability range. Moreover, the *Preschool Language Scales-Fourth Edition* (PLS-4) was administered showing difficulties in expressive language. There is a medical history of neurobehavioral, language and learning disorders as well as ASD in the extended family. The aunt of the participant was diagnosed with dyslexia. The mother, grand cousin and grandfather on the mother's side were diagnosed with ADHD and there is evidence of a genetic relation between autism and ADHD (Ronald, Simonoff, Kuntsi, Asherson, & Plomin, 2008). In addition, the father and the grandfather on the fathers' side were diagnosed with Asperger Syndrome.

APPENDIX G

Reliable Change Score Calculations

Participant A

RCI Calculations for Receptive Vocabulary

Calculations for PPVT-4:

SEM = SD $\sqrt{(1 - r)}$
SEM = 14.4 $\sqrt{(1 - .91)}$
SEM = 4.32

SED = $\sqrt{2(\text{SEM})^2}$
SED = $\sqrt{2(4.32)^2}$
SED = 6.1094

RC = (pre – post) / SED
RC = 17/6.1094
RC = 2.78 >1.96

RC = 15/6.1094
RC = 2.46 >1.96

Calculations for RDLS-3 Comprehension (C-C):

SEM = SD $\sqrt{(1 - r)}$
SEM = 4.43 $\sqrt{(1 - .75)}$
SEM = 2.215

SED = $\sqrt{2(\text{SEM})^2}$
SED = $\sqrt{2(2.215)^2}$
SED = 3.1324

RC = (pre – post) / SED
RC = 17/3.1324
RC = 5.43 >1.96

Participant A
(Continuation)

RCI Calculations for Expressive Vocabulary

Calculations for EVT-2:

SEM = SD $\sqrt{}(1 - r)$
SEM = 15.75 $\sqrt{}(1 - .95)$
SEM = 3.5218

SED = $\sqrt{}2(SEM)^2$
SED = $\sqrt{}2(3.5218)^2$
SED = 4.9805

RC = (pre – post) / SED
RC = 14/4.9805
RC = 2.81 >1.96

RC = (pre – post) / SED
RC = 10/4.9805
RC = 2.01 >1.96

Calculations for RDLS-3 Expressive (E-E):

SEM = SD $\sqrt{}(1 - r)$
SEM = 6.21 $\sqrt{}(1 - .86)$
SEM = 2.3235

SED = $\sqrt{}2(SEM)^2$
SED = $\sqrt{}2(2.3235)^2$
SED = 3.2859

RC = (pre – post) / SED
RC = 13/3.2859
RC = 3.95 >1.96

Participant B

RCI Calculations for Receptive Vocabulary

Calculations for PPVT-4:

SEM = SD √(1 - r)
SEM = 17.75√(1 - .94)
SEM = 4.3478

SED = $\sqrt{2}(\text{SEM})^2$
SED = $\sqrt{2}(4.3478)^2$
SED = 6.1487

RC = (pre – post) / SED
RC = 13/6.1487
RC = 2.11 > 1.96

RC = (pre – post) / SED
RC = 14/6.1487
RC = 2.28 > 1.96

Calculations for RDLS-3 Comprehension (C-C):

SEM = SD √(1 - r)
SEM = 4.43 √(1 - .75)
SEM = 2.215

SED = $\sqrt{2}(\text{SEM})^2$
SED = $\sqrt{2}(2.215)^2$
SED = 3.1324

RC = (pre – post) / SED
RC = 0/3.1324
RC = 0

Participant B
(Continuation)

RCI Calculations for Expressive Vocabulary

Calculations for EVT-2:

SEM = SD $\sqrt{}(1 - r)$
SEM = 16.65 $\sqrt{}(1 - .96)$
SEM = 3.33

SED = $\sqrt{}2(SEM)^2$
SED = $\sqrt{}2(3.33)^2$
SED = 4.7093

RC = (pre – post) / SED
RC = 10/4.7093
RC = 2.12 > 1.96

RC = 11/4.7093
RC = 2.34 > 1.96

Calculations for RDLS-3 Expressive (E-E):

SEM = SD $\sqrt{}(1 - r)$
SEM = 6.21 $\sqrt{}(1 - .86)$
SEM = 2.3235

SED = $\sqrt{}2(SEM)^2$
SED = $\sqrt{}2(2.3235)^2$
SED = 3.2859

RC = (pre – post) / SED
RC = 4/3.2859
RC = 1.22

Participant C

RCI Calculations for Receptive Vocabulary

Calculations for PPVT-4:

SEM = SD √(1 - r)
SEM = 14.4 √(1 - .91)
SEM = 4.32

SED = $\sqrt{2}(\mathrm{SEM})^2$
SED = $\sqrt{2}(4.32)^2$
SED = 6.1094

RC = (pre – post) / SED
RC = 23/6.1094
RC = 3.76 >1.96

RC = 19/6.1094
RC = 3.11 >1.96

C*alculations for RDLS-3 Comprehension (C-C):*

SEM = SD √(1 - r)
SEM = 4.43 √(1 - .75)
SEM = 2.215

SED = $\sqrt{2}(\mathrm{SEM})^2$
SED = $\sqrt{2}(2.215)^2$
SED = 3.1324

RC = (pre – post) / SED
RC = 22/3.1324
RC = 7.02 > 1.96

Participant C
(Continuation)

RCI Calculations for Expressive Vocabulary

Calculations for EVT-2:

SEM = SD √(1 - r)
SEM = 15.75 √(1 - .95)
SEM = 3.5218

SED = $\sqrt{2(SEM)^2}$
SED = $\sqrt{2(3.5218)^2}$
SED = 4.9805

RC = (pre – post) / SED
RC = 9/4.9805
RC = 1.81

RC = (pre – post) / SED
RC = 7/4.9805
RC = 1.41

Calculations for RDLS-3 Expressive (E-E):

SEM = SD √(1 - r)
SEM = 6.21 √(1 - .86)
SEM = 2.3235

SED = $\sqrt{2(SEM)^2}$
SED = $\sqrt{2(2.3235)^2}$
SED = 3.2859

RC = (pre – post) / SED
RC = 24/3.2859
RC = 7.30 >1.96

Participant D

RCI Calculations for Receptive Vocabulary

Calculations for PPVT-4:

SEM = SD $\sqrt{(1 - r)}$
SEM = 14.4 $\sqrt{(1 - .91)}$
SEM = 4.32

SED = $\sqrt{2(SEM)^2}$
SED = $\sqrt{2(4.32)^2}$
SED = 6.1094

RC = (pre – post) / SED
RC = 13/6.1094
RC = 2.13 > 1.96

RC = 14/6.1094
RC = 2.29 > 1.96

Calculations for RDLS-3 Comprehension (C-C):

SEM = SD $\sqrt{(1 - r)}$
SEM = 4.43 $\sqrt{(1 - .75)}$
SEM = 2.215

SED = $\sqrt{2(SEM)^2}$
SED = $\sqrt{2(2.215)^2}$
SED = 3.1324

RC = (pre – post) / SED
RC = 10/3.1324
RC = 3.19 > 1.96

Participant D (continuation)

RCI Calculations for Expressive Vocabulary

Calculations for EVT-2:

SEM = SD $\sqrt{}(1 - r)$
SEM = 15.75 $\sqrt{}(1 - .95)$
SEM = 3.5218

SED = $\sqrt{}2(SEM)^2$
SED = $\sqrt{}2(3.52)^2$
SED = 4.9805

RC = (pre – post) / SED
RC = 10/4.9805
RC = 2.01 > 1.96

RC = 11/4.9805
RC = 2.21 > 1.96

Calculations for RDLS-3 Expressive (E-E):

SEM = SD $\sqrt{}(1 - r)$
SEM = 6.21 $\sqrt{}(1 - .86)$
SEM = 2.3235

SED = $\sqrt{}2(SEM)^2$
SED = $\sqrt{}2(2.3235)^2$
SED = 3.2859

RC = (pre – post) / SED
RC = 12/3.2859
RC = 3.65 >1.96

APPENDIX H

Data collection: Joint Attention

Table 28.*Participant A: Joint Attention Measures*

	Baseline				Intervention									Follow-up
Eye contact	3	2	2	2	12	15	11	16	17	11	15	25	29	26
Alternate	0	0	1	0	2	2	2	2	3	3	5	5	5	6
Point	0	1	1	0	3	6	5	19	17	19	18	19	32	21
Point/eye contact	0	0	0	0	2	2	2	3	3	4	5	6	7	7
Show	0	1	1	2	1	1	2	2	1	2	3	2	3	3
Follow point/touch	2	1	1	2	10	6	10	15	13	16	17	17	18	19
Line of regard	2	2	1	1	11	4	8	10	11	12	11	12	12	14
Trials	1	2	3	4	5	8	11	14	17	20	23	26	29	30

Table 29.*Participant B: Joint Attention Measures*

	Baseline				Intervention									Follow-up
Eye contact	0	0	1	1	1	10	8	12	10	12	18	11	15	15
Alternate	0	0	1	0	1	2	2	2	2	4	6	6	7	12
Point	0	0	0	0	0	4	5	10	33	25	29	26	30	22
Point/eye contact	0	0	0	0	0	2	3	4	4	4	6	6	7	9
Show	0	1	1	0	0	1	1	1	1	2	1	1	3	2
Follow point/touch	1	1	1	2	11	13	11	14	15	13	14	14	26	24
Line of regard	0	1	1	0	1	3	6	7	8	8	8	15	17	16
Trials	1	2	3	4	5	8	11	14	17	20	23	26	29	30

Table 30.*Participant C: Joint Attention Measures*

	Baseline				Intervention									Follow-up
Eye contact	3	4	3	5	10	18	9	9	11	13	30	25	23	26
Alternate	1	0	1	0	6	4	4	2	8	6	10	10	8	9
Point	0	2	0	2	9	20	12	14	21	19	19	23	26	20
Point/eye contact	0	0	0	1	1	1	1	2	3	3	4	5	7	9
Show	0	1	0	0	4	4	3	4	4	4	6	6	7	8
Follow point/touch	0	1	1	1	7	18	15	19	22	16	26	25	27	29
Line of regard	0	0	1	2	14	5	15	13	16	12	11	15	16	17
Trials	1	2	3	4	5	8	11	14	17	20	23	26	29	30

Table 31.*Participant D: Joint Attention Measures*

	Baseline				Intervention									Follow-up
Eye contact	3	4	4	3	10	9	6	9	12	13	13	15	18	19
Alternate	2	1	1	1	1	1	1	1	4	5	6	7	7	8
Point	1	0	1	0	15	12	16	19	30	25	26	28	28	28
Point/eye contact	0	0	1	0	1	3	3	3	5	5	6	7	7	6
Show	0	0	1	1	1	1	1	2	1	1	2	1	3	2
Follow point/touch	0	0	0	0	6	15	22	21	23	22	23	24	25	27
Line of regard	0	1	0	1	9	10	11	9	11	10	11	10	12	13
Trials	1	2	3	4	5	8	11	14	17	20	23	26	29	30

Data collection: Mean Length of Eye Contact

Table 33.*Participant A: Mean Length of Eye Contact*

	Baseline				Intervention									Follow-up
MLE	1	1	1	1	1.1	2.1	2.0	3.2	3.2	3.4	3.5	3.5	3.7	3.3
Trials	1	2	3	4	5	8	11	14	17	20	23	26	29	30

Table 34.*Participant B: Mean Length of Eye Contact*

	Baseline				Intervention									Follow-up
MLE	0	0	1	1	1.1	1.3	1.5	1.6	1.7	1.8	2.3	3.0	2.8	2.5
Trials	1	2	3	4	5	8	11	14	17	20	23	26	29	30

Table 35.*Participant C: Mean Length of Eye Contact*

	Baseline				Intervention									Follow-up
MLE	1	1	1	1	2.1	2.0	2.2	2.1	2.2	2.4	2.5	2.8	3.1	2.9
Trials	1	2	3	4	5	8	11	14	17	20	23	26	29	30

Table 36.*Participant D: Mean Length of Eye Contact*

	Baseline				Intervention									Follow-up
MLE	1	1	1	1	1.7	2.2	3.0	2.8	2.4	2.3	2.5	2.7	2.9	2.7
Trials	1	2	3	4	5	8	11	14	17	20	23	26	29	30

APPENDIX I

The Two Standard Deviation Band Method

Figure 31. *The 2 SD Band Method designed for target behaviour 'show' (Participant A)*

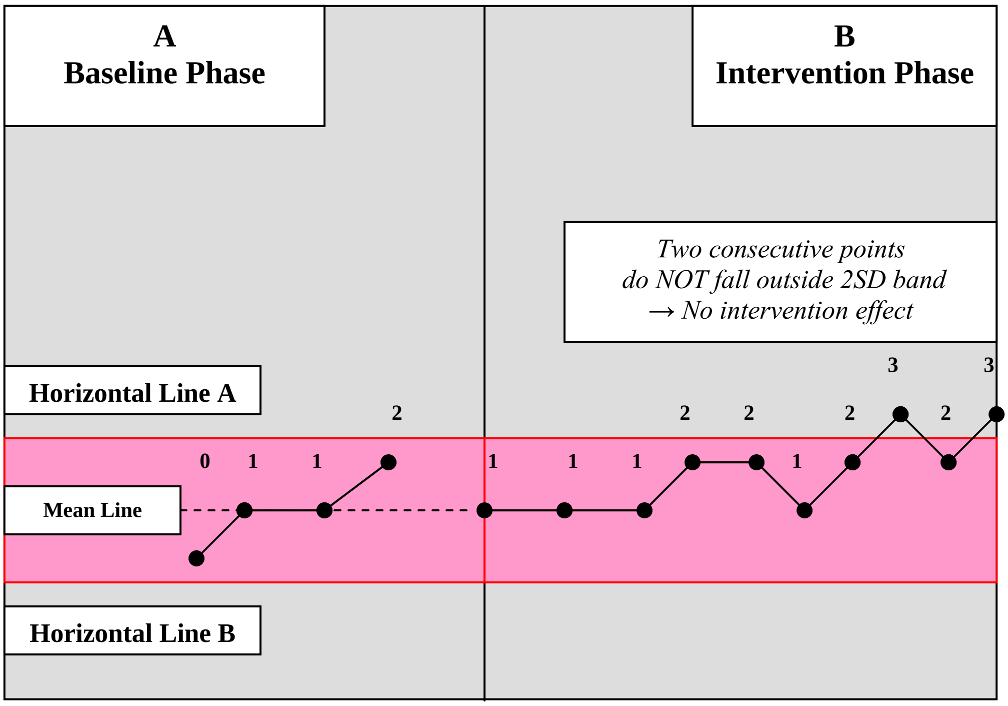
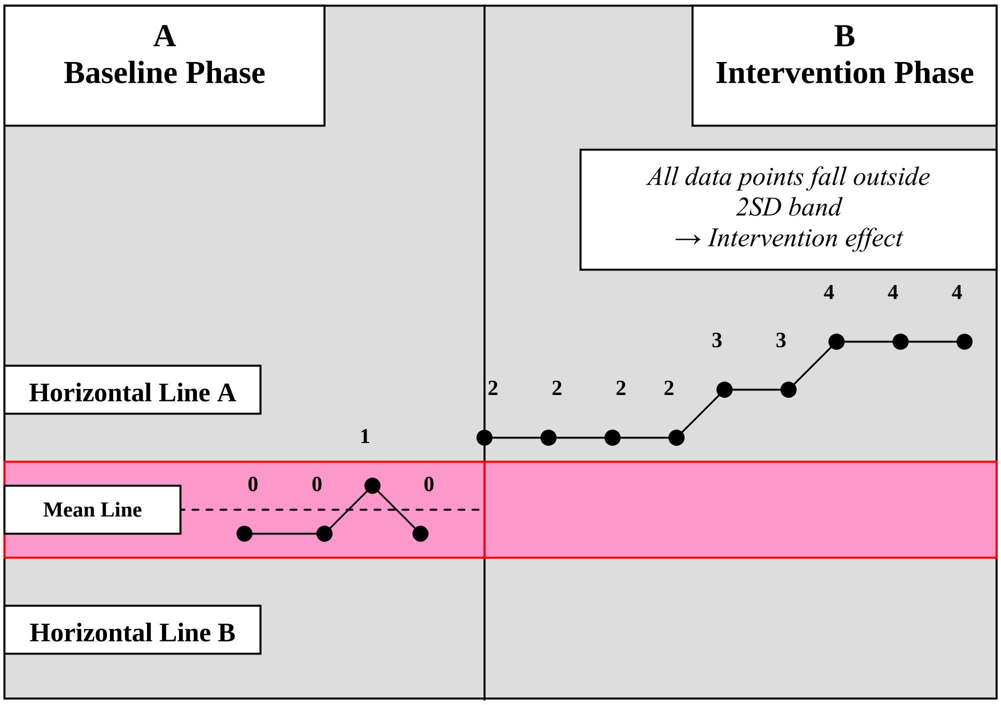


Figure 32. *The 2 SD Band Method designed for target behaviour 'alternate' (Participant A)*



APPENDIX J

Excerpts from statistical analyses

Statistical analyses for MLU in morphemes (participant A)

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
time	Sphericity Assumed	87.612	2	43.806	193.992	.000
	Greenhouse-Geisser	87.612	1.760	49.781	193.992	.000
	Huynh-Feldt	87.612	1.815	48.280	193.992	.000
	Lower-bound	87.612	1.000	87.612	193.992	.000
Error(time)	Sphericity Assumed	24.388	108	.226		
	Greenhouse-Geisser	24.388	95.038	.257		
	Huynh-Feldt	24.388	97.992	.249		
	Lower-bound	24.388	54.000	.452		

$F(2,108) = 193.992$, $p = .000$

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	MLUm1	2.9273	55	1.60848	.21689
	MLUm10	3.9091	55	1.39141	.18762
Pair 2	MLUm10	3.9091	55	1.39141	.19011
	MLUm20	4.7091	55	1.40992	.18762
Pair 3	MLUm1	2.9273	55	1.60848	.21689
	MLUm20	4.7091	55	1.40992	.19011

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	MLUm1 & MLUm10	55	.891	.000
Pair 2	MLUm10 & MLUm20	55	.864	.000
Pair 3	MLUm1 & MLUm20	55	.946	.000

Paired Samples Test

		Paired Differences					t	df	Sig.(2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	MLUm1-MLUm10	-.98182	.73260	.09878	-1.17987	-.78377	-9.939	54	.000
Pair 2	MLUm10-MLUm20	.80000	.73030	.09847	.60257	.99743	8.124	54	.000
Pair 3	MLUm1-MLUm20	-1.78182	.53371	.07197	-1.92610	-1.63754	-24.759	54	.000

$t(54) = -9.939$, $p = .000$
$t(54) = 8.124$, $p = .000$
$t(54) = -24.759$, $p = .000$

Statistical analyses for MLU in words (participant A)

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
time	Sphericity Assumed	73.745	2	36.873	244.993	.000
	Greenhouse-Geisser	73.745	1.822	40.478	244.993	.000
	Huynh-Feldt	73.745	1.882	39.183	244.993	.000
	Lower-bound	73.745	1.000	73.745	244.993	.000
Error(time)	Sphericity Assumed	16.255	108	.151		
	Greenhouse-Geisser	16.255	98.380	.165		
	Huynh-Feldt	16.255	101.631	.160		
	Lower-bound	16.255	54.000	.301		

$F(2,108) = 244.993$, $p = .000$

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	MLUw1	2.7273	55	1.89008	.25486
	MLUw10	3.4909	55	1.67634	.22604
Pair 2	MLUw10	3.4909	55	1.67634	.22604
	MLUw20	4.3636	55	1.37926	.18598
Pair 3	MLUw1	2.7273	55	1.89008	.25486
	MLUw20	4.3636	55	1.37926	.18598

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	MLUw1 & MLUw10	55	.972	.000
Pair 2	MLUw10 & MLUw20	55	.955	.000
Pair 3	MLUw1 & MLUw20	55	.976	.000

Paired Samples Test

		Paired Differences					t	df	Sig.(2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	MLUw1-MLUw10	-.76364	.46997	.06337	-.89069	-.63658	-12.050	54	.000
Pair 2	MLUw10-MLUw20	-.87273	.54618	.07365	-1.02038	-.72507	-11.850	54	.000
Pair 3	MLUw1-MLUw20	-1.63636	.61955	.08354	-1.80385	-1.46888	-19.588	54	.000

$t(54) = -12.050$, $p = .000$
$t(54) = -11.850$, $p = .000$
$t(54) = -19.588$, $p = .000$

Statistical analyses for MLU in morphemes (participant B)

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
time	Sphericity Assumed	20.958	2	10.479	63.906	.000
	Greenhouse-Geisser	20.958	1.850	11.327	63.906	.000
	Huynh-Feldt	20.958	1.913	10.956	63.906	.000
	Lower-bound	20.958	1.000	20.958	63.906	.000
Error(time)	Sphericity Assumed	17.709	108	.164		
	Greenhouse-Geisser	17.709	99.910	.177		
	Huynh-Feldt	17.709	103.300	.171		
	Lower-bound	17.709	54.000	.328		

$F(2,108) = 63.906$, $p = .000$

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	MLUm1	1.9818	55	1.07997	.14562
	MLUm10	2.4000	55	1.36897	.18459
Pair 2	MLUm10	2.4000	55	1.36897	.18459
	MLUm20	2.8545	55	1.49590	.20171
Pair 3	MLUm1	1.9818	55	1.07997	.14562
	MLUm20	2.8545	55	1.49590	.20171

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	MLUm1 & MLUm10	55	.944	.000
Pair 2	MLUm10 & MLUm20	55	.924	.000
Pair 3	MLUm1 & MLUm20	55	.927	.000

Paired Samples Test

		Paired Differences					t	df	Sig.(2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	MLUm1-MLUm10	-.41818	.49781	. 06712	-.55276	-.28361	-6.230	54	.000
Pair 2	MLUm10-MLUm20	-.45455	.57149	.07706	-.60904	-.30005	-5.899	54	.000
Pair 3	MLUm1-MLUm20	-.87273	.63987	.08628	-1.04571	-.69975	-10.115	54	.000

$t(54) = -6.230$, $p = .000$
$t(54) = -5.899$, $p = .000$
$t(54) = -10.115$, $p = .000$

Statistical analyses for MLU in words (participant B)

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
time	Sphericity Assumed	20.994	2	10.497	61.816	.000
	Greenhouse-Geisser	20.994	1.787	11.747	61.816	.000
	Huynh-Feldt	20.994	1.844	11.384	61.816	.000
	Lower-bound	20.994	1.000	20.994	61.816	.000
Error(time)	Sphericity Assumed	18.339	108	.170		
	Greenhouse-Geisser	18.339	96.504	.190		
	Huynh-Feldt	18.339	99.587	.184		
	Lower-bound	18.339	54.000	.340		

$F(2,108) = 61.816$, $p = .000$

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	MLUm1	1.8727	55	1.08959	.14692
	MLUm10	2.3455	55	1.44297	.19457
Pair 2	MLUm10	2.3455	55	1.44297	.19457
	MLUm20	2.7455	55	1.41707	.19108
Pair 3	MLUm1	1.8727	55	1.08959	.14692
	MLUm20	2.7455	55	1.41707	.19108

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	MLUm1 & MLUm10	55	.935	.000
Pair 2	MLUm10 & MLUm20	55	.940	.000
Pair 3	MLUm1 & MLUm20	55	.890	.000

Paired Samples Test

		Paired Differences					t	df	Sig.(2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	MLUm1-MLUm10	-.47273	.57267	.07722	-.62754	-.31791	-6.122	54	.000
Pair 2	MLUm10-MLUm20	-.40000	.49441	.06667	-.53366	-.26634	-6.000	54	.000
Pair 3	MLUm1-MLUm20	-.87273	.66818	.09010	-1.05336	-.69209	-9.686	54	.000

$t(54) = -6.122$, $p = .000$
$t(54) = -6.000$, $p = .000$
$t(54) = -9.686$, $p = .000$

Statistical analyses for MLU in morphemes (participant C)

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
time	Sphericity Assumed	50.339	2	25.170	51.949	.000
	Greenhouse-Geisser	50.339	1.471	34.219	51.949	.000
	Huynh-Feldt	50.339	1.502	33.510	51.949	.000
	Lower-bound	50.339	1.000	50.339	51.949	.000
Error(time)	Sphericity Assumed	52.327	108	.485		
	Greenhouse-Geisser	52.327	79.440	.659		
	Huynh-Feldt	52.327	81.121	.645		
	Lower-bound	52.327	54.000	.969		

$F(2,108) = 51.949$, $p = .000$

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	MLUm1	3.2364	55	1.71014	.23060
	MLUm10	4.1273	55	1.98190	.26724
Pair 2	MLUm10	4.1273	55	1.98190	.26724
	MLUm20	4.5636	55	2.74714	.37042
Pair 3	MLUm1	3.2364	55	1.71014	.23060
	MLUm20	4.5636	55	2.74714	.37042.

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	MLUm1 & MLUm10	55	.953	.000
Pair 2	MLUm10 & MLUm20	55	.946	.000
Pair 3	MLUm1 & MLUm20	55	.972	.000

Paired Samples Test

		Paired Differences					t	df	Sig.(2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	MLUm1-MLUm10	-.89091	.62872	.08478	-1.06088	-.72094	-10.509	54	.000
Pair 2	MLUm10-MLUm20	-.43636	1.08463	.14625	-.72958	-.14315	-2.984	54	.004
Pair 3	MLUm1-MLUm20	-1.32727	1.15557	.15582	-1.63967	-1.01488	-8.518	54	.000

$t(54) = -10.509$, $p = .000$
$t(54) = -2.984$, $p = .004$
$t(54) = -8.518$, $p = .000$

Statistical analyses for MLU in words (participant C)

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
time	Sphericity Assumed	56.776	2	28.388	59.083	.000
	Greenhouse-Geisser	56.776	1.402	40.510	59.083	.000
	Huynh-Feldt	56.776	1.427	39.774	59.083	.000
	Lower-bound	56.776	1.000	56.776	59.083	.000
Error(time)	Sphericity Assumed	51.891	108	.480		
	Greenhouse-Geisser	51.891	75.682	.686		
	Huynh-Feldt	51.891	77.084	.673		
	Lower-bound	51.891	54.000	.961		

$F(2,108) = 59.083$, $p = .000$

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	MLUm1	3.0545	55	1.47093	.19834
	MLUm10	3.9636	55	2.00890	.27088
Pair 2	MLUm10	3.9636	55	2.00890	.27088
	MLUm20	4.4727	55	2.58811	.34898
Pair 3	MLUm1	3.0545	55	1.47093	.19834
	MLUm20	4.4727	55	2.58811	.34898

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	MLUm1 & MLUm10	55	.953	.000
Pair 2	MLUm10 & MLUm20	55	.961	.000
Pair 3	MLUm1 & MLUm20	55	.956	.000

Paired Samples Test

		Paired Differences					t	df	Sig.(2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std Error Mean	Lower	Upper			
Pair 1	MLUm1-MLUm10	-.90909	.75210	.10141	-1.11241	-.70577	-8.964	54	.000
Pair 2	MLUm10-MLUm20	-.50909	.85792	.11568	-.74102	-.27716	-4.401	54	.000
Pair 3	MLUm1-MLUm20	-1.41818	1.25744	.16955	-1.75811	-1.07825	-8.364	54	.000

$t(54) = -8.964$, $p = .000$
$t(54) = -4.401$, $p = .000$
$t(54) = -8.364$, $p = .000$

Statistical analyses for MLU in morphemes (participant D)

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
time	Sphericity Assumed	53.685	2	26.842	300.460	.000
	Greenhouse-Geisser	53.685	1.325	40.516	300.460	.000
	Huynh-Feldt	53.685	1.346	39.898	300.460	.000
	Lower-bound	53.685	1.000	53.685	300.460	.000
Error(time)	Sphericity Assumed	9.648	108	.089		
	Greenhouse-Geisser	9.648	71.552	.135		
	Huynh-Feldt	9.648	72.660	.133		
	Lower-bound	9.648	54.000	.179		

$F(2,108) = 300.460$, $p = .000$

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	MLUm1	1.4364	55	.81112	.10937
	MLUm10	1.4909	55	.81360	.10971
Pair 2	MLUm10	1.4909	55	.81360	.10971
	MLUm20	2.6727	55	.72148	.09728
Pair 3	MLUm1	1.4364	55	.81112	.10937
	MLUm20	2.6727	55	.72148	.09728

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	MLUm1 & MLUm10	55	.960	.000
Pair 2	MLUm10 & MLUm20	55	.815	.000
Pair 3	MLUm1 & MLUm20	55	.787	.000

Paired Samples Test

		Paired Differences					t	df	Sig.(2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std Error Mean	Lower	Upper			
Pair 1	MLUm1 - MLUm10	-.05455	.22918	.03090	-.11650	.00741	-1.765	54	.083
Pair 2	MLUm10 –MLUm20	-1.18182	.47496	.06404	-1.31022	-1.05342	-18.453	54	.000
Pair 3	MLUm1 - MLUm20	-1.23636	.50785	.06848	-1.37365	-1.09907	-18.055	54	.000

$t(54) = -1.765$, $p = .083$
$t(54) = -18.453$, $p = .000$
$t(54) = -18.055$, $p = .000$

Statistical analyses for MLU in words (participant D)

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
time	Sphericity Assumed	57.709	2	28.855	284.396	.000
	Greenhouse-Geisser	57.709	1.000	57.709	284.396	.000
	Huynh-Feldt	57.709	1.000	57.709	284.396	.000
	Lower-bound	57.709	1.000	57.709	284.396	.000
Error(time)	Sphericity Assumed	10.958	108	.101		
	Greenhouse-Geisser	10.958	54.000	.203		
	Huynh-Feldt	10.958	54.000	.203		
	Lower-bound	10.958	54.000	.203		

$F(2,108) = 284.396$, $p = .000$

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	MLUm1	1.4000[a]	55	.70972	09570
	MLUm10	1.4000[a]	55	.70972	.09570
Pair 2	MLUm10	1.4000	55	.70972	.09570
	MLUm20	2.6545	55	.79857	.10768
Pair 3	MLUm1	1.4000	55	.70972	.09570
	MLUm20	2.6545	55	.79857	.10768

a. The correlation and t cannot be computed because the standard error of the difference is 0.

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	MLUm1 & MLUm10	55		
Pair 2	MLUm10 & MLUm20	55	.738	.000
Pair 3	MLUm1 & MLUm20	55	.738	.000

Paired Samples Test

		Paired Differences					t	df	Sig.(2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	MLUm1 - MLUm10								
Pair 2	MLUm10 - MLUm20	-1.25455	.55170	.07439	-1.40369	-1.10540	-16.864	54	.000
Pair 3	MLUm1 - MLUm20	-1.25455	55170	.07439	-1.40369	-1.10540	-16.864	54	.000

$t(54) = -16.864$, $p = .000$
$t(54) = -16.864$, $p = .000$