Language Acquisition in Children with Autism in the Arab World: Evidence from Processes of Phonology, Semantics, Syntax and Pragmatics

by

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I certify that the work presented in this thesis is my own

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ABSTRACT

Autism spectrum disorders have been identified in the Arab world for more than 25 years, and in common with Europe and North America, autism rates have shown dramatic increases in Middle Eastern countries. Whilst clinics in the Middle East offer diagnostic and therapeutic services for individuals with autism, they use diagnostic, adaptive and linguistic measures that have been standardized in the Western world, and the extent that these tests are appropriate for use with this group has yet to be investigated. The study reported in this thesis describes a detailed assessment of a group of children, diagnosed with autism in a specialist clinic in Beirut. These children were compared with chronological age and language matched typically developing Lebanese children, on levels of symptom severity, adaptive skills and language skills, using measures widely used in studies of autism in the West. The results from the standardized language tests were analysed using group comparisons, cluster analyses and correlations. The group comparisons revealed deficits, relative to age matched controls, on measures of phonological skill, lexical skill, syntactic skill and pragmatic skill in the autism group. However, the comparison between children with autism and language matched children revealed a different pattern of results and developmental delay in language skills in autism was discussed. Consistent with previous work carried out in the West, the results from the cluster analyses identified a subgroup of children with autism whose phonological and lexical skills were broadly age-appropriate. Preferential looking tasks, previously used to identify biases associated with language acquisition were administered and confirmed the existence of a noun bias and subject verb order bias in children with autism. It was concluded that whilst the Western and Arab worlds are culturally very

different, diagnostic, standardized and experimental tests used in the West are broadly effective when used to test English speaking children with autism in the Arab world.

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Chapter 1 : LITERATURE REVIEW

ABSTRACT

The studies described in this thesis are the first to investigate the use of diagnostic and language tests developed in the western world in an Arab autism clinic. This chapter will provide contextual information and will begin by giving a historical overview of the developments in diagnostic criteria, and clinical and language assessment methods that followed Kanner's first description of autism in 1943. Research findings that have informed our current understanding of language abilities in autism in the western world are discussed. Finally, prevalence and methods of autism assessment in the Arab world will be considered and the aims of the thesis will be described.

Introduction

More than 60 years ago, two very similar reports of children displaying severe social deficits and unusual behaviours and using the term 'autistic' were published. The first of these was Leo Kanner's seminal paper 'Autistic disturbances of affective contact' (1943) published in English, in Baltimore, USA, and describing 11 children with 'early infantile autism'. In October of the same year, Hans Asperger, in Vienna, Austria, submitted his thesis on ‘Autistic psychopathy in childhood’ and in the following year published, in German, his description of four children with ‘autistic psychopathy’.

Though these descriptions were similar in many ways, and both are broadly consistent with our current understanding of Autism Spectrum Disorder (ASD), there were important core differences across the two accounts. For example, Kanner described a profound absence of social engagement from, or shortly after, birth. He also noted that his cases exhibited a range of communication problems and unusual responses to the various objects around them. Three of the 11 children he described were mute, and the language of those who did speak was remarkable for echolalia, literalness and pronoun reversal. Asperger, on the other hand, suggested that the condition he described was seen only in males, and was observed in the face of relatively strong language and cognitive skills. He noted that idiosyncratic interests were common in this condition and that it also tended to run in families.

Early developments in the conceptualization and measurement of Autism

As with any newly identified disorder, the period following the early descriptions of Kanner (1946) and Asperger (1947), saw a burgeoning of scientific interest into the core features, prevalence and developmental course of the disorder/s they described. Understandably, the vast majority of early research studies focused on identifying the core diagnostic characteristics that define autism.

During the 1950’s researchers in the United States and Europe reported observations on children with similar characteristics to those described by Asperger and Kanner (Despert, 1951; Bosch, 1953; Bakwin, 1954). However, there was considerable confusion about the boundaries of the syndrome as well as its nature and causation (Rutter, 1974). This confusion rose from the name ‘autism’ which was confused with Bleuler’s term of active withdrawal into fantasy seen in schizophrenic patients (Bleuler, 1950).

The controversy surrounding the nature of autism and the dearth of careful research studies impeded progress for many years. However, in the late 1960s and early 1970s, there was a growing appreciation that autism was indeed a distinctive condition, and not simply the earliest manifestation of childhood schizophrenia. This period also saw a growing tendency to de-emphasize the role of theory and to establish a reliable description of the syndrome in research studies.

One of the earliest attempts to provide an operational approach to diagnosis was made by Rimland (1964) who developed a checklist for the diagnosis of autism. The checklist was to be completed by parents and comprised a set of questions about the development of the child during the first year of life. The total score from the checklist was used to provide an indication of the likelihood of autism. Although this early diagnostic tool met with some criticism since it relied solely on parental report, it provided a useful tool for clinicians. The development of diagnostic measures is yoked with research findings and changes in DSM, and the diagnostic tools used in the studies reported in this thesis will be discussed further in this chapter as well as in chapter 2.

In addition to defining the core social and communication deficits characterizing autism, researchers working in the 1950s and 1960s became increasingly interested in investigating language development in children with this diagnosis. Although Asperger had described relatively preserved language skills, the first systematic language studies were motivated by Kanner's (1946) description of echolalia, stereotyped utterances, inappropriate remarks, pronoun reversal and abnormal use of communicative gesture in the children he described. Consistent with Kanner's account, early research studies reported qualitatively abnormal speech, including a severe and extensive deficit in language comprehension, in control functions associated with language, and in processing symbolic or sequenced information (Rutter & Bartak 1965). Also consistent with Kanner's account, was the assumption that children with autism suffered from intellectual disability and that the social, linguistic and behavioural abnormalities arose as a secondary consequence of this (Rutter & Bartak, 1971). However, it was also assumed that the patterns of abnormalities described by Kanner and confirmed in research studies, was unique to autism, and that their use of language clearly distinguished them from children with other types of developmental disabilities (Bartak, Rutter & Cox, 1977).

Early research, building upon Kanner's (1946) description of autism, informed the first official categorical definition of autism. Rutter (1978), proposed four core features for the diagnosis of autism: (1) an onset prior to 30 months of age, (2) impaired social development of a distinctive type which did not reflect any mental retardation, (3) impaired communicative development not as a result of cognitive delay, and (4) the presence of unusual behaviors subsumed under the concept of 'insistence on sameness'. This clear and categorical definition represented a major milestone in our understanding of autism. Although 'childhood schizophrenia' had been included in DSM-II (1968), 'infantile autism' was included in a new category of childhood onset disorders, termed pervasive developmental disorders, for the first time in DSM-III (American Psychiatric

Association, 1980).‘Residual’ autism was also listed as a separate category of childhood onset pervasive developmental disorder (PDD) and was applied in cases where the individual’s disorder had once met the criteria for autism, but no longer did so. However, this implied that some individuals somehow ‘outgrew’ autism and this was not supported by research evidence (Cohen et al., 1987). Since DSM-III, there have been several changes in the descriptions of autism and related disorders, and these will be further discussed in the following sections.

Empirical studies of language and changes in diagnostic categorization and measurement in the1980’s

Following the early work carried out by Bartak and colleagues, psycholinguists investigated language in studies that compared verbal children with autism to children with general developmental delays or other syndromes such as Down syndrome (Bartolucci & Pierce, 1977; Tager-Flusberg, 1981). These studies often relied on natural language samples or used experimental tasks, and their results suggested that the language difficulties in autism did not result from deficits in phonology, lexical knowledge or syntax. On these measures children with autism performed at similar levels to control groups matched on language and general cognitive ability. However, these studies did not provide profiles of language deficits and abilities, and often included small samples of children with autism. The extent that the results could be generalized to the wider population of children with autism was therefore unclear.

One early study did use standardized measures of assessment to provide a more extensive assessment of language abilities in children with autism (Bartak, Rutter, & Cox, 1975). In this study, 49 children were selected on the basis of having a severe language disability. Of the 49 children, 19 were classified as 'autistic', whilst the remaining 23 children did not exhibit clear autistic features and were diagnosed with 'uncomplicated developmental language disorder' on the basis of their language comprehension and production difficulties. Although the two groups of children were matched on non-verbal IQ, numerous language differences, including echolalia and pronoun reversal distinguished the groups. Language abilities were measured using the Reynell Scales (Reynell, 1977), the Peabody Picture Vocabulary Test (PPVT) (Dunn & Dunn, 2007), and natural speech samples. Although the children with autism scored lower than the uncomplicated developmental language disorder group on the PPVT scores, and Reynell comprehension scale, the groups did not differ on measures of production, such as mean utterance length or grammatical complexity analysed using the natural speech samples. This pattern suggested that comprehension may be more seriously impaired in autism than production. However, since the autism sample was pre-selected for the presence of comprehension difficulties, it may not be possible to generalize the results to the entire population of children with autism. A follow-up study assessed the same children in middle childhood and found that children with autism made less progress in language acquisition than the children in the developmental language disordered group. However, it was also noted that the latter group showed increased signs of social deficits, and in some ways were more like the children with autism than they had been in the initial test phase (Cantwell, Baker & Rutter, 1989).

During the 1980's it was becoming evident that a clearer definition of autism was needed in order to enable more rigorous research and to aid in clinical diagnosis. In DSM-III-R (American Psychiatric Association, 1987) the term residual autism was removed and the new, developmentally oriented term 'autistic disorder' replaced 'infantile autism'. The new criteria were arranged developmentally and grouped into three broad categories relating to: (1) social development, (2) communication and play, and (3) restricted activities and interests. The strong developmental orientation was a major improvement in DSM-III-R and motivated new empirical research and the design of more reliable methods of diagnosis.

In 1980, Schopler, Reichler, DeVellis and Daly, developed the childhood autism rating scale (CARS) to reflect changes in categorization and the new developmental emphasis in DSM-III-R. The CARS uses a structured assessment of a child's behaviours and is administered and scored by a trained rater. It includes a number of scales (see chapter two for more detail) which are scored on a continuum ranging from normal to severely abnormal and it provides an estimate of autism severity. Other diagnostic tools developed within the same time frame as CARS include the Behavior Rating Instrument of Autistic and Atypical Children (BRIAAC) (Ruttenberg, Kalish, Wenar & Wolf, 1977), the Behaviour Observation Scale for Autism (BOS) (Freeman et al., 1980), and the Autism Behavior Checklist (ABC; Kurg et al., 1980).

One outcome of research studies carried out during this period was that disturbances in language and language development came to be viewed as central features in autism, with the degree of language impairment being a key prognostic factor. However many of the studies carried out during this period relied on the same theoretical and methodological framework that had been used to study language acquisition in typically developing children, and there was no consensus about the validity of such an approach when applied in autism research. It was becoming increasingly clear that researchers should consider carefully the appropriateness of comparison groups, and a major research aim should be to determine whether the language abnormality in autism was global or involved selective impairment of specific language components. Some studies carried out during this period did focus on specific aspects of language functioning, and indicated that whilst phonological and syntactic development follow the same course in children with autism and typical development, fundamental abnormalities in semantic and pragmatic development are characteristic in autism (Tager-Flusberg, 1981).

During the 1980s it became increasingly clear that pragmatics, or the appropriate use of language in the social and communicative context, was an area of language that was seriously impaired in autism (Tager-Flusberg, 1981; Frith, 1989). This motivated the search for a unifying theoretical account that could explain the specific pattern of language and communicative difficulties in autism. Researchers began to focus on social and cognitive impairments in children with autism, and carried out experimental studies of emotion perception, theory of mind, executive function and Weak Central Coherence (Frith, 1989; Panksepp, 1982; Ozonoff, Pennington &Rogers, 1991). In line with Kanner, Hobson (1989) argued that primary deficits in emotion perception, underpinned the abnormal behavior and language difficulties in autism. According to Hobson, children with autism do not experience early ‘inter-subjectivity’ with their carers and this greatly limits their opportunities for emotional, social and language development.

However, during this time period, developmental psychologists were becoming increasingly interested in the extent that typical children could infer the mental states of others (their intentions, beliefs and desires) (Premack & Woodruff, 1978). When a deficit in Theory of Mind, was revealed in autism (e.g. Baron-Cohen et al, 1988; Frith, 1989; Tager-Flusberg, 1989) it was postulated that this accounted for many symptoms of the disorder. One example of such reasoning was put forward by Tager-Flusberg (1981) who claimed that a theory of mind deficit would have a profound impact on communication ability, because the essential motivation to communicate lies in the desire to share intentions, thoughts and emotions with others (Tager-Flusberg, 1981). According to Tager-Flusberg, an inability to understand that people may know different things from oneself and that language is a key means for discovering the contents of another person's mind, has an impact on preverbal communication skills very early in a child's life. This is seen in the lack of gestures or vocalizations used to express their needs, or communicate objects of shared interest (protodeclarative gestures). These deficits however, extend across both non-verbal and verbal aspects of communication. At the non-verbal level there is difficulty in conveying emotional attitudes, and at the verbal level, there are problems with understanding and using literal language (Tager-Flusberg, 1996).

At the same time, other theories were beginning to emerge for the reason behind social deficits in children with autism. Executive function deficits were postulated to underlie many of the symptoms seen in autism. Such deficits are apparent in difficulties in planning, impulse control, inhibition of responses and flexibility of thought and actions. Researchers argued that such deficits are responsible for some of the primary symptoms seen in autism such as rigid and inflexible demeanor, narrow interest and stereotypical behaviour, inability to self-reflect or self-monitor (Ozonoff, Pennington& Rogers, 1991).

Weak Central Coherence (WCC) was another theory that emerged at that time. Its roots were embedded in visual context studies showing that children with autism do not interpret visual data in the same way as typical children (Happé, 1996). Initially these experimental studies were interpreted as providing evidence for a global processing deficit, and in her highly influential book, Frith (1989) proposed that individuals with autism fail to grasp the grand point, and instead focus their attention on irrelevant details. WCC influenced thinking about language acquisition in autism, and researchers began to address claims that atypical information processing, might reduce the autistic child's ability to make contextually meaningful connections between linguistic information. In experimental studies testing this hypothesis, Jolliffe & Baron-Cohen, (1999) showed that children with autism, compared with typical controls, were less likely to spontaneously use sentence context to guide the appropriate pronunciation of a homograph, to select the most coherent inference from competing alternatives to form a story, or to use context to interpret ambiguous sentences presented in auditory form (Jolliffee & Baron-Cohen, 1999).

Theoretical accounts have enabled researchers to make specific testable predictions about language deficits in autism, but to date none appear to provide a full account of the broad range of social/communicative difficulties characterizing this disorder.

Empirical studies of language and changes in diagnostic categorization in the1990's

During the 1990s it became apparent that the new scheme of a broadened diagnostic concept in the DSM-III-R, and variability in the ways that clinicians and researchers approached diagnostic and classification issues, made research findings very difficult to interpret (for a discussion, see Rutter & Schopler, 1992). In contrast to DSM-III-R the autism criteria in the ICD-10 system were more extensive and detailed and included the age of onset as an essential diagnostic feature. ICD-10 also provided separate clinical descriptions and research criteria for a range of pervasive developmental disorders (PDD), including Rett's syndrome, Asperger's syndrome, childhood disintegrative disorder, and atypical autism as well as the sub-threshold PDD-NOS category (Rutter & Schopler, 1992).

As a result of concerns about the DSM-III-R, a large multisite field trial was undertaken for DSM-IV and included ratings of nearly 1000 autism cases described by over 100 clinicians (Volkmar et al., 1994). Results yielded some limited evidence for the validity of the ICD-10 categorical definition of autism. When compared to individuals meeting criteria for high functioning autism, individuals meeting criteria for Asperger's syndrome (AS) were less likely to have experienced delays in the development of spoken language and to currently exhibit language/communication deviance. They were more likely to possess isolated special skills (or abnormal preoccupations), and motor delays were more variable in this group. The comparison also showed that social, communicative and stereotypical symptoms were less severe and individuals with AS were more likely to exhibit verbal IQ scores that were greater than performance IQ scores, while the opposite trend was observed in individuals with HFA. Such results led to a reduction in the number and details of the ICD-10 criteria (which were seen as over stringent), and informed a revised definition of autism in the DSM-IV (1994). According to these standards, a total of at least six criteria from impairments in social interaction, communication and restricted interests sections are to be met in order to meet criteria for autism, with at least two social impairment criteria present.

With the emergence of these new criteria, various diagnostic instruments, rating scales and diagnostic checklists were devised in order to better identify and categorize autism. These tests have been widely used in research and clinical settings for the purpose of diagnosis, assessment and behavioural characterization. The Autism Diagnostic Interview-Revised (ADI-R) (Lord, Rutter & Goode, 1994) was one of the tools that aimed to quantify the severity of autism to assist in both clinical and research settings. The ADI-R is a parent interview that provides insight into the severity of autism and its development. Another measure that was developed in concordance with the ADI-R is the Autism Diagnostic Observation Schedule (ADOS) (Lord, Rutter, DiLavore, Risi, 1995). The assessment includes four modules, which can be used to test high functioning adults as well as children with little or no language. It consists of a series of structured and semi-structured tasks that involve social interaction between the examiner and the child, adolescent or adult. The examiner observes and identifies segments of the individual's behavior and assigns these to predetermined observational categories. Categorized observations are subsequently combined to produce quantitative scores for analysis. Research-determined cut-offs identify the potential diagnosis of autism or related autism spectrum disorders, allowing a standardized assessment of autistic symptoms. In the following years, many more standardized assessment tools were developed and these enabled clinicians to carry out diagnosis and categorization as well as to study the core symptoms of autism. Such assessment tools either rely on parental/ care-taker interview or on direct behavioral observation by a trained clinician or researcher.

At that time, theorizing about how typically developing children acquire language began to take a new shape. There was increasing criticism of Chomsky's account, which had argued that children are born with innate abstract principles that guide the acquisition process (Chomsky, 1968, 1986). Guided by Skinner's critique of Chomsky's account, usage based linguistics emphasized the central processing principle that language structures emerge from language use. According to this new account, language is learned socially, mainly by imitative learning in which the learner acquires not only the forms of symbols of language, but also its use in acts of communication (Carpenter, Nagell, & Tomasello, 1998). In this view language acquisition is driven by a child's desire to use language to perform communicative functions and to understand the utterances of others (Lieven, 2011). Researchers such as Tomasello et al. (1998) emphasized that functional language refers to the attempt of one person to manipulate the mental state of another person. This implicated the construct of joint attention, that is, the ability to share attention with other persons to objects of mutual interest, the ability to follow the gesture of another person to objects outside the realm of immediate interaction, and the ability to imitatively learn intentional actions of others including their communicative acts. These abilities are present very early on in typical children and research has shown that children as young as 9-12 months can engage in episodes of joint attention, implicated in successful word learning (Tager-Flusberg, 2001).

Whilst this new way of theorizing about language acquisition looked promising for researchers interested in language development in autism, there was an increasing awareness of the huge variability in language deficits in this disorder. Within many or most individuals with autism, developmental changes in communicative deficits were apparent. While pronoun reversal, echolalia and stereotyped language were common at the early developmental stages, these unusual uses of language were not always evident in children who made marked advances in language development, and variability in the extent of the individual's communicative impairment seemed to be related to the severity of their autistic symptoms. In their paper entitled 'Language disorders in children with autism', Rapin & Dunn (1996) emphasized that children with autism varied greatly in their cognitive ability and that whilst global intelligence scores ranged between profound disability to superior intelligence, intelligence test profiles were almost always uneven. According to Rapin and Dunn, this variability contributed to heterogeneous language skill levels in children with autism. In their paper, they identified two types of language deficits in children with autism. The first, more severe type, involves a deficit in lower levels of language processing, for example, phonology and syntax, whereas the second type involves deficits in higher order language processing of complex syntax and semantics and the formulation of discourse, with pragmatics and comprehension being impaired in both. Rapin & Dunn proposed a further type of language disability, termed developmental language disorder (DLD), which is common in autism and results from their universal pragmatic deficits. This was the first attempt at sub-typing the language deficit seen in autism.

To test this new theory of language subtypes in autism, Jarrold, Boucher, and Russell (1997), examined the profile of language abilities in a group of 120 children diagnosed with autism. This was the first study of its kind to investigate language profiles in such a large sample of children. Jarrold et al. used a battery of standardized tests to measure different aspects of language, these tests included the British Picture Vocabulary test (BPVS) (Dunn, Dunn, & Whetton, 1982) and the Renfrew Word Finding Vocabulary Scale (RWFVS) (Renfew, 1980), to test vocabulary comprehension, the Action Picture Test Information test (APTI) (Renfew, 1981), to test vocabulary production, and the Test for Reception of Grammar (TROG) (Bishop, 1990) and Action Picture Test of Grammar (APTG) (Renfew, 1980) to test grammar comprehension and production respectively. The main finding from the study was that children's performance was fairly equivalent across the language measures, indicating a relatively uniform profile of language attainment. In addition, there was no evidence of different language profiles in any diagnostic subgroup of children. Unlike previous literature, this study found that receptive abilities were similar to expressive abilities, and that vocabulary did not differ from grammatical knowledge. However, a major limitation in this study was that the diagnosis of most of the participants was not well documented, and the study inclusion criterion was not clearly defined. A further methodological shortcoming was that the standardized language data were collected under different test conditions and did not include the same tests across all participants. Finally, in the main data analysis raw scores were converted to mental age equivalent scores and a more appropriate approach would have been to carry out a profile analysis of the standard scores (Kjelgaard & Tager-Flusberg, 2001).

Kjelgaard & Tager-Flusberg's (2001) pioneering study, attempted to address the methodological limitations in the Jarrold et al., study. They used a broader range of language measures, to investigate phonology, lexical knowledge, semantics and grammar. Kjelgaard & Tager-Flusberg were specifically interested in examining findings from earlier research (Bartak et al., 1977), which suggested that there was some similarity between autism and developmental language disorder, which was now termed specific language impairment (SLI). Although SLI is heterogeneous, it is described in children whose non-verbal IQ scores are within the normal range, but whose performance on language tests (on measures of vocabulary and/or grammatical ability) fall more than one standard deviation below the mean.

The test battery used in Kjelgaard & Tager-Flusberg's study included standardized measures that have been used to diagnose SLI, such as the Clinical Evaluation of Language Fundamentals (CELF) (Semel, Wiig, & Secord, 2000) and the non-word repetition test (Gathercole & Baddeley, 2000). This enabled Kjelgaard & Tager-Flusberg to determine whether children with autism, who have impaired language skills, show a similar language profile to children with SLI. A further aim of their study was to characterize the heterogeneity of language abilities seen in children with autism, by profiling the language abilities across measures of phonology, vocabulary and higher order language skills (semantics and syntax). 89 4 – 14 year old children with a diagnosis of autism completed the standardized tests mentioned. The results firstly revealed great variability in the extent that the children could complete the entire battery of tests. This did not appear to be directly associated with age, but by the extent of the task demands. Such heterogeneity was also reflected in the test results, which showed some children performing at age appropriate levels and others performing at significantly lower levels. Children were then divided into subgroups defined on the basis of their performance on either the PPVT or the CELF. This resulted in groups with (1) normal language, (2) borderline language deficit and (3) language impairment.

Another interesting finding, which emerged from the study, was that the profile of performance of some children with autism was similar to that observed in SLI. Earlier work had shown that children with SLI showed poorer performance on tests of grammatical ability than on tests of vocabulary (Rice, 1999) and Bishop et al., (1996) had identified difficulties on test of non-word repetition even in those with normal articulation skills. In the Kjelgaard & Tager-Flusberg study, a group of children with autism performed at lower levels on tests of grammatical ability than on tests of vocabulary and were also impaired on tests of non-word repetition. Articulation was spared within all the different sub-groups of children with autism. This finding suggested that some children with autism may have a parallel or overlapping SLI disorder, as indicated by their pattern of impaired performance on diagnostic language measures. Such a finding opened the door for extensive research on the issue of an overlap between SLI and autism.

This study was essential in showing patterns of language subtypes in autism. Similarly it was important in showing the similarity between the language deficit seen in some children with autism and in other identified developmental language disorders (Rapin, 1996). However not all studies have reported this same overlap with SLI, For example, Whitehouse and Bishop (2008) observed some similarities in the language profiles of children with autism and SLI but also reported a different pattern of errors on standardized assessments (especially non-word repetition tasks which will be discussed in more depth in chapter 4). These findings provided evidence against the idea of an SLI subtype in autism. Further analyses suggested that deficits in language processing experienced by some children with autism may arise when there is substantial impairment in multiple autistic domains, since deficits in structural language were most common in children with the highest autism symptomatology.

Empirical studies of language and changes in diagnostic categorization in the 21st century

At the turn of the 21st century autism was a clearly identified neurodevelopmental disorder and was gaining more and more attention in research. This was mainly due to the increase in prevalence rates in most parts of the developed world: in the USA prevalence rates jumped from 1 in every 2500 children born in 1985 to 1 in 250 children born in 2000. The percentage increase was 120% in cases of autism compared to 15% increase in cases of epilepsy and 17% increase in cases of mental retardation (California Dept. of Developmental Services, 2003). Along with changes in our understanding of the prevalence of autism came changes in our understanding of intellectual disabilities in this disorder, away from the view that all children with autism suffered from some sort of intellectual deficit (Rutter & Bartak, 1971). A study carried out by Fombonne, (2005) showed that approximately 20–30% of those with autism have intelligence within the normal range with a full scale IQ score of 70 or above. However, more recent work carried out in the UK suggests that the prevalence of low IQ in autism is lower than that reported in Fombonne's study. Charman, Pickles, Simonoff, Chandler, Loucas and Baird, (2010), conducted comprehensive clinical assessments with 75 children with autism of which 55% had intellectual disability (IQ < 70) but only 16% had moderate to severe intellectual disability (IQ < 50). The results showed that 28% of the sample had average intelligence (IQ 85-115) whilst 3% were of above average intelligence (IQ > 115). Individuals with normal or higher IQ scores are commonly described as high-functioning autism, and may acquire large vocabularies (Jarrold et al., 1997; Lord and Paul, 1997; Saldana et al., 2009), and consistently perform at age appropriate levels on standardized tests of vocabulary (Fein et al.,1996; Jarrold et al., 1997; Tager-Flusberg, 2001), single (written) word recognition and story recall tests (Norbury & Bishop, 2002).

By the turn of the century it had become clear to researchers working on autism, that language and communication abilities varied markedly (Bishop & Rosenbloom, 1987; Bishop, 2000; Kjelgaard & Tager-Flusberg, 2001; Lewis et al., 2007; Rapin & Allen, 1983, 1987; Rapin & Dunn, 2003; Rapin et al., 2009; Rutter, 1974, 1978; Tager-Flusberg & Joseph, 2003; Tomblin, 2011; Whitehouse et al., 2008), and researchers began to focus attention on questions about the relationship between language and communication development and severity of autism symptoms. Charman et al. (2005) and Luyster, Qiu, Lopez, and Lord (2007) observed a significant negative relationship between early receptive and expressive language scores and later autism symptom severity in the early school years. In addition to studying language in the context of symptom severity, researchers have also investigated language and communication outcome in relation to type of clinical diagnostic category. In general, such research has shown that semantic impairments are most severe in children with low-functioning autism, i.e., children with a diagnosis of autistic syndrome/autistic disorder and low cognitive function, and least severe in children diagnosed with Asperger Syndrome (Boucher, 2003). However, as previously mentioned it was found that some individuals with autism possess cognitive skills that are within the normal range (high-functioning autism) and they may also have relatively good verbal skills (e.g., Bennett et al., 2008; Gillberg, 1998). In contrast, some children diagnosed with PDD-NOS (pervasive developmental disorder – not otherwise specified) may have no expressive language at all (e.g., Thurm et al., 2007). Research investigating language and communication in relation to PDD categorization has yielded mixed results, especially when non-verbal mental age has been controlled. For example, Luyster, Lopez et al. (2007) found that receptive and expressive language skills as well as use of later developing gestures (as measured by the McArthur Communication Development Inventories, CDI) were lower in a group of children with autism compared to a group of children diagnosed with PDD-NOS, even after controlling for non-verbal mental age. However, when Charman et al. (2003) used the CDI to make a similar comparison, he found that the autism and PDD-NOS groups only differed on early developing gestures. This underscores what is emphasized in a recent paper by Wing, Gould, and Gillberg (2011), namely that it often is extremely difficult to define boundaries of different subgroups among children with ASD.

Such research showing increased variability in the spectrum, as well as difficulty in identifying different disorders that fall under it, prompted changes in the DSM-V (American Psychiatric Association, 2013). In the DSM-IV, children diagnosed with

Autism Spectrum Disorder Disorder (ASD), Asperger's Syndrome (AS), and Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS) shared overlapping diagnostic criteria. As a result, there has been an enduring debate regarding the appropriateness of the current categorical classification system used to diagnose this group of disorders, commonly referred to as Autism Spectrum Disorders (ASD). Ongoing research examining the boundaries of the disorders comprising the spectrum yielded inconsistent findings in symptom differences and this led the American Psychiatric Association to propose important revisions for version five of the Diagnostic and Statistical Manual of Mental Disorders. An important change was the inclusion of a one dimensional category that encompassed the subcategories that had been included in DSM-IV. In DSM-IV impaired social interaction, impaired social communication and restricted behaviour pattern had formed the triad of impairments characterizing autism and in DSM 5 impaired social interaction and communication, became one conjoined category of impairment with restricted behaviors forming a second. It is hoped that this current formulation will enable clinicians to carry out more precise diagnoses and will increase consistency in both research and clinical applications.

Autism in the Arab world

Although autism occurs in all cultures and countries, most published studies of this disorder have been conducted in Western countries. This means that relatively little is known about the clinical presentation of autism in Middle Eastern and Arab countries. Whilst some studies have been carried out in the Arab Countries, they are very basic in nature, for example investigating epidemiology of occurrence and trends in prevalence rates (Al-Salehi & Ghaziuddin, 2009). It would therefore be appropriate to say that the current extent and quality of autism research in the Arab world is roughly equivalent to that carried out in the Western world forty or fifty years ago. This failure to advance autism research may reflect that fact that the developing world, including the Arab world, has long struggled with issues such as increased child mortality rates, child malnutrition rates and the spread of epidemics. However, in recent decades there has been a fivefold decrease in child mortality rates in the Arab world and North Africa and this success has brought a new determination to improve the quality of life of children and to foster their development during the early years of life. This includes recognition of autism, a condition long hidden in much of the Arab world (UNICEF, 2011).

In a UK based study, Baird et al., (2006) reported a prevalence rate of 39 per 10,000 for autism and 77 per 10,000 for all forms of autism spectrum disorders (ASD). In contrast, recent reports suggest that the prevalence of autism in the Arab world ranges from 1.4 cases per 10,000 children in Oman to 49 per 10,000 children in the United Arab Emirates (Al-Farsi, Al-Sharbati, 2011; Eapen et al, 2006). While these studies appear to show that autism prevalence rates are considerably lower in some Arab countries than in the developed world, it does not necessarily mean that the condition is less prevalent in those countries. Many factors might contribute to a lower reported incidence of autism in Arab countries. For example, it is often difficult for a child with autism to access diagnostic services and pediatricians may be less experienced in the diagnosis and management of psychiatric disorders compared to their Western counterparts. In general, there are fewer psychiatrists specializing in childhood development problems in the Arab world.

A lack of awareness of ASD among parents in the Arab world may also result in a failure to recognize symptoms and seek diagnosis and treatment. This is especially likely in cases of children with mild forms of autism. So both under-diagnosis and under–reporting may contribute to the disparity in the reported prevalence of autism between Arab countries and the West. Other explanations, whilst largely outside the scope of this study, might also be briefly considered. For example, Middle Eastern cultures have a distinct character, with living and nutritional habits that could serve a potentially protective role. The conditions in the country where the study reported in this thesis was carried out (Beirut, Lebanon) are similar to those of much of the Arab world. Here cultural norms and fear of social rejection might play a crucial role in the under-reporting of autism symptoms, whilst urban living and a well-balanced nutritional Mediterranean diet might serve a protective role against the development of autism symptoms (Hussein, 2011). However, any such claims remain speculative, as no research has investigated the effects of Arab culture on autism.

Although the precise causes of autism are yet to be determined, the condition has genetic underpinnings (Bailey, Philips, Rutter, 1996) and this may have particular relevance when considering prevalence rates in the Arab world. In a Saudi Arabian study, Al-Salehi and colleagues (2009) found that almost one third of a cohort of children with autism had a history of consanguinity; that is a child had parents who were close relatives, such as first and second cousins. Consanguineous marriages, for example between first cousins, can be quite prevalent in Arab countries. For example 34% to 80% of all marriages in Saudi Arabia, are between first cousins. This rate depends upon location as the rate is higher in rural communities than in urban and suburban settings.

While the Saudi findings do not directly link consanguinity and autism in Arab countries, they may suggest that families in Saudi Arabia have a higher incidence of autism, making them ideal candidates for genetic screening studies.

Screening and assessment services for children and adults with autism in the Arab World were first initiated in 1987 in the Hashemite Kingdom of Jordan (Al-Smadi, 1987). The Jordanian equivalent version of the Autism Behavior Checklist (ABC; Krug, Arick, & Almond, 1980a, 1980b) was adapted from its American (English) origin to be the first and the only useful and valuable assessment tool to help professionals in the Arab World assess children and adults with autism (Al-Smadi, 1987). Since then, more and more services are being offered to affected children and their families, and centres are beginning to use western diagnostic tools as well as western speech and language standardized assessments. It is now estimated that Egypt has around 400 centers offering private services including speech therapy, occupational therapy, and diagnostic evaluations (The Egyptian Autistic Society, 2014), in the United Arab Emirates it is estimated that there are over 65 centers offering similar services (Autism UAE, 2013). Whilst these changes are greatly welcomed there, assessment tools that are being used in these centres have not been evaluated and their usefulness in service provision has yet to be demonstrated.

Caring for an individual with autism in the Arab world is mostly offered only in private institutions and places a considerable burden on family finances. A recent study into the economic effect of autism in Egypt found that 83.3– 91.3% of people with autism live at home with their families. The scarcity, distance and high costs of private residential placements, such as group homes, means that these families are left with little option but to keep their children with autism at home for an indefinite period, often well into their adult years (Mendoza, 2010)

While children with autism in the Western World are generally enrolled in mainstream or special needs educational institutions, autism care in Egypt and the rest of the Arab World is usually home-based, with a few exceptions of children who are accepted into expensive private schools and are asked to pay double fees on the grounds that they need “extra care”. Although as many as 54.7-62.7% of surveyed individuals with autism in Egypt were of school age (4–22 years old), less than a quarter of these were actually enrolled in schools. Most parents and household members cited developmental and learning obstacles and peer ostracism as the main reasons that their children with autism remained at home (Al-Salehi, 2009). Many families cannot afford the substantial expenses of the scarce special needs schools located in cities. Some non-profit organizations, such as Arab autism societies, try to help abate such problems and offer specialized education and information for parents, but there is only so much they can do, given the extent of the problem and their limited financial resources.

With regard to the assessment tools used in clinics and schools in the Arab world, little has changed since they were first introduced in 1987. Al-Bostanjy (2007) conducted a study to evaluate the current assessment and evaluation practices in two countries in the Arab World (Jordan and Egypt) and reported that the current use of diagnostic measures is unacceptable and insufficiently takes account of recent improvements in special education services in the region. In addition, he noted that many of the current assessment practices in these countries utilize alternative assessment (observations, interviews, and teachers’ records) practices as a formal assessment tools instead of standardized assessment measures. Additionally, he found that most of the current Jordanian standardized assessment tools (regardless of purpose and type of disability) that have been adapted to the Jordanian culture need to be appropriately normed. As previously suggested, research studies using standardized assessment tools in the Arab World have been particularly rare. Although most centres use western based and western-normed standardized tests in evaluating and diagnosing autism, very little is known about how well the children tested perform on such measures in relation to their peers in the western world. Until such work is done, questions about the validity and/or reliability of these tests, when used in the Arab setting, remain unanswered.

Current thesis

As highlighted above, there is a huge need for scientific research into autism in the Arab World. Questions about the use of standardized assessments used in clinics in the Arab world, experimental paradigms used in Western research studies, language heterogeneity and the relationship between language deficits and symptom severity have yet to be addressed. The studies described in this thesis are the first to address these questions in the Arab context. The study was carried out in Beirut, Lebanon, and addressed four main research aims, that are detailed below.

1. Explore language skills in clinically referred children with autism and compare them to typically developing comparison children living in Beirut, Lebanon using diagnostic and language assessment methods used in autism research in the Western world.

2. Explore heterogeneity and potential language subgroups in the autism group in the context of similar work carried out in the Western world.

3. Explore the relationship between measures of symptom severity and language skills in the autism group in the context of similar work carried out in the Western world.

4. Evaluate the use of experimental methods, used in the Western world, to measuring the mechanisms implicated in language acquisition in the children with autism and typically developing comparison children.

The next chapter will describe the methods used in the study described in the thesis. Details about the child participants and the measures and procedures used in the study will be provided.

Chapter 2 : METHODS

ABSTRACT

The aim of this chapter is to provide a detailed summary of the standardized tests, methods, and procedures used in the study reported in this thesis. Information about the background, recruitment and assessment of the participants is also described. The chapter is divided into the following main sections: standardized test battery and materials, participants and statistical analysis.

STANDARDISED TEST BATTERY AND MATERIALS

DIAGNOSTIC MEASURES

Two rating scales developed to identify autism, and used in the clinic from which the participants were recruited, were included in the test battery and are described below. These are the GARS and the CARS, tests which are more readily available and commonly used in the Arab World, than the ADI/ADOS, which are more commonly used in studies conducted in the Western World. These two scales rely on parental report as well as clinical observation, providing multiple reports to inform diagnosis.

Gilliam Autism Rating Scale – 2 (GARS-2)

The GARS-2 (Gilliam, 2000) is used to identify, diagnose, and estimate the severity of autism. The GARS-2 is considered to be an informant instrument, in that it uses caregiver responses as a means of providing the clinician with information about the child. The GARS-2 is comprised of three core subsets; Stereotyped Behaviours, Communication, and Social Interaction. An optional subset, called Developmental Disturbances, is also included. These three core subsets (and one optional subset) map onto diagnostic criteria used to identify autism in the DSM IV-R, which was in use when the study was designed. The structure of the GARS-2 creates quantitative measures of impairment in each of the three areas critical for diagnosis. In order to allow for categorical diagnosis, cut-offs for clinically significant impairment across the four criteria are provided. Children who achieve the cut-offs for all four areas are then considered eligible for an autism diagnosis.

Caregivers are asked to rate the child's overall behaviour in relation to the items in the subset, and are given the option of rating the behaviour as: Never observed, Seldom Observed, Sometimes Observed or Frequently Observed.

Each of these items corresponds to a raw score of 0, 1, 2, 3 or 4, respectively. The raw scores are then summed to give a total raw score for this domain. This is repeated for each of the three domains (Stereotyped Behaviours, Communication and Social Interaction). Raw scores from each subdomain are then converted to a standard score, which are then summed and provide the sum of standard scores. Finally, the sum of standard scores is converted to an Autism Index (AI) which provides a categorical diagnosis. The (AI) is used by the clinician to aid in the diagnosis of the child. The AI corresponds to the severity of the symptoms presented, the higher the score, the greater the severity of autism symptomatology (AI: ≥85 autism very likely; 70-84 autism possible; ≤69 autism unlikely).

An important strength of the GARS-2 is that it was normed on a large group. Data included in the manual was drawn from a study of 720 teachers and 372 parents from 46 US states and Canada who reported on a total of 1,092 3 – 22 year old individuals with autism. Gilliam (1995) reported excellent psychometric properties for the GARS-2. Coefficient alphas for the four subscales ranged from .88 to .93, with an average value of .90. Item-total point biserial correlation coefficients for all items were above .35 and median correlations for all four subscales ranged from .61 to .69. Test–retest reliability coefficients for the three behavioural subscales were above .81 and was .88 for the total score. Inter-rater reliability was calculated on data from a sample of 57 children, and coefficients ranged from .73 to .82 for the behavioural subscales and was

.88 for the Autism Index AI (Gilliam, 1995). Eleven of the 57 pairs of raters used in the inter-rater reliability study were parent–teacher pairs and their level of agreement was reported to range between .85 and .99 for the behavioural subscales and was reported to be .99 for the AI.

Childhood Autism Rating Scale (CARS)

The CARS (Schopler, Reichler, & Renner,1988) was developed by the Treatment and Education of Autistic and Related Communication Handicapped Children (TEACCH) program staff in North Carolina and aimed to provide a framework for formalizing observations of the child's behaviour throughout the day. In the standardization sample of 1,606 children with autism, 71% had IQ scores that were below 70 and 17% had IQs scores that ranged between 70 and 84. Percentage agreement between the CARS and clinical diagnoses using ADOS was 87% in the normative sample. Independent psychometric support for the CARS is excellent (Perry, Condillac, Freeman, Dunn-Geier, & Belair, 2005).

The CARS is a 15-item behaviour-rating scale, completed by a clinician, which helps to identify children with autism and to distinguish them from developmentally disabled children who are not autistic. The CARS is suitable for use with any child older than two years of age. Developed over a 15-year period, with more than 1,500 cases, CARS includes items covering different characteristics, abilities, or behaviors (see fig 2-2). After observing the child and examining relevant information from parent reports and other records, the examiner rates the child on each item. The ratings determine the degree to which the child's behaviour deviates from that of a normal child of the same age. A seven-point scale, with 1 being typical and 4 being severely abnormal is used. In order to allow the rater a wider range of reporting options half scales (e.g.: 1.5, 2.5) may also be selected. A total score is computed by summing the individual ratings on each of the 15 items (See figure 2-1).

Relating to People	2
Imitation	3
Emotional Response	2
Body Use	2.5
Object Use	3
Adaptation to Change	1.5
Visual Response	2
Listening Response	2.5
Taste, Smell, and Touch Response and Use	1.5
Fear or Nervousness	1
Verbal Communication	4
Nonverbal Communication	2
Activity Level	1.5
Level and Consistency of Intellectual Response	4
General Impression	3
Total Score	35.5

Figure 2-1 Subsets on the CARS

Children who score above a given point (30) are categorized as autistic. In addition, scores falling within the autistic range can be divided into two categories: mild-to-moderate (total score 30-45) and severe (total score 45-60). (Schopler, 1988).

ADAPTIVE FUNCTIOING MEASURE

Whilst diagnostic status had been established using CARS and GARS, further information about severity on specific DSM criteria was deemed necessary. Therefore an adaptive functioning test was used to assess each participant's overall skill level and overall development. Specifically this probed the following: (a) Delays or abnormal functioning in at least one of the following areas, with onset prior to age 3 years: (1) social interaction, (2) language as used in social communication, or (3) symbolic or imaginative play (In Diagnostic and Statistical Manual of Mental Disorders (Fourth Edition-Text Revision (DSM-IV-TR); and (b) linguistic skills. Measures included in the developmental scales of the adaptive functioning test were used for comparison participant matching. The following section details the assessment measure used in the study.

The Vineland Adaptive Behavior Scales

With adequate psychometric properties, reliability coefficients ranging from .83 to .99 (Sparrow, 2005), the Vineland Adaptive Behavior Scales-2nd Edition (Vineland-II) is an individually administered measure of adaptive behavior from birth through to 90 years. VABS-II provides a measure of the individual's overall level of adaptive functioning as well as his/her adaptive functioning in specific areas, namely: Communication, Daily living skills, Socialization and Motor skills. The Parent/Caregiver interview form of the Vineland II was used in the current study. The form is considered to be an informant instrument and is administered by the clinician in an interview with the parent/caregiver of the child.

The distinct adaptive domains and sub-domains measured by the Vineland-II are consistent with current research on adaptive behaviour and correspond to the specifications identified by the American Association on Mental Retardation (AAMR, 2002) and the DSM-IV-TR, (APA, 2000). With increased item density at the early ages, the Vineland-II provides a more complete picture of the section of the population that is undergoing the most rapid and dramatic developmental changes. The Vineland-II has undergone extensive bias reviews and statistical analyses to ensure that individuals of either sex and from a variety of ethnic and socioeconomic backgrounds can be assessed with confidence.

Parents/caregivers are asked to rate the skill on the frequency of the behaviour observed on a four item rating scale: Usually (2), Sometimes or Partially (1), Never (0) or Don't Know (DK). Raw scores are then calculated from each subdomain respectively. Since each subdomain starts at the age zero, a basal score of three consecutive (2) responses is taken and a ceiling score of three consecutive (0) responses is taken, the scores are added up and the sum is calculated following the basal items up until the ceiling items.

The raw score of each subdomain is summed and then converted into a v-scale score as well as age equivalence. Scores from each subdomain are reported. Age Equivalent scores and Standard Scores (M = 100; SD = 15) are provided for each domain.

For the purpose of this clinical study, and consistent with other studies (e.g. Luyster, Kadlec, Carter & Tager-Flusberg, 2008), equivalence scores were used to match the children with autism to typical children on the basis of parent-reported language. The Vineland has been used in such studies as a measure of language since its language subdomains correlate highly with language tests that measure receptive and expressive language. Examples include the Mullen Scales of Early Learning (Mullen, 1995), and MacArthur-Bates Communicative Development Inventories (MCDI; Fenson et al., 1993).

Table 2-1 shows correlations between the receptive and expressive raw scores for the VABS and these two measures. Chapter three will further consider the rationale for choosing the Vineland as a language matching assessment.

Table 2-1 Spearman's Rho correlations for raw score measures of receptive and expressive language on the VABS in comparison to both the Mullen and the MCDI

	Vineland
Receptive	
Mullen	.53*
MCDI	.77*
Expressive	
Mullen	.85*
MCDI	.88*

Mullen = Mullen Scales of Early Learning; Vineland= Vineland Adaptive Behaviour Scales; MCDI = MacArthur Bates Communicative Development Inventory
* P <.001

Use of the Vineland as a language matching measure

The first aim of this study was to explore language skills in clinically referred children with autism and compare them to typically developing comparison children living in Beirut, and the third aim of the study was to explore heterogeneity and potential language subgroups in the autism group. As a more detailed investigation of these aims could be made on the basis of a comparison with chronological and language matched typical children, data from two control groups were included in the analysis.

This approach is widely supported in the literature. For example, Charman (2004) emphasized the importance of including language matched groups in studies assessing linguistic abilities in autism. According to Charman, the child's level of language impairment, and the extent that s/he can use his/her available language communicatively are both important questions. Language competence is therefore a critical matching variable to consider in group-matched research designs. Challenges to this initiative however are noted, and include the poor language competence of many preschoolers with ASDs, the uneven profile of language competency in children with ASD, and the difference between performance on measures of formal language competency in the testing situation and everyday language use. In his paper Charman (2004) suggested including information from several sources or combined subsets such as those included in the Vineland Adaptive Behavior Scales to meet these challenges. He specifically mentions the VABS as a suitable linguistic measure used for matching and advises the use of a "language composite" variable that can be entered into any statistical analysis. If language was a significant predictor of performance, for instance on an experimental task, then a post hoc investigation to assess which of the three subsets contributed most variance to this could be carried out (with appropriate caution).

LANGUAGE MEASURES

The Comprehensive Test of Phonological Processing (CTOPP) (Wagner, Torgesen, & Rashotte, 1999) is a test developed to assess phonological processing abilities in individuals aged between 4 and 24 years. The authors developed two versions of the measure, one for kindergarteners and first graders (ages 4 – 6; version B) and the second for second graders through college students (ages 7-24; version A). The CTOPP comprises the 12 subsets outlined below (6 core and 6 supplemental), each of which typically consist of 18 to 20 items, providing adequate floor and ceiling performance.

Three kinds of phonological processes are tested in the CTOPP: phonological awareness, phonological memory and rapid naming. These three processes are related to normal phonological development in the domains of speech, reading and writing, and are also believed to be implicated in learning disabilities in these domains (Thambirajah, 2011). Since the main purpose of using this test was to measure phonological processing, the first two subsets were used in the study.

The raw score for each subset is converted into an age equivalency, a grade equivalency, a percentile, and a standard score. The standard score has a mean of 10 (SD=3). The subset standard scores are combined to make three composite standard scores. Each composite has a mean of 100 (SD=15). The CTOPP is administered individually, with the core subsets taking around 30 minutes to complete. Given the age of the clinical sample tested in this study, version B, designed for children aged 4-6 years was used. This version consists of seven core subsets and one supplemental subset.

The CTOPP was standardized on a population of 1,656 persons drawn from the four major U.S. geographical regions. Confirmatory factor analysis supports the construct validity of the CTOPP. A longitudinal correlation study testing the criterion prediction of the CTOPP against the Woodcock Reading Mastery Test-Revised (Woodcock, 1997) was carried out with 216 Kindergartners. The results showed that correlations on the Woodcock Reading Mastery Test-Revised and the CTOPP subsets range from 0.16 to 0.74. In a study that compared the CTOPP to the Lindamood Auditory Conceptualization Test (Lindamood & Lindamood, 1979), correlations on the subsets ranged from 0.41 to 0.75. The CTOPP reports inter-scorer reliability of at least 0.95 or above, and the content sampling coefficients on subsets range from 0.77 to 0.90. The coefficients for the composite scores range from 0.83 to 0.96.

Phonological Awareness

In the CTOPP, the Phonological Awareness Composite is comprised of three subsets: ‘Elision’, ‘Sound Matching’ and ‘Blending Words’. Responses are given to each item with either 0 or 1 point, with the sum of points earned on each subset providing the raw score. The raw score for each subset is converted into an age equivalency, a grade equivalency, a percentile, and a standard score. The subset standard scores are combined to make 3 composite standard scores.

‘Elision’: Elision requires the child to repeat a verbally presented stimulus word while omitting a sound. For example, “Say ball. Now say ball without saying /b/”. Reflecting a typical developmental trajectory, the items on the elision subset of the CTOPP typically begin with easy compound words and become progressively more difficult (e.g., “Say *Starfish*”, “ Now say *starfish* without saying *fish*), then switch to syllables (e.g., “Say *running*.”, “Now say *running* without saying *ing*.”), then to onset and rime (e.g., “Say rant.” “Now say rant without saying the /r/.”), and finally to individual phonemes (e.g., “Say *toad*.” “Now say *toad* without saying the /d/.”) Preschool nonreaders are typically not able to perform the elision on individual phonemes. The Elision subset is comprised of 18 items and the examiner is instructed to begin with the easy compound words. This enables the examiner to establish base and ceiling levels.

‘Sound matching’: This subset measures the ability of a child to choose the word that contains a target sound. Words are presented orally and the child is shown a card containing pictures of four words. The subset is composed of two parts. In Part 1, the child is required to match the initial sound of the word, hence the tester says a word and asks the child to select, out of three word choices, the word that starts with the same sound as the initial word (e.g., the child is asked, "Which word starts with the same sound as *sock*? *Sun*, *cake*, or *bear*?"). In Part 2 the child matches the last sound in the words: here the tester asks the child to select, out of three word choices, the word that *ends* with the same sound as the initial word. This subset has 20 items, and testing is discontinued after 4 out of 7 items are answered incorrectly.

'Blending words': In this subset, the child is asked to listen to parts of words and blend them together to make a whole word. The child will hear short segments of words, one part at a time, and is asked to blend the segments together (e.g., "what word do these sounds make? t-oi "). This subset has 20 items, and testing is discontinued after the student misses three items in a row or when the child completes all items. Standard scores for each sub-test and three composite scores are obtained. Standard scores for Elision and Blending Words are summed, the summed value is converted into a Phonological Awareness quotient; the Sound Matching scores are not used for children under the age of 6.

Phonological Memory

The phonological memory composite in the CTOPP is made up of two subsets: 'Memory for Digits' and 'Nonword Repetition'.

'Memory for digits': Is a measure of a child's ability to repeat increasingly longer lists of numbers in the exact order presented on an audiotape. It is a 21-item subset and number lists range in length from 2 to 8 digits. After a child has listened to a series of audiocassette recorded numbers (rate 2/sec) the child is asked to repeat numbers in the same order e.g.: “5, 2” and “9, 2, 4, 8, 3”.

‘Non-word repetition’: Requires that a child repeat non-words, varying in length from 3 to 15 sounds, e.g. “meb” and “teebudieshawlt”. Non-words are presented on a CD and the child is required to repeat the word after hearing it once. This subset is comprised of 18-items, accuracy is scored as the number of consonants and vowels repeated correctly, and items are presented to ceiling performance. Standard scores for Memory for digits and Non-word repetition are summed, and the summed value is converted into a Phonological Memory composite.

The Peabody Picture Vocabulary Test-4

The PPVT-4 (Dunn & Dunn, 2007) is one of the oldest and most widely used standardized tests to examine vocabulary knowledge in children. It is normed for use with individuals aged between 2.5 and 90+ years and is highly suitable for use with clinical as well as typically developing populations. The PPVT is a brief, individually administered norm-referenced assessment of listening comprehension for spoken words in Standard English. The PPVT-4 is divided into two domains: Receptive (choose correct picture) and Expressive (name picture) vocabulary. Most items assess concrete vocabulary, including object names, action words, and descriptors. An overall standard score (mean = 100, SD = 15) is provided. The PPVT-4 assesses children’s comprehension of single words by requiring them to point to a coloured picture (from a field of four) that corresponds to the word spoken by the examiner. Items increase in complexity, and testing continues until a ceiling is reached. For students with extremely impaired speech or motor problems the examiner can point to each quadrant and take a head nod or eye blink as an indication of their response. The PPVT-4 consists of four illustrations for 204 words, which illustrate the target, a phonological distracter, a semantic distracter and an unrelated item. The words are presented orally by the experimenter and the children are required to select the corresponding illustrations.

The standardization sample for the PPVT-4 included 3,540 individuals in age norms (2:6–90+) and a subset of 2,003 individuals in grade norms. The test was co-normed with the Expressive Vocabulary Test-2 (EVT-2; Williams, 2007). The norm sample matches the current U.S. population by sex, race/ethnicity, geographic region, socioeconomic status (SES) including father's education level and, clinical diagnostic or special-education status. As the PPVT-4 has high sensitivity and revised standardization norms for ethnic minorities and groups, it was selected for use in the current study. However, the participants in the study (autism; typically developing) come from different ethnic and social economic backgrounds and this may have resulted in variable exposure to lexical knowledge. Variability, resulting from cultural variability in the participant sample will be further discussed in this chapter.

The PPVT-4 is designed to measure a wide range of ability and is suitable for assessing individuals with special needs. As no reading or writing is required, the test can be used for measuring receptive vocabulary development among non-readers and those with written-language difficulties. The language abilities of the children in this clinical study ranged widely and whilst some children were non-verbal others possessed age-appropriate language skills at the time of testing. The test's receptive format makes it particularly useful for evaluating individuals with expressive-language impairments, since it does not require spoken or verbal interaction. As neither an oral nor pointing response is needed, individuals with severe language delay or fine /gross motor delays, observed in some children with autism, may be tested successfully. Also, the black outlines of the full-color illustrations enable the testing of most individuals with moderate visual disabilities, such as the visual integration difficulties also observed in some children with autism.

The test has two forms, A and B, which are used for progress testing. Form A was used for this clinical study as no progress measurements were needed. This test is untimed but during the standardization of the test 90% of the examinees completed the test in 20 minutes or less (Dunn & Dunn, 2007). All tests were conducted using the test materials required for the PPVT which includes an easel with all the required pictures and word stimulus. The PPVT was administered according to the published instructions.

Test for the Reception of Grammar (TROG-2)

The TROG-2 (Bishop, 2003) is a standardized measure of grammatical comprehension. It is appropriate for children aged 4 to 13 years and has been standardized with more than 2000 British children who did not have any known disability. Intended client groups for TROG-2 include people with specific language impairment, hearing loss, learning difficulties and acquired aphasia. In Great Britain the TROG was standardized on 792, of 4 to 16 year old children with difficulties such as specific language disorders and autism as well as on 70 adults with similar disorders (Bishop, 2003). As the TROG-2 has been used to assess understanding of grammatical contrasts in English in children with specific language disorders and autism, it was deemed appropriate for the population in this study.

The format of this test is similar to that of the PPVT-4, where the child is shown four pictures and asked to choose the one that matches the sentence produced by the examiner. Most of the blocks assess relatively simple grammatical constructions, and restricted vocabulary is used in sentences to minimize the possibility that not knowing the meaning of individual words would prevent a child from passing blocks. The test, which takes approximately 20 minutes to administer, enables the examiner to consider not only how a child's grammar comprehension compares with that of other children of the same age, but also to pinpoint specific areas of grammar comprehension difficulty.

The 20 blocks of trials each test a different grammatical construct, ranging from bare nouns to embedded sentences (see figure 2-2).

Block	Construction	Example of construction
A	Two elements	The sheep is running
B	Negative	The man is not sitting
C	Reversible in and on	The cup is on/in the box
D	Three elements	The girl pushes the box
E	Reversible SVO	The cat is looking at the boy
F	Four elements	The horse sees the cup and the book
G	Relative clause in subject	The man that is eating looks at the book
H	Zero anaphor	The man is looking at the horse and running
I	Reversible above and below	The flower is above the duck
J	Reversible passive	The cow is chased by the girl
K	Pronoun binding	The man sees that the boy is pointing at him
L	Not only X but also Y	The pen is not only red but also long

M	Pronoun gender/ number	They are carrying him
N	Comparative/absolute	The duck is bigger than the ball
O	Neither nor	The girl is neither pointing nor running
P	X but not Y	The cup but not the fork is red
Q	Postmodified subject	The elephant pushing the boy is big
R	Singular plural inflection	The cows are under the tree
S	Relative clause in object	The girl chases the dog that is jumping
T	Centre-embedded sentence	The sheep the girl looks at is running

Figure 2-2 Blocks that make up the TROG-2 and descriptions of what they measure

Raw scores on the TROG-2 correspond to the number of blocks in which the child answered all four items correctly and are converted to a standard score based on chronological age. The TROG-2 was administered according to the published instructions.

Children's Communication Checklist (CCC-2)

The Children's Communication Checklist (CCC-2; Bishop 1998) is used as a systematic assessment of the pragmatic aspects of communication. Given that most tests of pragmatics (especially those used for testing the younger population, 0-4 years) are designed as naturalistic observation assessments. The CCC-2 was first developed with the specific goal of distinguishing subgroups within the language-impaired population. For example, children who have pragmatic difficulties can be differentiated from those with more typical forms of specific language impairment (SLI), where the principal problems are with language structure. The checklist was designed to be completed by a professional (teacher or speech and language therapist) who knows the child well. When completing the CCC-2, the rater is required to indicate whether an item (e.g.: “ignores conversational overtures from others”) ‘definitely applies’, ‘applies somewhat’, or ‘does not apply’. S/he is also given the option of responding ‘unable to judge’ but is discouraged from using this response unless there has been no opportunity to observe the behaviour in question.

The majority of items are based on clinical descriptions of a subtype of specific language impairment known as semantic-pragmatic disorder (Bishop et al. 1983). In total 9 domains of language are tested. These are; speech, syntax, inappropriate initiation, coherence, stereotyped conversation, use of context, rapport, social relationships, and interests. Each of the 9 domains of functioning is treated as a subscale. Subscales C-G (inappropriate initiation, coherence, stereotyped language, use of context, and rapport) comprise the pragmatic composite. In addition, one set of items assessing aspects of speech production and another assessing syntactic complexity are included to provide information about intelligibility and complexity of expressive speech and language. To give an indication of how far non-language features of autism cluster with pragmatic impairments, two further sets of items, assessing social relationships and interests, are also included. These 9 broad domains are divided into 93 items, some of which ask about positive characteristics of the child, thereby providing raters with the opportunity of commenting on strengths as well as weaknesses, and to avoid raters developing a response set (Bishop, 2000).

Experimental Tasks of Linguistic Abilities

The fourth aim of the study was to evaluate the use of experimental methods, used in the Western world, to measure the mechanisms implicated in language acquisition in the children with autism and typically developing comparison children. So, in addition to the standardized tests of language described above, all participants completed two experimental studies that investigated the extent that children with autism showed noun and subject verb order (SVO) biases. A full description of test development and piloting of these paradigms is provided in chapter 6.

The method used in the experimental chapters is called the Intermodal Preferential Looking Paradigm (IPL). This method is particularly well suited to the current study for a number of reasons. First, it does not necessarily require participants to make verbal or other types of deliberate responses and can therefore be used with children who are intellectually lower functioning and have social interaction difficulties. Linguistic audio stimuli were projected from a central speaker rather than from a person and this potentially reduced the degree of stress that participants who found interactions particularly difficult experienced. The presented video clips were short (under 6 minutes), so did not impose excessive task demands on children with attention difficulties.

Background of Study

The child participants with autism were recruited through a local clinic in Beirut Lebanon that offers diagnostic assessments and Applied Behaviour Analysis (ABA; Lovaas, 1987) treatment services for children with autism. The recruitment and testing was carried out during 2011, a year that witnessed political instability in the Middle East and particularly in Lebanon which was on the brink of a second civil war.

The facility 'Stepping Stones Center' was the clinic chosen for the recruitment of children. Stepping Stones Center www.steppingstonesca.com is part of a chain of clinics found in many countries around the world including the United States, Lebanon and United Arab Emirates. Children from all over Lebanon came to the clinic in the hope of obtaining a diagnosis and in order to secure the required treatment. In the period before the study began, personnel at the clinic disseminated information about the study to the parents of children, who were registered for assessment and treatment.

Language and cultural background

Of considerable significance in the current context, are concerns about using linguistic measures that have been normed in a different culture. When writing test items, English native speakers may include items that are manifestations of their native culture and such artifacts may be wrongly taken as indicators of language comprehension. McGinley (2002) points out that some standardized tests used in the US contain items that may be culturally biased. She cites the Woodcock-Johnson Revised (Woodcock, McGrew & Mather, 2001), a test that aims to examine cognitive abilities, but includes items describing American nursery rhymes and pop songs, which may well be unfamiliar to learners from other cultures.

A test is considered "culturally fair" if test-takers from different cultural backgrounds but with the same intellectual ability or equal contextual knowledge about the construct being measured, achieve the same score. Test takers not familiar with the culture within which a given test is developed may obtain low scores, not because they lack specific skills but because inappropriate culture specific items have been inadvertently included in the test (Brown, 2004).

Most standardized English language test items have been validated to ensure that none are culturally sensitive and can be used in varied English speaking cultures. Since this is a crucial issue for the current sample, the discussion below considers the tests used in the current study in the cultural context. It will then consider the findings in relation to the appropriate use of these tests in a Lebanese population. For example, the PPVT-4 was standardised on a broadly representative U.S. sample, and the wider group norm for this test is based on data from a large representative group of children from ethnic minorities (Dunn & Dunn, 1997; Stockman, 2000). In gauging the suitability of the PPVT-III for use with an at-risk sample of African American children, Washington and Craig (1999) found that their scores on the PPVT-III did not significantly differ from the norm group. As a result of this finding, they concluded that the PPVT-III represents a valid and culturally fair test suitable for use with African American children and children from other cultures. Platt (2010) measured the appropriateness of using the PPVT-III as a standardized vocabulary measure for linguistically diverse kindergarten children in Canada. In her study she examined response patterns of young Canadian children using the PPVVT-III and looked for items that might be culturally biased using differential item functioning (DIF), defined as a statistical property of a test item in which different groups of test takers who have equal ability in the construct being measured have different average item scores because they are of different sociocultural groups. This analysis showed limited indications of DIF in the first 168 items of the PPVT-III, suggesting minimal test bias on the PPVT-III.

Also, Haitana e. al, (2010) investigated issues of cultural bias in using the PPVT-III as a measure of English language in New Zealand by comparing PPVT-III scores obtained by 46 Māori children from three different age groups (5-11 years) with scores from the standardisation sample. Results revealed that the PPVT-III appeared to be suitable for use with Māori as a receptive vocabulary measure, and no culturally biased items were reported.

The CTOPP (Wagner, Torgesen, & Rashotte, 1999) has also undergone comprehensive analysis using DIF procedures. In the CTOPP manual its authors point out that DIF analysis was used for all test items using logistic regression techniques for four dichotomous groups (males vs. females, European Americans vs. Non-European Americans, African Americans vs. non-African Americans, and Hispanic Americans vs. Non-Hispanic Americans). The authors reviewed each of the items for which statistically significant comparisons were found and eliminated all items with suspect content. The CTOPP has been used since cross-culturally. For example, Leafstead and Gerber (2005) examined phonological processing in English speaking Spanish children and Marinova-Todd, Zhao and Bernhardt (2010) tested Mandarin-English speaking children on all subsets of the CTOPP, including phonological awareness, phonological memory and rapid naming. The test was administered in its original format and no issues of cross cultural difference were reported. The TROG-2 (Bishop, 1998) has also been used cross-culturally. In their study, Hutchinson, Whiteley, Smith and Connors (2003) used the TROG (and several other linguistic measures) to test the receptive English language skills of children living in North-West England, who were native speakers of other languages including Gujarati, Urdu, Punjabi, Bengali, and Pushto. Quinn (2010) also used the TROG-2 to measure receptive grammar in children from different cultures who were in the process of acquiring English as a second language. In this study Quinn tested 130 children from 5 different school districts, mostly in Indian, who migrated to the United Kingdom and were learning English as a second language. Quinn noted no cultural loadings on any specific item on the TROG-2.

The Children's Communication Checklist-2 (CCC2) has also been used cross-culturally and has proven to be an efficient tool in helping identify pragmatics difficulties in non-English speaking cultures. The CCC2 has been particularly widely used in Norway, where several researchers (Helland & Heimann 2007; Helland et. al 2009) have used it to identify children with pragmatic difficulties. The CCC2 has been translated into Norwegian (Schølberg & Thorkildsen, 1998) and Dutch (Guertus et. al, 2009).

Whilst none of these populations are drawn from the Arab world, and the possibility exists that cultural artifacts will impose limits on the various tests' suitability for use in the current study, their cross-cultural evaluation provides some basis for believing that their usefulness goes beyond their country of origin. This is the first study to assess a sample of clinically referred children with autism, using standardized assessment tools in Lebanon, and careful consideration was therefore taken in the selection and administration of tests included in the assessment battery.

Language and historical context

The dominant language in Beirut city, Lebanon, is Arabic and the second language is English. French comes in third place. The English language has been used as a second language and mode of instruction since the arrival of Western missionaries in the 18th and 19th centuries and the emergence of English as a leading international language for business, technology, and communication (Diab, 2005). In 1946, English and French became compulsory foreign languages in secondary schools and the Lebanese government's official curriculum for public schools gave equal importance to both. During the early 1800s English was so widely used in the Lebanon that several decrees pertaining to language education were issued, most of which aimed at strengthening the role of Arabic in education and using it as a medium of instruction. However, these decrees were mostly a hasty expression of national pride and did not result from careful planning. French and English were ''deeply rooted in the Lebanese educational system'' (Shaaban & Ghaith, 1996, p. 101) and both remained dominant as the media of instruction in many Lebanese schools as well as in the community.

In the current study, great care was taken to ensure that all participants used English as their first language. The reasons behind the use of English as a first language rather than Arabic will be discussed further below in this section.

Consistent with their diagnoses of autism, all the participants in autism tested in this study had a history of language delay, and so most had been taken to see a specialist at an early age. Indeed, the average age of first referral in Lebanon, is at 24 months when the child is expected to begin to use sentences requesting what he/she wants or needs (Ministry of Health – Lebanon MOH http://www.moph.gov.lb/). Most of the speech therapy in Lebanon is carried out by American certified speech therapists. When confronted with a child who can speak either English or Arabic, speech therapists invariably refer to use English. This is because English is thought to be an easier language to learn than Arabic and therapists believe that it presents fewer difficulties for children struggling with language delay. Arabic and English differ in a number of ways. For example, regarding phonological production, consonants and vowels constitute the first learning blocks of language /m/ /a/ /b/ (English) /kha/ /kua/ /dua/ (Arabic), and are much easier to pronounce in English than in Arabic. A second important difference between Arabic and English is that first words for everyday objects are shorter and have fewer sounds in English than in Arabic, so they are more "child-friendly" and easy to teach. Within the bilingual Beirut setting, typically developing children always acquire the English words for everyday objects before the Arabic ones, so it seems very logical to teach children with language difficulties the easier language first, especially if English is a viable option for use in the family and school setting. In relation to grammar the Arabic language is again far more challenging than English. In Arabic, not only is there a "she" and "he" equivalent, objects are given genders which need to follow through in the structure of the sentence. This makes it harder for children to master any kind of grammatical construct and for speech therapists to teach them. When it comes to the use of language in a social context, which in and of itself poses particular difficulties for children with autism, Arabic is problematic. It is loaded with numerous subtle rules for addressing different people. There is also a formal and informal method of speech that has to be taught in order to differentiate people in order of social context and closeness. Arabic also has two forms: Modern Standard Arabic, used in formal domains across the

Arab world, and various local colloquial varieties. A final and important point is that there are many more teaching resources in the English language than in Arabic and this also makes it easier for speech therapists to teach in this language. Typically, a multi-disciplinary meeting between teachers, parents and speech therapists will take place before any decision about which language will be used in therapy is reached. In the clinic in Beirut 70% of families decide to use English. The team then has to ensure that this language is used in the child's home and school environments to ensure ease of generalization of concepts. A child could not work with a speech therapist in English if s/he attends an Arabic speaking school, or converses with his/her parents and siblings in Arabic. It is stressed, as a matter of utmost importance that parents, teachers and friends must converse with the child in English only.

Due to the widespread use of English as a second language in Lebanon, most schools have an Arabic section and an English section that differ on their language of instruction. Parents who chose English as their language of instruction in therapy would be expected to enroll their children in the English section of their school. In most cases however, children are placed in an alternative special education section where the language of instruction is always English.

Participants

Trained and qualified clinical psychologists diagnosed the children using the (CARS) (Schopler, 1999) and (GARS) (Gilliam, 2000), this was carried out in the clinic and separate from participation in the study. The diagnosis followed the criteria set forth in the DSM-IV (Diagnostic Statistical Manual IV; American Psychiatric Association, 1994).

Thus Asperger's syndrome and PDD-NOS (Pervasive Developmental Disorder, Not Otherwise Specified) were available if the clinicians felt the need to diagnose children under the spectrum. Parents of children with one of these three diagnostic labels were given letters describing the current study, as well as consent forms to be signed and returned to the clinic if they were happy for their child to participate in the research that formed the basis of this thesis. Approximately 90% of those parents approached agreed to sign the consent forms and a total of 37 children with autism were recruited to the study. Of these, 3 dropped out after the first two sessions due to a change in clinics, 4 children were excluded due to their use of Arabic as a first language, and 8 children were excluded due to an inability to understand and comply with the task demands. The remaining 22 children therefore comprised the total autism sample.

At the onset of the study wide heterogeneity in linguistic ability and symptom severity was noted in the participant sample. Some of the children were able to produce words, as well as word combinations during their assessment procedure, while others presented as non-verbal and were unable to produce words during their assessment. The children with autism who participated in the study ranged in age from 42 to 78 months. All used English in their home, nursery and school settings and all tests and assessments were conducted in English in the clinic. Although consent was provided by four Arabic speaking families, they were excluded from this study.

Much of the experimental work on language abilities in children with autism has been conducted on children under the spectrum of ASD, so includes children with Asperger's syndrome as well as children with PDD-NOS. However, all of the participants in the current study were diagnosed with autism. Indeed, the clinic from which the children were recruited did not have any cases with a diagnosis of PDD-NOS or Asperger's syndrome at the time the data were collected. Questions about diagnostic practice in Beirut and the extent that the results from the current sample can be generalized to other populations will be further discussed in the final chapter.

Considerations on assessing low functioning children with autism

All children scheduled for therapy during the recruitment phase of the study, were offered the opportunity to participate. As this meant that some intellectually low functioning children participated, careful consideration was given to the suitability of the assessments selected. It was also important to ensure that levels of intellectual functioning were considered in the interpretation of the test results.

The large majority of research into language acquisition in autism has been carried out with higher-functioning populations. Such individuals have a broader behavioural repertoire and are able to cope with higher task demands. However, the fact that much of what we know about language in autism is based on test results from selected groups of intellectually high functioning children leaves many questions about language in less able children unanswered. In this clinical study, both high and low functioning children with autism were examined and it was anticipated that this would enable a broader, more comprehensive and generalizable insight to emerge. Since the assessment battery used in the study was conducted by the same researcher at the clinic where the study was conducted, assessment consistency was ensured across participants.

However, the inclusion of intellectually lower functioning children, who may experience difficulties understanding the standardized or experimental tests instructions, or might not be able to comply to task demands for other reasons, poses risks in terms of floor effects on the measures. As such, careful consideration was needed to ensure that children who were non-verbal or intellectually low functioning were able to reach at least basal levels on each measure, and that performance on each of the standardized and experimental tasks was not confounded by measures of intellectual ability.

In order to address these issues, base line measures were obtained on standardized tests and extensive piloting was carried out on experimental tasks, correlations were carried out on measures of intellectual functioning and language, and individual and subgroup data were examined and analysed where appropriate. These measures are discussed in more detail below.

Baseline measures of standardized tests: each of the standardized tests used in this thesis provided baseline measures at the beginning of testing. This ensures that the participant understands the basic instructions of the test and is therefore able to at least complete a set of simple questions at the beginning of each testing session. Any variation afterwards will be due to the participant's linguistic abilities that are being tested. During testing, careful consideration was taken to ensure that all these children succeeded on the basal items of a test, with some tests including training (e.g., the PPVT (Dunn & Dunn, 2007) to ensure participants understand the test procedure. Most of the tests selected in this thesis are used in clinical populations and are designed for such purposes, the PPVT for example which tests receptive vocabulary knowledge, will make exceptions for students with extremely impaired speech or motor problems, and the examiner can point to each quadrant and take a head nod or eye blink as an indication of a child's response. However, in the current study, 8 of the original sample of 30 children recruited were unable to meet the requirement of completing a training session or to correctly answer the basal items on a test and were therefore excluded from the study. This might have been due to their age, their intellectual ability, or their verbal ability.

Correlations were conducted to increase understanding of the effects of intellectual functioning on test performance. Having a diverse population is important, and analysis of covariance techniques were used to control for the effect of intellectual ability. The examination of subgroups is a method used extensively in research into linguistic ability (Prior et al., 1998; Norbury & Bishop, 2002; Lindgren et al., 2009) and will be carried out on the data from this study. If intellectually low functioning children perform at lower levels than their higher-functioning peers on some standardized tests or experimental paradigms, the sub-group analysis will highlight this. If however, these children perform just as well as their higher functioning peers on some measures, this also will be revealed in the sub-group analysis, and will allow for further analysis into the factors that influenced their performance.

Age range used in study

The age range used in this study is 43 months-86 months (3.5yrs-7.1yrs). Many linguistic studies have used such a broad age range. For example, Kjelgaard and Tager-Flusberg (2001) investigated language functioning in a group of 89 children diagnosed with autism who were aged between 4 and 14 years (see Chapter 1 for a fuller description of this study). Harper-Hill et al. (2013) investigated heterogeneity in language abilities in 9-16 year old children with ASD and typical development. (see Chapter 1 for a fuller description of this study).

Ethics

Ethical approval was granted by the Ethics Committee of the Department of Psychology at Goldsmiths, University of London, and the procedures conformed to BPS ethical guidelines for working with children and vulnerable people. Parents of child participants were made aware that the project had been approved by Goldsmiths, University of London and gave full consent for their child's participation.

Selection Criteria

The three selection criteria were that the child must: (1) have received a diagnosis of autism; (2) have not been diagnosed with any other disorder; (3) fall within the age range of 43-86 months (3.5-7 years). Only participants fulfilling all three criteria were included in the study. On recruitment to the study, each individual participant's diagnosis was conducted using the Childhood Autism Rating Scale - Second edition (CARS-2; Schopler et al. 1988) and the Gilliam Autism Rating Scale – Second edition (GARS-2; Gilliam et al. 1995). A group of typically developing children, age and verbal-mental age matched to the children with ASD, also completed the studies described (see below).

Comparison and group matching

A control group of 38 typically developing children, age 30-86 months (2.5yrs-7yrs) participated in the study. In order to recruit these children the Lebanese Evangelical School was contacted http://www.lesbg.com/, and through this contact all children who spoke English as a first language were approached. Consent forms were sent to parents and approximately 55% of those parents approached gave consent to participate in the study. These children were then screened for developmental disorders (Autism Spectrum

Disorder including PDD-NOS), ADHD (Attention Deficit Hyperactivity Disorder), and Dyslexia, using the Assessing Linguistic Behaviors Communicative Intentions Scale (ALB) (Olswang, Stoel-Gammon, Coggins & Carpenter, 1987) and the Attention Deficit Hyperactivity Disorder Test (ADHDT) (Gilliam, 1995). Any child who met diagnostic criteria for any of these disorders was excluded from the study. Children who met the current study's selection criteria were then assessed on all experimental measures including diagnostic and developmental measures.

As previously mentioned in this chapter, chronological age and language matched control children were included in the study. Within the autism group, some children were intellectually high-functioning, and less likely to show a large mental age/chronological age discrepancy than would be observed in the intellectually low functioning children for whom such a discrepancy could be large. The study investigates language across a number of subdomains and the inclusion of two control groups will allow a finer grained analysis of the autism data. The inclusion of two control groups will be further discussed in the context of the data analysis carried out in the experimental chapters. The data from the three groups of participants are shown in Table 2-2.

Table 2-2 shows descriptive statistics for all three participant groups in this clinical study.

Table 2-2 Mean, SD and range of age as well as gender distribution of the autism as well as language matched and age matched control groups

	Age	**Gender**

		Mean	S.D.	Range	Boys	Girls
Autism (n=22)		67m	13.5m	43-86m	N= 17	N= 5
Typical (n= 38)	Age matched (n=22)	64.5m	12.5m	41-86m	N= 13	N= 9
	Language Matched (n=16)	55m	14.8m	30-75m	N=10	N=6

Statistical Analysis

This thesis employed a mixed methods approach. Standardized assessments were used as well as new experimental paradigms. Group differences were analyzed using ANOVA and t-tests, and the existence of sub-groups was analyzed using two-step cluster analysis using Schwarz's Bayesian Information Criterion (BIC). Relationships between symptom severity and performance on standardized assessments as well as on the experimental paradigms were analyzed using correlation analysis. Relationships between the experimental tasks and standardized assessment tests were analyzed using correlation and regression analysis. For all parametric inferential statistical tests the necessary assumptions were checked. Before conducting the ANOVAs or correlational analysis the data was checked for normality of distribution and equality of variances.

Power of effect size

Inferential statistics make it possible for researchers to make statements about a population based upon a sample taken from the population. In order for these statements to be accurate, the sample must be representative of the population and the underlying assumptions of the statistical test being used must be met**.** The power of a statistical test is its ability to detect an effect when its present, and is the probability that the researcher will avoid making a Type II error (failing to reject a null hypothesis that is false). A main factor that affects statistical power is sample size. The following guidelines from Cohen (1988) indicate that if the standard alpha level of .05 is taken and requires the recommended power of .8, then 28 participants are needed to detect a large effect size (r=.5).

In this study, with the standard alpha of .05 and a sample size of about 20 per group (22 Autism, 16 Language match, 22 Age match), tests of between-group differences between means had a power of .632 to detect a large effect size (d=0.8). Conventionally, a test with power greater than .8 is considered statistically powerful (Field, 2000). Many studies with similar sample sizes have carried out similar analysis. For example, Gabig (2008) tested a sample of 15 children with autism and 14 typical age matched children and Harper-Hill et al. (2013) tested a sample of 20 children with autism and 15 typically developing children matched on age. Therefore it was deemed appropriate to use the sample size available for the current study.

Missing data

Since the standardized assessment tests were part of the Clinic's protocol of admitting children for services, all of the children had completed their standardized assessment tests and therefore the full set of participants for each group completed all standardized language assessments. (Since any child who was not able to complete such tests was not included in the study from the outset.) The experimental paradigms (see chapters 6 and 7) posed a challenge however, and some of the children failed to complete some of them. In chapter 6 missing data was treated with list-wise deletion and analysis was conducted without the missing data. Although this could potentially decrease the sample size and thus the power for the experimental studies, as well as biasing the results to children who were able to complete the experimental tests, it remains a better option than pairwise deletion or mean substitution. Details of these children and the paradigms they failed to complete are detailed in the relevant sections of chapter 6.

In this chapter, background information on the recruitment and assessment of the participants who completed the study was detailed. Assessment tools and methodological issues concerning participant matching and statistical analysis were also discussed. In the following chapter (chapter 3) the results from the diagnostic and adaptive functioning tests described in this chapter will be reported.

Chapter 3 : DIAGNOSTIC AND DEVELOPMENTAL ASSESSMENTS

ABSTRACT

This chapter begins with a brief review of the literature into the use of the GARS, CARS and the Vineland Adaptive Behavior scales in assessments of children with autism spectrum disorder in Western countries and countries in the Arab world. GARS, CARS and Vineland Adaptive Behavior Scales data for a sample of 22 clinic referred children with Autism are then presented and analysed. The results of the analysis are discussed in the context of the studies described in the literature review.

Introduction

The following sections will describe the two diagnostic measures used in this study The GARS-2 (Gilliam, 2000), the CARS (Schopler, Reichler, & Renner,1988) and the VABS-II (Sparrow, 2005). Since collecting the data for the current study and due to the increased use of these measures in the Arab world (as will be discussed in detail) the CARS and the VABS-II have been translated into Arabic. However, even if these translations had been available at the time of testing, the validity or accuracy of the translated versions has yet to be confirmed so they could not have been used with confidence. Also, as discussed in chapter 2, therapy was delivered in English and parents and teachers used this language to communicate with the children in their everyday interactions.

GILLIAM AUTISM RATING SCALE (GARS)

Previous research in the Western world and Arab world

The GARS is one of many diagnostic measures of ASD used for research purposes in the western world. It has been widely used in many studies that require diagnostic measures as well as determining symptom severity (Ozonoff et al., 1991; Sundaram, Kumar & Makki 2008; Schreck, Mulick & Smith, 2004). In one study, Garcia-Lavin & Morin (2011) examined the levels of agreement among measures of Autism Spectrum Disorder in a sample of thirty-seven school-age children, aged between 5 and 12 years of age. They administered the Autism Diagnostic Interview-Revised (ADI-R) (Lord , Storoschuk, Rutter , & Pickles, 1993), the Childhood Autism Rating Scale (CARS), the Gilliam Autism Rating Scale (GARS), and the Autism Diagnostic Observation Schedule-Generic (ADOS-G) and compared the data from these assessments against DSM-IV-TR Diagnostic Criteria (structured Interview). Specifically, they compared the positive predictive values and specificity of the tests. Positive predictive value (PPV) refers to the power of an instrument to identify a disorder and specificity refers to the probability that a child without the disorder will screen negative for the disorder on the assessment. The results from Garcia-Lavin et al.'s study, revealed similar levels of specificity as well as similar positive predictive value rates for all four diagnostic measures thus confirming that the GARS was appropriate for use in the study in terms of its predictive validity for children with autism.

In addition to its broad use in the western world, the GARS has been used as a measure of diagnosis across centres in the Arab world. However, published studies reporting the use of GARS in this context are particularly rare. While most diagnostic centres in the Arab world use western based and western-normed standardized tests in evaluating and diagnosing autism, very little is known about how children in the Arab World perform on such measures in relation to their peers in the western world, and this raises important questions about the validity or reliability of these measures when used in such a setting. In order to contextualize this problem, the development of diagnostic services in the Arab World will be briefly described.

In the Arab World, screening and assessment services for children and adults with autism were initiated in 1987 in the Hashemite Kingdom of Jordan (Al-Smadi, 1987). The Autism Screening Instructional Planning (ASIEP) measure was a Jordanian adaptation of the Autism Behavior Checklist (ABC; Krug, Arick, & Almond, 1980a, 1980b) and was the first and the only useful and valuable assessment tool to help Arab world professionals assess children and adults with autism (Al-Smadi, 1987). In 2007, Al-Bostanjy conducted a study to evaluate the current assessment and evaluation practices in two countries in the Arab World (Jordan and Egypt) and concluded that current diagnostic practices were unacceptable and insufficient and had failed to keep pace with the improvements in educational provision for individuals with special needs in the region. In addition, he noted that many of the current assessment centres in both Jordan and Egypt, centres in these countries were utilizing alternative assessment (observations, interviews, and teachers' records) practices rather than formal assessment tools during diagnosis. Additionally, he found that most of the standardized assessment tools (regardless of purpose and type of disability) that were in use in Jordan had been adapted to better reflect the culture but had not been appropriately normed.

In an effort to introduce a more reliable and valid diagnostic instrument to the Middle East, Al-Jaberi (2008) investigated the validity and reliability indicators of the Jordanian translated Arabic version of the Gilliam Autism Rating Scale (GARS-2) (Gilliam, 2005). In this study, the GARS-2 was translated from English into Arabic and appropriate validity and reliability indicators were collected from a Jordanian sample of 3 to 13 year old students with autism. Since the publication of Al-Jaberi's (2008) paper, the translated version of the GARS-2 has been used in research studies of autism in the Middle East. For example, Hussein,Taha and Al-Manasif (2012) recruited children from Egypt and Saudi Arabia and compared them on demographic background, clinical characteristics and presentations of autism. The study also compared methods of examination and intervention across the two countries. The sample included 48 children with ASD, who were assessed both clinically and psychometrically using the GARS - Arabic version (Al-Jabery, 2008), the Vineland Adaptive Behavioral Scale – Arabic version (discussed below) (Eletibi, 2004), and the Stanford Binet IQ test - Arabic version (Hanoura, 2002). The results from the standardized assessments and tests of adaptive functioning were comparable to previous studies, carried out in the Western world, using the English versions of the tests. Specifically, results from the assessment using the GARS-Arabic version revealed average symptoms for 34.8%, above average symptoms for 17.4%, below average symptoms for 30.5%, low symptoms for 13% and very low symptoms for 4.3%. Similar studies have been conducted in the western world and have been important in highlighting the correlation between symptom severity and adaptive functioning in those children with autism tested.

These studies are comparable to the Hussein et al. (2012) study and its results. In 2006, Mazefsky and Oswald (2006) assessed 78 children with autism living in the USA using GARS-2, ADOS and ADI-R. The analysis of the data from the GARS-2 showed that most children (46.8%) with autism achieved an average score on symptom severity (97.61), while 22.5% scored above average, and 30.7% scored below average on the scale evaluating symptom severity, consistency between measures of symptom severity also revealed good agreement between GARS-2 and ADOS and GARS-2 and ADI-R.

Similarly, South et al. (2002) , conducted a study in the United States and examined the validity of the GARS-2 when used with a sample of 119 children diagnosed with autism and observed average severity scores in 47%, below average severity scores in 39%, above average severity scores in 9% and very low scores in 24%. Their study, however, went beyond measuring percentages of participants falling within each diagnostic category and looked at the extent that scores for each of the GARS subdomains correlated with ADI-R and ADOS-G subdomains. The results from this analysis revealed small associations between ADI-R social interaction and GARS social interaction (r =.26), without any other correlations between any other GARS and ADI-R scales. This led South et al. to conclude that while reliability among the individual GARS scales was good, convergence with similar scales from gold-standard research diagnostic measures was poor, and advised the use of a variety of sources of information regarding the child's behavior and history, as is recommended in the GARS manual. Lecavalier (2005) conducted a similar study in the United States, in which the diagnostic validity, inter-rater reliability, and effects of participant characteristics of a sample of 360 children with autism spectrum disorders was measured using the GARS. Results revealed high internal consistency and diagnostic validity. Gender effects were examined for the 347 ratings for which the student's gender was reported. Boys obtained slightly higher scores on all three behavioural subscales and on the total score, but none of these comparisons reached statistical significance. On the whole, parents reported highest severity on the social interaction subset, followed by the communication subset then the stereotyped behavior subset. Age effects were examined by correlating chronological age and GARS raw subscale and total scores. This revealed a significant association between age and scores on the Communication subscale only. Levels of functioning effects were examined by correlating Scales of Independent Behavior – Revised (SIB-R) scores and GARS raw subscale and total scores. All four SIB-R domain scores were significantly and negatively correlated with the three behavioral subscales and total GARS score, revealing a significant relationship between higher levels of symptoms and lower levels of functioning. Overall, the strongest association was with the SIB-R Social Interaction and the GARS Communication Skills.

To date, no such work has been carried out in the Arab world and research studies have largely been restricted to relatively simple descriptions of the prevalence and characteristic traits of children with autism and the types of services offered. Also, no studies have directly investigated the relationship between symptom severity and scores on adaptive functioning or linguistic measures, or looked at within group differences as an effect of IQ or age. The following section directly relates to the aim that examines symptom severity in children with autism in the Arab world, so it is possible to consider language abilities in this context. The section below describes the results from the analysis of GARS-2 data obtained from the group of autistic and typically developing children described in chapter 2.

Results

Test of violation of normality and skewness were carried out on the data. Whilst some positive skewness was observed, this was insufficient to violate normality. No outliers were detected.

First, classification of the autism group was considered. Table 3-1 shows the percentage of children in the autism group according to their GARS Autism Quotient (AI) classifications. The mean GARS AI for the autism sample was 101.2 (*SD* 17.5), 1 point above the reference mean. The difference between this sample mean and the standardization mean of 100 is statistically non-significant ($r = 4.12$, $p= 0.5$).

Table 3-1 GARS AI classifications showing percentage of the autism group in each diagnostic category

	n	% of sample	% expected from norms
"Very low" or "low" (AI < 80)	2	9.0%	9%
"Below Average" (80 - 8 9)	4	18.2%	16%
"Average" (90-109)	9	40.9%	50%
"Above average" or higher (≥ 110)	7	31.8%	25%

Second, the GARS total and subset scores were considered for the three groups of participants (see Table 3-2).

Table 3-2 Mean (SD) scores for each group on the three GARS subsets and the total Autism Index

Subsets	**Autism Group (22)**	**Age Matched (22)**	**Language Matched (16)**
Stereotyped Behaviors	8 (2.5)	0.9 (0.8)	0.9 (0.5)
Communication	10 (2.6)	1.4 (0.6)	1.3 (0.4)
Social interaction	10.1 (3.1)	1.0 (0.8)	1.5 (0.5)
Autism index	101 (17.5)	46.6 (9.6)	42.1 (7.8)

The data for each of the GARS subsets and autism index (AI) were analysed separately using a one way ANOVA, with group as the between subject variable. Bonferroni corrections were carried out to correct for multiple comparisons p/3 = 0.016. For the stereotyped behavior score, there was a significant main effect of group $F\,(2,59) = 88.28$, $p < .001$. For the communication subset score, there was a significant main effect of group $F\,(2,59) = 94.96$, $p < .001$. For the social interaction score, there was a significant main effect of group $F(2,59) = 72.28$, $p < .001$. A post hoc Tukey test revealed that on the stereotype behavior subset children with autism performed at a significantly lower level than both age matched controls ($p < .001$) and language matched controls (p <.001). The performance of the two control groups did not differ (p =.93). On the communication subset children with autism also performed at a significantly lower levels than both age matched controls (p <.001) and language matched controls (p <.001). The performance of the two control groups did not differ (p =.84). On the Social interaction subset children with autism performed at a significantly lower level than both age matched controls (p <.001) and language matched controls (p <.001). The performance of the two control groups did not differ (p =.51).

Having considered the GARS subset performance of the three groups, attention was turned to the children with autism's subset scores. Following the GARS manual, a child is considered to have a significant degree of deficit in a given domain if s/he obtains a standard score above 5. As can be seen from the Venn diagram below (see Figure 3-1), a prominent deficit in the language domain n = 15 as well as the social interaction domain n = 15, showing increased symptomology in the area of language delay and social interaction delay, was observed for most children. Such a finding is consistent with the observation that language delay and atypical language development is among the most frequent reasons for initial referral for young children with autism, and arguably one of its most prominent features at the age of this sample. This is also true for the children with autism in the Arab world where language deficits are one the most prominent reasons for referral (Hussein et al., 2002).

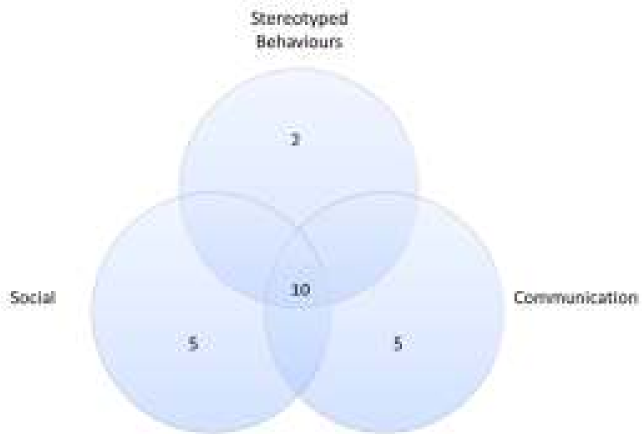


Figure 3-1 Venn diagram showing the number of participants with autism with a significant degree of deficit in the each GARS domain

Discussion

The results from the analysis of the GARS data failed to reveal a statistically significant difference between the mean AI for the autism group 101.2 and the standardization mean of 100. The analysis showed that only 9% obtaining a “low” or “very low” diagnostic probability, while only 18.2% obtained a “below average” probability of autism. It was observed that 40.9% the sample obtained an “average” probability of autism, while the remaining 31.8% obtained an “above average” probability of autism. As these figures were very close to the expected norms suggested by the manual (table 3-2) this suggests good sensitivity of the GARS when used with this Arabic sample. Although these results differ from those of South et al., 2002, they are consistent with results from studies carried out in the Arab World. For example, when Hussein et al. (2011) tested children with autism using the Arabic Translated version of the GARS, he observed that 34.8% scored in the average symptoms category, 17.4% scored in the above average symptoms category, 30.5% scored in the below average symptoms category, 13% scored in the low symptoms category and 4.3% had very low symptoms on the scale.

The results from the comparison of the autistic and typically developing groups in the current study, revealed significant differences on all GARS subsets. It was interesting to note that some of the children from the typically developing groups showed elevated levels of abnormal behavior on some of the measures of the GARS. Whilst none of these scores reached the autism cut-off point and difficulties in the stereotyped behavior subset was not reported for any of the typically developing children, 3 of the 22 children from the age matched group (13.6 %) reported difficulties in the communication or social interaction subsets. Such difficulties from the communication subset included the following items: “Does not ask for things he or she wants”; and “inappropriately answers questions about a statement or a brief story” . Difficulties from the social interaction domain included “Does not imitate other people when imitation is required or desirable”. However, such difficulties may reflect the child’s developmental level, rather than a communication of social interaction abnormality. Indeed Bishop et al. (2002) noted relatively high rates of “impairment” on ADOS-G items in typically developing participants. This kind of diagnostic problem is not unusual in the field of autism research, and Mahoney et al. (1998) noted that difficulties in deciding whether or not a specific behavior was consistent with the child’s developmental level was a major cause of diagnostic disagreement among experienced clinicians. Social interaction skills are still developing in middle childhood, and it is clear that some variability in attainments of skills assessed by GARS can be expected in children of this age, and there is no reason to expect that this would not be true in a sample from the Arab world as well.

In summarizing the results from the GARS, it appears that the findings of the current study were comparable to results from previous similar studies carried out in the in the Western world. Very few studies have reported on the use of GARS in the Arab world, and none have carried out a comparison between children with autism and age and verbal mental age matched typically developing comparison groups. The motivation for using GARS-2 in the current study have been described above. However, it is acknowledged that this scale has limitations, including a reliance on informant report rather than direct observation, as well as clinical standardization. Therefore information from a second diagnostic measure was collected. The Childhood Autism Rating Scale (CARS) was administered to all participating children prior to the onset of the study. This measure depends on the observations of the clinician and provides a second screen of the degree of symptoms present.

CHILDHOOD AUTISM RATING SCALE (CARS)

Previous research in Western and Middle Eastern countries

The CARS has been widely used as an instrument for diagnosis and research in the Western world. Results from research conducted in the Western world using the CARS will be highlighted below. This will demonstrate the suitability of this instrument as a diagnostic measure in the study reported in this thesis, and will also provide a Western context within which the results from the study can be evaluated.

One of the earliest studies to use the CARS, was carried out by Teal and Wiebe (1986), who demonstrated that CARS scores significantly differentiated children with autism from children without autism but with intellectual disability. Mayes et al. (2009) found that classification accuracy was 98% for CARS clinician scores and 93% for CARS parent scores in a sample of children with clinical diagnoses of low functioning autism vs. attention-deficit/hyperactivity disorder. Similar levels of diagnostic agreement (98%) between clinician scores on the CARS and the Checklist for Autism Spectrum Disorder (Schopler, Reichler, & Renner, 1986) were also observed (Mayes, 1999).

According to Ozonoff, Goodlin-Jones and Solomon (2005), studies report high criterion-related validity, inter-rater and test–retest reliability, and internal consistency on the CARS, even when completed by raters with little knowledge about autism or training on the CARS. A study by Rellini, Tortolani, Trillo, Carbone and Montecchi (2004) showed that the CARS has better diagnostic validity than other autism rating scales such as the Autism Behavior Checklist (Krug, Arick & Almond, 1978). CARS classification accuracy for children with autism (2–22 years of age) was 98% in a study carried out by Eaves and Milner (1993) and 92% in a study carried out by Sevin, Matson, Coe and Fee (1991). In samples of children with autism and other disorders, agreement between the CARS and DSM-IV diagnoses using the ADOS was 100% in one study (Rellini et al., 2004) and 88% in another (Perry, Condillac, Freeman, Dunn-Geier & Belair, 2005). In studies of individuals with suspected autism, diagnostic agreement between the CARS and the Autism Diagnostic Interview-Revised (ADI-R) was 86% in a study by Pilowsky, (1998) and 67% in a study by Saemundsen, (2003).

Botting and Conti-Ramsden (2003) also used the CARS to measure symptom severity in a group of 67 children with various diagnoses, but all with communication difficulties. Their sample included children with ASD, children with Specific Language

Impairment (SLI) and children with Pragmatic Language Impairment (PLI). Their aim was to determine whether standardized language tests that measure semantics, grammar and pragmatics are sensitive enough to discriminate between those three groups. In addition they explored the relationship between language ability and symptom severity measured using the CARS. Results revealed that linguistic markers were able to effectively differentiate SLI, PLI and autism. Results revealed the highest CARS scores in children with autism (indicating high symptom severity) followed by children with PLI and children with SLI. However, there were some children with a diagnosis of PLI, whose scores were indistinguishable from those of the children with autism. The analysis of the between group differences showed that children performed differently on the linguistic markers according to their performance on the CARS, so those in the ASD group performed similarly to each other on the CARS and on most linguistic markers. However within group differences revealed no real effect of symptom severity, suggesting that children in the ASD group did not perform better on the linguistic markers if their severity on the CARS was lower, and the same held for children in the SLI and PLI group. Results from western studies have highlighted the appropriateness of using the CARS as a diagnostic measure and as a measure of symptom severity in relation to linguistic studies.

Although studies carried out in the Arab World have reported the use of CARS for diagnostic purposes, these studies have largely examined prevalence rates, presentation of ASD, clinical correlates of ASD and comorbidity between ASD and other disorders (Al-Salehi, Al-Hifthy & Ghaziuddin, 2009). However, in 2013 Al Koury-Dirani and Alameddine argued that a validated and translated CARS scale would enable researchers to conduct scientifically rigorous studies, which would enable clinicians to identify autism and plan appropriate intervention approaches. The published Arabic version of CARS-2 (Al Khoury-Dirani et al., 2013) presents good psychometric properties in the translated manual. This version however was published after data collection and design of the experiment and was not considered for use in the study reported in this thesis.

Since the publication of the CARS-2 Arabic version, it has been used to diagnose children participating in autism research studies in the Arab World. However, again, most of these studies have investigated prevalence rates, sex differences between children with autism and service provision in the Arab World. To date no study (using either the English or Arabic versions of CARS/CARS-2) has investigated symptom severity in relation to language skills in groups or subgroups of children with autism. The following section describes the results from the analysis of CARS data obtained from the group of autistic and typically developing children described in chapter 2.

Results

Test of violation of normality and skewness were carried out on the data. This failed to reveal significant violations of normality.

A number of outliers in the age matched control group were reported. Two typically developing children obtained high scores and examination of these showed that case 39 (age = 5.6) achieved a score of 20 on the CARS standard score and, case 44 (age = 4.5yrs) achieved a score of 25. Neither scores reached cutoff scores for autism, but they were 2 SD and 3 SD respectively, from the mean for the control groups. These children's parents had expressed some worries about their child's ability to interact with other children and their test results included elevated scores on the "relating to people" and "imitation" subsets. However, inspection of the GARS data for these children showed that their scores did not reach autism threshold. The data showing CARS results and nonverbal and verbal communication subsets on the CARS for the three groups are shown in table 3-3, the remainder of the subsets are shown in figure 3-2.

Table 3-3 Results showing CARS standard scores (ss) and results on the nonverbal communication and verbal communication subsets for the autism group and the two control groups

Group	**CARSss**		**Nonverbal Communication**		**Verbal Communication**	
	Mean	SD	Mean	SD	Mean	SD
Autism	36.1	(4.0)	2.8	(0.6)	3.5	(0.6)
Age matched	17.0	(1.7)	1.3	(0.5)	1.4	(0.5)
Language Matched	16.2	(1.7)	1.4	(0.5)	1.2	(0.5)

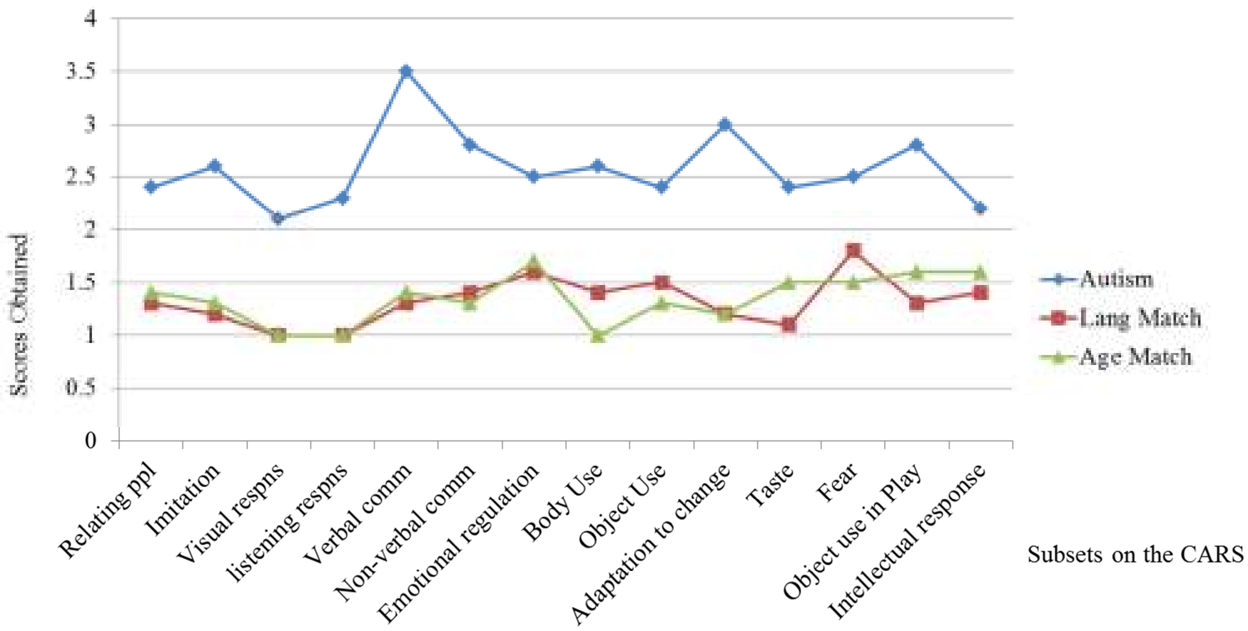
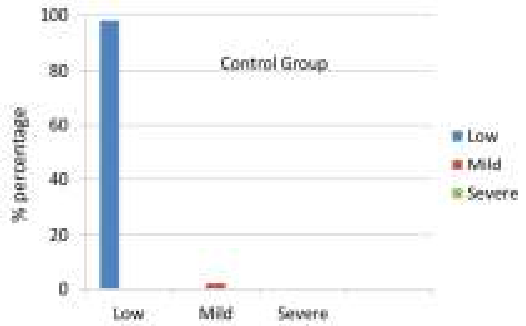


Figure 3-2 Results showing CARS standard scores (ss) and the rest of the subsets on the CARS

The data for each of the CARS subsets and standard score (ss) were analysed separately using a one way ANOVA, with group as the between subject variable. Bonferroni corrections were carried out to correct for multiple comparisons p/14 = 0.003. For the standard score, there was a significant main effect of group F (2,59) = 98.0, $p <$ .001. For the relating to people subset score, there was a significant main effect of group F (2,59) = 28.59, $p < .001$. For the imitation subset, there was a significant main effect of group F (2,59) = 27.53, $p < .001$. For the visual response subset, there was a significant main effect of group F (2,59) = 26.21, $p < .001$. For the listening response subset, there was a significant main effect of group F (2,59) = 33.17, $p < .001$. For the verbal communication subset, there was a significant main effect of group F (2,59) = 43.13, $p <$ .001. For the non-verbal communication subset, there was a significant main effect of group F (2,59) = 57.16.13, $p < .001$. For the emotion regulation subset, there was a significant main effect of group F (2,59) = 55.39, $p < .001$. For the body use understanding subset, there was a significant main effect of group F (2,59) = 25.21, $p < .001$. For the object use subset, there was a significant main effect of group F (2,59) = 37.89, $p < .001$. For the adaptation to change subset, there was a significant main effect of group F (2,59) = 56.71, $p < .001$. For the taste subset, there was a significant main effect of group F (2,59) = 28.30, $p < .001$. For the fear subset, there was a significant main effect of group F (2,59) = 30.69, $p < .001$. For the object use in play subset, there was a significant main effect of group F (2,59) = 75.81, $p < .001$. For the intellectual response subset, there was a significant main effect of group F (2,59) = 49.19, $p < .001$.

A post hoc Tukey test revealed that on all subsets of the CARS children with autism performed at a significantly lower level than both age matched controls (p <.001) and language matched controls (p <.001) on all subsets. The performance of the two control groups did not differ and p ranged from .39 to .96 .

As the Tukey test showed that the two control groups did not differ on any of the subsets, their data were combined in the following exploration of the data. Figure 3 -3 shows levels of symptom severity for children with autism and typically developing children.



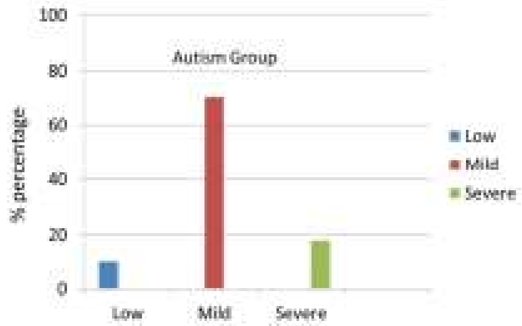


Figure 3-3 Symptom severity data for the children with autism and the two control groups combined since their results did not differ from each other on the subsets of the CARS

As the figure shows, 70% of the children with autism obtained results that show mild-moderate symptoms of autism, while 18% presented with severe symptoms of autism, and 10% presented with low symptoms of autism. Within the combined typical group (both age and language matched) 98% of individuals presented with low symptoms of autism, and 2% presenting with mild symptoms of autism. Such results from the typical group are expected of typical children since such a test only gives low, mild or high symptoms and does not include 'no symptoms present' category. The 2% presenting with mild symptoms represent the two outliers discussed above.

Discussion

Consideration of the CARS scores revealed that 70% of the children with autism obtained results suggesting mild-moderate symptoms of autism, while 18% presented with severe symptoms of autism, and 10% presented with low symptoms of autism. These results are not comparable to previous results from studies using the CARS in the Western world. For example, Rellini et al. (2004) found that 44% of their sample presented with mild-moderate autism scores and 56% presented with severe autism scores. Potential explanations for this discrepancy will be further discussed in the final chapter.

Looking more closely at the subsets of the CARS, deficits were reported most severely in the verbal communication subset and non-verbal communication subset. This is similar to the finding on the GARS, that showed the highest difference in the communication subset. This is comparable to studies in the western world that have looked at various symptoms in children with autism and have found that children with autism present the most severe symptoms in the areas of language and social interaction (Rogers et al., 2003); no studies were found that directly looked at and compared subsets of the CARS specifically, either in the Western or Arab world.

Consideration of the CARS symptom severity scores with those obtained from the GARS similarly differed. On the basis of the GARS assessment it was suggested tentatively that children in the Arab world might present with more severe symptoms of autism than their peers in the western world. However, the results from the analysis of the CARS data did not support this suggestion. One reason for this discrepancy could be that the GARS depends solely on parental report for completing the assessment and thus informing the diagnosis, while the CARS is comprised of clinician observations. It might be the case that parents of children coming in for assessments are over-emphasizing some of the symptoms in their children, perhaps unconsciously. Unfortunately there are no studies in the Arab world that examine the accuracy of parental reports in diagnosing children with autism. Results from the Western world, however, show that parents can be seen as crucial informants as they offer information on their child's abilities (and disabilities) outside of educational and clinical settings. Stone and Lemark (1999) have found that parent's reports on the social deficits of their young children with autism were consistent with the findings of diagnostic assessment results that are based on clinical observation of this group, substantiating parent's reliability as an information source about their children with autism.

Examination of the data from the sample of typically developing children showed that 98% presented with low symptoms of autism, and 2% presenting with mild symptoms of autism. However, it is worth noting here that these scores are not indicative of a developmental disorder. The lowest possible score that a child can get on the CARS is Low severity, so there is no a 'typical' or 'non-autistic' category. The reason for this is that the CARS was specifically designed as a measure to determine symptom severity in clinically referred children with an indication of developmental delay, and not with children who are typically developing. Within the typically developing groups 'mild severity' was reported for 2% of children and this may reflect the nature of the screening test, which requires parents to allocate scores (e.g., 1, 1.5, 2) for minor difficulties and behavioural challenges that are commonly observed in typically developing children. Furthermore, as discussed in the previous section on the GARS, coding of items on the GARS depends in part on the developmental level reached by the child. During testing it appeared that some scores reflected developmental immaturity rather than atypical development. Between group performances on the CARS revealed significant differences between children with autism and their age and language matched peers on all subdomains. The greatest difference was in the verbal communication, followed by non-verbal communication and relating to people subsets. This is comparable to studies carried out in the Western world that have looked at various symptoms in children with autism and have found that they present the most severe symptoms in the areas of language and social interaction (Rogers et al, 2003).

THE VINELAND ADAPTIVE BEHAVIOR SCALES

Previous research in the Western world and Arab world

The Vineland Adaptive Behavior Scales-II (VABS-II; Sparrow, Balla & Cicchhetti, 1984) have been widely used over the past two decades to assess adaptive behavior in individuals with autism as well as other populations. Research using the VABS-II has focused on obtaining profiles of relative strengths and weaknesses on the individual domains of the VABS-II within samples of individuals with autism, and it has been suggested that children with autism exhibit a distinct profile, with highest scores in Motor (if administered) and Daily Living domains, lowest scores in the Socialization domain, and intermediate scores in the Communication domain (Kraijer, 2000). In the largest study of its kind, Carter, Volkmar, Sparrow, Wang, Lord, and Dawson (1998) examined adaptive behaviour profiles in a sample of 684 children and adults with autism in the USA. The sample was divided into four groups based on age (under 10 years vs. 10 years and older individuals) and language ability (verbal and nonverbal). The results showed that most groups demonstrated the predicted ‘‘autism profile’’ with higher Daily Living scores, lower Socialization scores, and intermediate Communication scores when age equivalent scores were used, and it was suggested that the presence of a clear and consistent ‘‘autism profile’’ on the VABS-II could inform diagnostic decision-making. Data from the VABS-II are often used in this way in clinical practice (Perry, Flanagan, Dunn-Geier, & Freeman, 2009), and were used as an informative diagnostic tool in the clinical setting for the current study. The VABS-II manual includes a section suggesting that an uneven profile is characteristic of children with autism.

The VABS-II has been used extensively as a developmental tool to measure communication, daily living skills, socialization and motor skills in the Western world. Following the pioneering work of Bartak and Rutter (1975), who used the VABS to measure social interaction skills in children with autism, studies measuring linguistic abilities in these children have utilized this measure in various research designs. For example, Klin et al. (2007) used the VABS to measure communication and social skills and examine those abilities, and disabilities, against symptom severity using the ADOS. Their results revealed a significant correlation between VABS measures and ADOS scores. Specifically the level of communication ability, as measured by the VABS, was correlated significantly with levels of both communication and social disability as measured by the ADOS. A significant relationship was found between age and VABS scores but the relationship between age and ADOS scores was not significant. The study also reported significant correlations between IQ and the VABS communication subscales (Klin et al, 2007).

Luyster, Kadlec, Carter and Tager-Flusberg (2008) also used the VABS to measure linguistic abilities and adaptive functioning in children with autism. The goals of their study were to investigate language in toddlers with ASD and to identify early correlates of receptive and expressive language. Receptive and expressive scales from the Mullen Scales of Learning (Mullen, 1995), as well as the VABS communication subset were used as measures of language skill. The analysis showed that scores on the VABS and Mullen scales were significantly correlated. As a group, toddlers with ASD exhibited delays in both receptive and expressive language abilities across the measures, with significantly higher expressive language scores compared with receptive language scores on both measures. Thus in their study the VABS was used as a measure of language skill as well as adaptive functioning, and a number of predictors of concurrent language skills were examined, including chronological age, nonverbal cognitive ability, imitation, play, gestures, initiation of joint attention (IJA), response to joint attention (RJA), and motor skills. For receptive language, significant concurrent predictors were gestures, nonverbal cognition, and RJA. Significant predictors of expressive language included nonverbal cognition, gestures and imitation.

In a longitudinal study looking at the effect of symptomatology on language acquisition in children with autism, Paul, Chawarska, Cicchetti and Volkmar (2008) measured language using the VABS and the Mullen scales, and autism symptoms using the ADOS and ADI-R in 37 15-25 months old children. Adaptive functioning was also measured using the VABS. As the participants in the study received speech and language therapy sessions at the same clinic, researchers were able to conduct follow-up visits using a similar assessment protocol one year later. Results from the first visit revealed that in comparison to their relatively preserved skills in nonverbal areas, toddlers with autism showed significant deficits in both expressive and receptive language skills as measured by the VABS. The second visit a year later demonstrated marked growth in language skills as measured by the VABS and Mullen scales. However, two groups emerged, one that had ‘good’ outcome in language ability (as measured by a 12 months increase on the VABS) and one that did not have a ‘good’ outcome in language ability (as measured by less than 12 months increase on the VABS). When the two groups were compared on the individual subsets of the ADOS, the only scale on which they significantly differed was the responsive joint attention one (RJA). During the first assessment the ‘good’ outcome group had performed better than the ‘not good’ outcome group on this ADOS measure.

The use of the VABS as a measure of adaptive functioning in clinical settings is extensive in the Arab World. In 2004, it was translated into an Arabic version by Eltebi (2004) and has since been used in research studies. Hussein, Taha and Al-Manasef (2011) used Arabic versions of the VABS, as well as the Arabic versions of the GARS and Stanford Binet tests to examine the characteristics of Egyptian and Saudi children with autism. The pattern of results from the study were very similar to those reported in western studies using these scales. For the VABS, difficulties in communication, daily living skills, socialization and motor subdomains were all observed. The most severe deficits were in the communication subdomain, followed by the socialization subdomain, with the least severe deficits observed in the motor skills subdomain. In a US based study of 178 children with autism Klin and Saulnier (2006) observed the same profile of disability on the VABS-II as that observed by Hussein et al. in their Arabic sample of children with autism. In both studies communication abilities were most severely affected and motors skills least severely affected. However, Klin et al.'s study went a step further by comparing measures of ability on the VABS-II to measures of disability as measured by the ADOS, and by examining the effects of age on performance. The results from this analysis revealed a weak relationship between ability as reported by the VABS-II adaptive scores and disability as reported by the ADOS. Measures of symptom severity on the ADOS did not correlate with level of disability as measured by the VABS-II. However, a positive relationship between IQ scores and the VABS-II Communication subset and a negative relationship between age and VABS-II scores were reported. The relationships between age and ADOS scores was not significant.

To date, no study has measured associations between symptom severity measured using diagnostic measures such as GARS and CARS and performance on the VABS-II in children with autism in the Arab World. Given the extent to which the VABS-II is used in autism clinics in the region, it is crucial to make such a comparisons. The following section describes the results from the analysis of the VABS-II data obtained from the group of autistic and typically developing children described in chapter 2.

Results

Test of violation of normality and skewness were carried out on the data. This failed to reveal significant violations of normality. No outliers were detected in the analysis,

As the VABS-II provides an age equivalent score for language domains it was used in the current study as an indicative measure of language ability, and language age equivalent scores were used to match the participants with autism to their typical peers.

The means and standard deviations for the subsets of the VABS-II are shown in table 3-4.

Table 3-4 Mean (SD) age equivalent scores for each group for each VABS-II subset, group comparisons are shown

	Communication	Daily living	Socialization	Motor
Autism (22)				
Mean	22.6	22.9	21.4	20.0
SD	5.9	4.3	4.9	3.8
Language matched (16)				
Mean	25.2	30.1	29.5	28.7
SD	6.9	6.0	7.1	4.2
Age Matched (22)				
Mean	44.4	41.8	43.8	28.7
SD	6.0	7.2	7.4	4.0

The data for each of the Vineland subsets standard scores were analysed separately using a one way ANOVA, with group as the between subject variable. Bonferroni corrections were carried out to correct for multiple comparisons p/4 = 0.0125.

For the communication subset score, there was a significant main effect of group F (2,59) = 25.21, $p < .001$. For the daily living subset score, there was a significant main effect of group F (2,59) = 49.30, $p < .001$. For the socialization subset score, there was a significant main effect of group F (2,59) = 20.59, $p < .001$. For the motor subset score, there was a significant main effect of group F (2,59) = 61.42, $p < .001$.

A post hoc Tukey test revealed that children with autism performed at a significantly lower level than both age matched controls (p <.001) and language matched controls (p <.001) on the motor subset, and the daily living score subset. The performance of the two control groups did not differ (p =.431) and (p =.215) respectively. However, on the communication subset, the children with autism performed at a significantly lower level only from the age matched controls (p <.001), but did not differ from the language matched group (p =.913). The two control groups did differ from each other on the communication subset (p <.001) (p <.001). On the socialization subset the autism group differed from the age matched group (p <.001), and differed from the language matched group (p <.05) however did not reach significance due to Bonferroni corrections. Finally, the two control groups did differ from each other (p <.05), however did not reach significance due to Bonferroni corrections.

Since the Vineland was used as a matching measure to match children with autism with their younger typically developing peers, and since post hoc tukey tests showed no difference in the communication domains in children with autism and their younger typically developing peers. Details of the scores from the communication subdomain are shown below. The data from the communication subsets are shown in table 3-5: Receptive, Expressive and Written language.

Table 3-5 Results of different groups on communication subset on the VABS-II

Group	**Receptive**		**Expressive**		**Written**	
	Mean	SD	Mean	SD	Mean	SD
Autism	7.6	1.4	5.9	1.8	9.7	3.2
Age matched	14.6	2.5	14.5	2.3	15.3	2.3

Lang Matched	9	1.8	7.5	2.3	10.0	2.5

The data for each of the domains were analysed separately using a one way ANOVA, with group as the between subject variable. Bonferroni corrections were carried out to correct for multiple comparisons p/3 = 0.016. For the receptive communication standard score, there was a significant main effect of group F (2,59) = 37.0, $p < .001$. For the expressive communication standard score, there was a significant main effect of group F (2,59) = 41.5, $p < .001$. For the written standard score, there was a significant main effect of group F (2,59) = 20.0, $p < .001$. A post hoc tukey test revealed that children in the age matched group performed at a significantly higher level than both language matched controls (p <.001) and children with autism (p <.001) on all domains. The performance of the language matched group and children with autism did not differ and was (p =.93) on the written domain, (p =.34) on the receptive domain and (p =.51) on the expressive domain.

The second aim of this thesis was to measure the association between symptom severity and linguistic ability. To fulfil this aim the two measures of symptom severity outlined above (GARS, CARS) were compared to the relevant subsets of the VABS-II. In order to analyze the relationship between adaptive functioning and symptom severity, raw scores from the communication subset on the VABS-II, GARS and CARS standard scores were converted into z-scores for comparison (see figure 3-9). It is worth noting that many scores on the VABS-II subsets were below the mean (and therefore showed a minus z-score). As can be seen from figure 3-4 most cases with low symptoms do show higher scores on the VABS-II communication subset (e.g., cases 8, 9, 14).

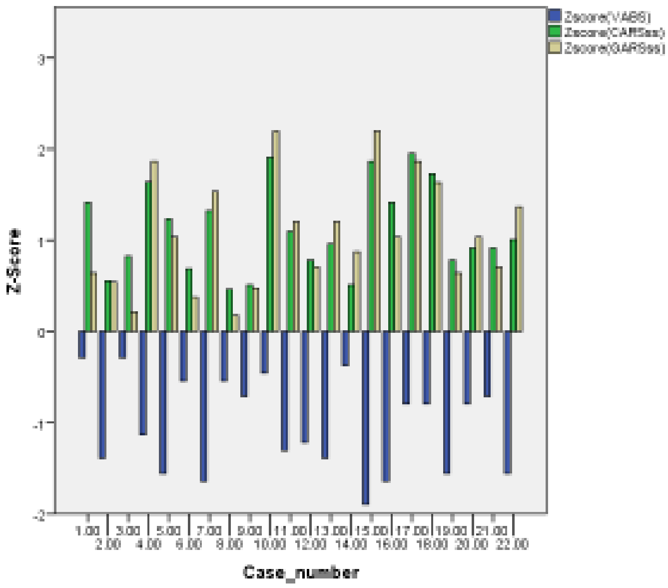


Figure 3-4 Z-scores of the GARSss , CARSss and VABS-II communication subset of children with autism, high z-CARSss and z-GARSss scores indicate high severity while a high z-VABS-II scores indicate high ability

Pearson product moment correlation analyses were conducted using standard scores to investigate the relationship between VABS-II communication, socialization and living skills with CARS and GARS as well as with age for the children with autism. It is important to note that higher VABS scores signify greater ability, whereas higher CARS and GARS scores signify greater disability. Bonferroni corrections were conducted *p*/5 = .01.

Table 3-6 Pearson product moment correlations between VABS-II subsets, age, CARS standard scores (CARSss) and GARS standard scores (GARSss)

	Age	CARSss	GARSss
VABS			
Communication	-.15	-.49*	-.54**
Socialization	-.53**	-.51*	-.52*
Living skills	.14	-.12	-.32
Motor	-.07	-.20*	-.35
Age	1	.35	.40
CARSss	.35	1	.60**

* p < .05 level (2-tailed)
** p < .01 level (2-tailed)

As shown in table 3-6, there was a strong negative correlations at $p < .01$ between VABS-II socialization score and age suggesting that the gap in social abilities between individuals with higher functioning autism and their typical peers increases with age (i.e., that individuals with autism become less able relative to same-age typical peers as they move into later adolescence). There were also strong correlations between the CARS and GARS subscales.

Examining the relationship between VABS-II measures and the CARSss Pearson correlations were carried out on the scores for the autism group. Bonferroni corrections were conducted with $p/12 = .004$. Table 3-7 below shows the correlations between the subscales on the CARS and the VABS-II. Results from the autism sample indicated that level of communication ability on the VABS-II was correlated with communication disability, as well as with level of intellectual response and object use in play on the CARSss, however the size of correlation for the latter was weak. This finding shows that there is a relationship between lower levels of communication and social disability and higher levels of communication skills in children with autism. Also levels of living skills ability correlated with emotional regulation and adaption to change, but again the size of the correlation was weak. Levels of social ability correlated with social disability on the

CARSss as well as correlating with communication measures, however the size of correlation in the latter was weak. Levels of Motor skill ability correlated with Body use disability, however the size of correlation was weak. The correlations that were statistically significant are shaded.

Table 3-7 Pearson correlation *r* values between subsets of the VABS-II and subsets of the CARSss for children with autism

	VABS-II			
	Communication	Living Skills	Social	Motor
CARSss :				
Relating to people	-.20*	-.15	-.57**	-.23
Social understanding	-.34	-.42	-.24*	-.29*
Emotional Regulation	-.12	-.43*	-.20*	-.35
Body Use	-.30	-.20	-.07	-.55*
Adaptation to change	-.14	-.44*	-.15	-.42
Visual response	-.32	-.09	-.16	-.19
Listening response	-.25	-.37	-.18	-.03
Fear or Anxiety	-.21	-.12	-.31	-.07
Nonverbal communication	-.45*	-.16	-.17*	-.18
Verbal Communication	-.51**	-.18	-.22*	-.17
Level of intellectual response	-.37*	.02	-.18	-.13
Object use in play	-.28*	-.02	-.28*	-.9*

* p < .05 level (2-tailed)
** p < .01 level (2-tailed)

Moving onto consideration of the relationship between the GARS disability measures and the VABS-II ability measures, Pearson correlations were carried out. Bonferroni corrections were carried out, p/3 = .016. As shown in table 3-8 below, the communication subset of the VABS-II correlated with the social interaction, communication and stereotyped behaviour disability measures of the GARS. The social subset of the VABS-II correlated with the social interaction and communication GARS disability measures.

Table 3-8 Pearson correlation *r* values between subsets of the VABS-II and subsets of the GARS

	VABS			
	Communication	Living Skills	Social	Motor
GARS				
Social Interaction	-.67**	-.48*	-.50**	-.20
Communication	-.58**	-.21	-.56**	-.29
Stereotyped behaviour	-.28*	-.15	-.37*	-.41*

* p < .05 level (2-tailed)
** p < .01 level (2-tailed)

Discussion

The results presented in this chapter represent the first examination of adaptive functioning measures and the relationship between disability and ability in children with autism in the Arab world. Previous studies carried out in the Western world have identified a VABS profile in children with autism that is characterized by significant deficits in socialization, intermediate deficits in communication, and relative strengths in daily living skills (e.g., Bolte & Poustka, 2002; Carter et al., 1998). In the comparison of VABS-II data reported in this chapter the most striking difference across groups was between the autism group and the age matched typically developing group in the communication and socialization subsets. These results are consistent with those from studies carried out in the Western world, both in terms of between group differences and in the profile of disabilities in the autism groups (Luyster, 2008).

One interesting finding to emerge from the analysis was that the smallest between group difference was in the VABS-II written domain where the children with autism performed closer to their peers than on other domains. This finding may suggest that children with autism have relatively intact processes when it comes to written communication, whilst experiencing significant difficulties with receptive or expressive communication. The results also showed a trend in performances with younger typical children showing higher performances in receptive communication than the expressive communication (Hudry et al., 2009; Saulnier & Klin, 2007), where usually typical children exhibit greater receptive than expressive abilities. This trend was also seen in the autism group with higher receptive communication skills than expressive communication skills. Such a trend was not observed for the older group (age matched controls), where their performances across domains (receptive, expressive and written) was very similar.

The VABS-II sums three subsets into one communication composite score that was used for matching in the study (See chapter 2). The effect of summing the three subsets together might give weight for differences in skills. For example children might be doing very well on the written subset and poorly on the expressive subset (which is the case with children with autism) and summing these might mask poor performance on the expressive subset and provide a misleading average score. However, it may be erroneous to select one subset for matching. For example, matching based on the expressive subset alone, would not allow for consideration of other skills (receptive and written) that are cornerstones of linguistic ability. Therefore, the best solution is to be cautious while analyzing and attributing variance to any of the communication subsets alone.

Relatively few studies have investigated the relationship between autistic symptomatology and adaptive functioning, and for those that have, the measures used to assess disability have differed across studies. In a study using the *Wing Autism Diagnostic Interview Checklist* (Leekam, Libby, Wing, Gould, & Taylor, 2002), a negative correlation was found between severity of autistic symptoms and adaptive behaviour as measured using the VABS (Liss et al., 2001). Klin, Saulnier, Sparrow, Cicchetti, Volkmar, and Lord, (2007) found that VABS-II measures correlated with ADOS scores, specifically the level of VABS-II communication ability was significantly correlated with levels of both communication and social disability as measured by the ADOS. There was no significant correlation between levels of social ability and levels of communication or social disability for their sample. In other words, lower symptomatology related to better communication but not social skills in real-life situations for their autism group. However, the overall size of the correlations between VABS-II and ADOS scores were quite low in the study and this suggested that the associations between levels of autistic symptomatology and levels of adaptive functioning in real life were not strong.

In the current study the sizes of correlation varied, the CARSss revealed significant correlations with weak strengths while the GARSss revealed greater sizes of correlation and more significance across the subsets. Both measures did show good agreement, as such, differences in such measures could be attributed to the fact that their subsets measure different sets of skills (or lack of).

Some research investigating the relationship between IQ measures and the VABS has revealed a positive relationship (Freeman, Del'Homme, Guthrie, & Zhang, 1999). However other studies show that there is no direct relationship between the two (Liss et al., 2001; Schatz & Hamden-Allen, 1995; Szatmari, Bryson, Boyle, Streiner, & Duku, 2003). The VABS Communication domain has been shown to have the highest positive correlation with IQ, although several studies also shown a positive correlation between nonverbal IQ and VABS Communication, Socialization, and Daily Living scores (Schatz & Hamden-Allen, 1995). Other studies have found that both early language and nonverbal skills were important predictors of outcome in VABS Communication and Socialization domains (Szatmari et al., 2003). The results from the study described in this chapter revealed further factors that are in play, such factors include level of intellectual response and object use in play as measured by subsets on the CARS. However such relationships did not reveal significant correlations.

In summary results from the VABS-II revealed a profile for children with autism in the Arab world that is similar to that of children in the western world, in that their social and communication subset was the most affected, followed by motor and daily living skills. In the communication subset, children with autism performed similarly to their language matched peers in that their scores in the receptive domain were higher than their expressive domain; such a trend was not apparent in the older age matched group. With regard to symptom severity, results from studies in the western world show mixed results. In this study correlations differed, with the CARSss revealing significant correlations with weak strengths while the GARSss revealed greater size correlations and more significance across the subsets.

In the following chapter associations between symptom severity and its relation to performance on standardized language assessment tests will be analyzed, as well as the existence of subgroups in relation to aspects of linguistic ability.

Chapter 4 : PHONOLOGICAL AND LEXICAL SKILLS

ABSTRACT

The first section of this chapter will review the literature on phonological processing abilities in children with autism, and will highlight the threefold aims of this chapter in relation to the thesis. Following this, results will be outlined according to such aims. These include examining differences between children with autism and the two control groups, examining the existence of subgroups in relation to linguistic abilities and analyzing the association between symptom severity and performance on measures of language abilities; outcomes will be highlighted accordingly. Finally, these results will be discussed within the context of previous research into phonological processing in autism. Section two will begin with a literature review of the lexical processing abilities of children with autism, and will highlight the aims of the study. Following this, results will be described and discussed within the context of the literature review into lexical processing in autism. The relationship between phonological and receptive lexical skills will then be investigated and the language data will be analysed for subgroups. Finally, the relationship between language skills and levels of symptom severity will be explored.

Introduction

The overarching aims of this thesis are to explore language skills using assessment methods used in autism research in the Western world, to explore the relationship between language skills and symptom severity, and to consider heterogeneity and potential language subgroups in the sample tested. To date, no studies have carried out such a detailed investigation of language abilities in English speaking children with autism living in the Arab world, and the studies described in chapters four and five will investigate phonology, lexical, syntax and pragmatics skills using standardized tests widely used in the Western world.

PHONOLOGICAL PROCESSING IN CHIDLREN WITH AUTISM

Phonological processing refers to the use of phonological information, especially the sound structure of one's oral language, during reading, writing, listening and speaking (Jorm & Share, 1983; Wagner & Torgesen, 1987). The main role of the phonological processing system is to analyse and manipulate sound structures to create meaningful words, which constitute the basis of communication.

The Comprehensive Test of Phonological Processing (CTOPP) (Rashotte, Torgesen & Wagner, 1999) tests three kinds of phonological processes, namely phonological awareness, phonological memory and rapid naming. These three are related to normal phonological development in the domains of speech, reading and writing, and are also believed to be implicated in learning disabilities in these domains (Thambirajah, 2011). In the first study described in this chapter, phonological processing and phonological memory will be investigated. These processes are very important for vocabulary acquisition, which will also be measured, using the Peabody Picture Vocabulary Test (PPVT).

Phonological awareness relates to the awareness of, and access to one's oral language (Mann, 1986). Spoken words are made up of phonemes and these phonemes also correspond to the written form of the word. For example the words cat, hat and mat are related phonologically; they have different initial phonemes /c/, /h/, and /m/ but identical medial and final phonemes. Children with good phonological awareness are sensitive to these differences and similarities and such awareness follows a well-defined developmental trajectory. The developmental phonological processing trajectory begins with awareness of word-length phonological units, followed by syllable length phonological units, reaching to awareness of phonological units within a syllable. Finally, full phonological awareness is when a child is able to isolate and manipulate individual phonemes, including consonant clusters, for example segmenting the word *cat* into individual phonemes. This constitutes the basis for reading and writing (Kavanagh & Mattingly, 1972).

To date there has been little research into the nature of phonological awareness in children with autism in the Western world and no research at all in the Arab world. Additionally, since phonological awareness constitutes the basis of reading, most studies that look at phonological awareness in children with autism have assessed phonological awareness in the light of its implications for reading skills. The existing literature on reading ability in children with autism suggests that some children may develop and understand the phonemic structure of words, despite having significant language and communication deficits. For some children an unusual preoccupation with letters and print may result in precocious reading ability, a characteristic referred to as hyperlexia (Aaron, Frantz, & Manges, 1990; Nation, 1999). However, not all children with autism show this unusual preoccupation with print, and some studies have tried to investigate phonological awareness in children with autism who are not hyperlexic.

In one study, Newman et al. (2007) used the Sound Awareness subtest from the Woodcock-Johnson Tests of Achievement– III (Woodcock, McGrew, & Mather, 2001) to examine reading-related skills of children with ASD, with and without a history of hyperlexia, and a control group of TD children matched on age and single word reading. The Sound Awareness subtest is a measure of phonological awareness that includes tasks of rhyming, sound deletion, sound substitution, and sound reversal within words. Between-group differences in performance on the sound awareness test emerged for the children with ASD. Those with ASD and a positive history of hyperlexia outperformed those with ASD and no history of hyperlexia on the phonological awareness tasks, indicating stronger phonological analysis skills in the hyperlexia group. The children with ASD who had no history of hyperlexia performed at significantly lower levels than the group with ASD/hyperlexia and the TD children on the tasks.

Gabig (2010) further studied phonological awareness skills in 14 school-aged non-hyperlexic children (five to seven years old) with Autism using elision and sound blending tasks from the comprehensive test of phonological processing (CTOPP). The children's performance on the phonological awareness tasks was compared to the performance of 10 typically developing (TD), age-matched children. Despite having adequate single word reading ability, the children with Autism displayed phonological awareness skills that were weaker than those of the TD children. For TD children, a strong, positive relationship between their single word reading ability and phonological awareness skills was noted. However for children with autism, word reading did not appear to be related to phonological awareness.

Other studies within this area have explored the phonological awareness (PA) skills of children with ASD as part of a larger battery of language and literacy-related measures. In one such study, the phonological awareness skills of children with ASD were measured pre- and post-training as a means of exploring the effectiveness of a computer-based literacy teaching program (Heimann, Nelson, Tjus, & Gillberg, 1995). Pre-training phonological awareness assessments demonstrated that both the ASD and the mixed handicap groups had phonological awareness skills that were significantly poorer than those of the TD children. However, the children with ASD were among the only participants whose mean phonological awareness scores actually decreased following the computer training intervention. Unfortunately, as PA skills were not the main focus of the study, no explanation for this finding was offered.

Taking into account the limited findings from these studies, it would appear that children with autism who do not have hyperlexia obtain lower scores on measures of phonological awareness than their typically developing peers. However, none of these studies have investigated the relationship between phonological awareness and other linguistic abilities, the potential existence of subgroups with impaired or spared phonological processing, or the relationship between phonological processing and levels of symptom severity.

Another important aspect of phonological processing that has been studied extensively in the Western world, and has had a great effect on how the language deficit in children with autism is categorized (especially in relation to its overlap with SLI) is phonological memory. Phonological memory refers to the use of phonological codes for short-term storage of language based information (Neath, 1999). Phonological memory is believed to consist of two components that work together. The first component is a phonological store that can be thought of as a "tape recording loop that continuously records the most recent two seconds worth of auditory information that has been processed" (Naglieri, 2009, p.512), and the second component is an articulatory control process that can provide input to the phonological store and can refresh its content so that information can be stored for longer than two seconds. Tasks in which participants are asked to repeat non-words (as used by Kjelgaard & Tager-Flusberg, 2001) are particularly sensitive to phonological memory deficits, as affected individuals cannot draw on previous experience to help them complete the task. Non-words are composed of random phonemes and follow rules of standard English phonology and stress patterns. Although these words sound quite similar to existing English words, they are different enough to discourage the use of other strategies besides phonological memory. Children with language deficits, for example those with Specific Language Impairment (SLI), are typically able to repeat short non-words accurately but show performance decays with non-words of three or more syllables. Such results suggest that their difficulty is in holding novel phonological material in memory, rather than in basic aspects of perception and production (Bishop, 2008). A deficit in phonological memory is typically seen in children with SLI and dyslexia (Torgesen, 1996), and measures of non-word repetition serve as important markers of the symptoms of SLI.

Language-impaired children with autism also show poor non-word repetition. Kjelgaard and Tager-Flusberg (2001) administered a range of language tests to a large group of children with autism aged between four and 13 years. Participants were divided into normal, borderline and language-impaired groups on the basis of their performance on the Clinical Evaluation of Language Fundamentals-III (Semel, Wiig, & Secord, 1995).The results showed that the language-impaired subgroup was characterized by broad deficits in syntactic and semantic ability. However, the most striking finding was the poor performance, revealed in both the borderline and language-impaired groups, on a task of non-word repetition. This deficit is believed to be a defining feature of the SLI phenotype (Tager-Flusberg & Cooper, 1999).

Other studies have revealed a similar deficit in in children with autism. In one study, Gabig (2008), examined verbal working memory and language ability in 15 school-age children with autism using three verbal working memory tasks and one story recall task. The CTOPP was used as a measure of verbal working memory, its sub-components non-word repetition, memory for digits, and sentence imitation, were given to children with autism and age-matched controls. Verbal working memory measures were chosen to reflect increasing levels of cognitive-linguistic complexity. Story retelling was measured using The Renfrew Bus Story (Cowley & Glasgow, 1994) and was scored for the percentage of propositions recalled and the average utterance length. A profile of verbal working memory deficits was seen in children with autism, with poorer performance on more complex verbal memory tasks. The results also showed that performance on the three verbal memory tasks was independent of articulation ability. For the group with autism, receptive vocabulary was positively associated with sentence imitation and story recall but not with non-word repetition or digit span.

Botting and Conti-Ramsden (2003) used the Recalling Sentences subtest of the revised edition of the Clinical Evaluation of Language Fundamentals (CELF-R; Semel, Wiig, & Secord, 1987) in conjunction with measures of past tense use and non-word repetition to investigate differences in the language profiles of participants identified as having SLI, ASD, and pragmatic language impairment (PLI). Of the three measures used, the Recalling Sentences subtest was most accurate in differentiating the language abilities of the ASD group from controls. This finding suggests that the ability to repeat sentences may be sensitive in discriminating between language impaired children with ASD and language impaired groups without autism. Additionally, group comparisons indicated that results on the Children's Test of Nonword Repetition (Gathercole, Willis, Baddeley & Emslie, 1994) were significantly lower for children with SLI than all other groups. However the non-word repetition task failed to discriminate between the PLI group and ASD group. This might suggest different underlying mechanisms for the different disorders seen in children with SLI compared to that seen in children with ASD. Although children with ASD may be identified by language markers, performing fairly poorly on non-word repetition tasks (as in Kjelgaard & Tager-Flusberg, 2000), the majority might not have the same severe non-word repetition deficits as children with SLI.

Other studies have reported similar results in relation to the phonological memory deficit in children with autism. Whitehouse and Bishop (2008) carried out a comparison of language profiles, oral motor skills, and autism-related behaviors in a group of children with SLI and groups of children with autism and normal language (Aapp) and autism and structural language difficulties (Apoor). Results revealed that although there were some similarities in the language profiles of the SLI and Apoor autism groups, the two groups differed on the tests of oromotor ability and verbal short-term memory as well as showing a different pattern of errors on the non-word repetition task. These findings provide evidence against the idea of an SLI subtype in autism. On the basis of further analyses, Whitehouse and Bishop suggested that the non-word repetition deficits in some children with autism may arise when there is substantial impairment in multiple autistic domains, since deficits in non-word repetition and structural language were seen in children with the highest level of symptom severity.

Looking at the link between language difficulties and autism from an alternative perspective, and of relevance to the third aim of the current study, Leyfer, Tager-Flusberg, Dowd, Tomblin and Folstein (2008) set out to explore the extent to which specific clinical features of autism could be observed in children with SLI. They directly compared groups of non-verbal intelligence matched children with autism and SLI using ADI and ADOS to test severity of symptomatology, and CTOPP and CELF-III, to test language. The results revealed significantly higher scores in the autism group compared with the SLI group on the expressive and receptive subscales of the CELF-III as well as on the Non-Word Repetition subtest of the CTOPP. Significant correlations between the receptive and expressive language subtest scores from the CELF-III did not correlate with the ADI-R and ADOS domain scores for either group. Moreover, no difference was found in the frequency of language deficits between the children with autism who scored at or above the cut-off on the ADI and ADOS social and communication domains. Most relevant for this thesis, the study did not demonstrate a relationship between the non-word repetition score on CTOPP and autism symptoms for the children with either autism or SLI.

As highlighted above, there are two contending hypotheses as to the nature of phonological memory deficits seen in children with autism. One the one hand, some researchers suggest that there is a subtype of children with autism who have a language impairment very similar to that seen in children with SLI, and that the non-word repetition deficit (being a strong clinical marker for SLI) reflects such shared etiology (Kjelgaard & Tager-Flusberg, 2001; Tager-Flusberg & Joseph, 2003). On the other hand some researchers suggest that such a difficulty might be due to the output demands of the task. These researchers posit that whereas the non-word repetition deficits in SLI result from genetic factors affecting memory mechanisms important for language, language difficulties in autism are associated with broader autistic symptoms (Whitehouse et al. 2007; Ronald et al. 2006). However, not all researchers agree on the effect of autistic symptoms on the language deficits as some work has shown a non-significant correlation between phonological processing deficits and symptom severity (Leyfer et al., 2008).

The heterogeneity within the language skills of children with autism is multifaceted. Research has clearly identified that there are correlations between measures of intellectual functioning as measured by the WISC/WISC-R or WPPSI (Wechsler, 1974) and language abilities (Howlin, Savage, Moss, Tempier & Rutter, 2013). Thus some of the heterogeneity in language skills in autism may reflect the significant variability in the cognitive abilities of these individuals. However, this correlation is difficult to interpret as a lack of association between language abilities and measures of IQ have been identified in smaller cohorts within the broader category of ASD (Kjelgaard & Tager-Flusberg, 2001). Previous research (Lindgren et al., 2008) has clearly identified the existence of linguistic subgroups in populations of children with autism and this has highlighted the variability of language skills in this disorder. Whilst it appears that there is a subgroup with close to normal language abilities there are also children who exhibit severe linguistic deficits (Bishop & Rosenbloom 1987; Bishop et al. 2000; Kjelard & Tager-Flusberg, 2001).

The identification of subgroups within broad diagnostic groups has prompted researchers to use new methods for identifying heterogeneity within these groups and to measure differences between emerging subgroups. Traditionally, group studies use language measures to compare the language profile of children with autism and their typically developing peers. However, such measures can mask the variability within the samples under comparison and some researchers are now using cluster analysis to investigate variability within samples of children with autism. Cluster analysis is a statistical tool which identifies subgroups, or clusters of participants within a larger group, based on their performances on relevant independent variables (Burns & Burns, 2009). One of the potential limitations of cluster analysis is that it will always identify clusters (Field, 2000) and it is important that the choice of clustering variables is motivated by theoretical considerations (Cornish, 2007).

The relationship between phonological awareness and phonological memory is theoretically and empirically supported. Therefore in the current study phonological awareness and phonological memory were the clustering variables used to explore the presence of subgroups in the children diagnosed with autism. Three previous studies have utilized cluster analysis to explore language subtypes in autism (Lewis, Murdoch and Woodyatt, 2007; Rapin, Dunn, Allen, Stevens & Fein, 2009; Harper-Hill et al., 2013). In the study by Lewis et al. (2007) language performance was compared across autism and typically developing groups and cluster analysis was then used to investigate the language profiles of the 20 child participants with autism. This cluster analysis was driven by the five linguistic index scores of the CELF-R (Semel et al., 1987). Whilst post hoc analysis identified statistical differences among clusters and broad descriptions of each cluster were provided, specific measures used in clustering and differences across clusters were not fully specified. In the study by Rapin and colleagues, the Photo Articulation Test, a measure of expressive phonology, was used in a cluster analysis of data from a sample of 62 children with a diagnosis of autism. Cluster analysis of test scores on expressive phonology and comprehension of words and sentences yielded 4 clusters. These were, Cluster 1 where phonology and comprehension were both low, Cluster 2 where phonology was low, and comprehension was near average, Cluster 3 where phonology was average and comprehension was low to low average, and Cluster 4 where phonology and comprehension was average or better. This cluster analysis supported two major types of language disorders in autism. These were driven by impaired expressive phonology, each divisible by comprehension ability. The results from the study appeared to discount a single language disorder in autism and were consistent with earlier-defined clinical subtypes (Rapin et al. , 2006)

Harper-Hill, Copland and Arnott (2013) extended the work carried out by Rapin et al. (2009) and Lewis et al. (2007) by conducting post hoc comparisons using individual subtests to drive the cluster analysis. They used the Children's Test of Non-word Repetition (Gathercole et al., 1994) and the CELF-4 recalling sentences subset as clustering variables to explore the possible existence of subgroups within a sample of 20 children with autism and 15 typically developing children. The initial group comparisons revealed no differences between children with autism and their typically developing peers on standard clinical assessments of language ability, reading ability or nonverbal intelligence. However, a hierarchical cluster analysis based on spoken non-word repetition and sentence repetition identified two clusters within the combined group of children with autism and controls. The first cluster (N = 6) presented with significantly poorer performances than the second cluster (N = 29) on both of the clustering variables in addition to single word and non-word reading. The significant differences between the two clusters were explained by increased language impairment and autistic symptomatology in cluster one. The comparison was enriched by contrasting symptom severity in the two clusters as well as the different linguistic measures which had not driven the initial cluster analysis. Such a method allowed for greater understanding of the variability within each group.

The first aim of the current study was to measure linguistic abilities in English speaking children with autism and their typically developing peers, all of whom lived in the Arab World. Phonological awareness and memory were assessed as part of the battery of standardized English language tests that addressed this aim. It was hypothesized that children with autism would differ significantly from their age and language matched peers on measures of phonological awareness and phonological memory. The second aim of the study was to examine the existence of subtypes within the total sample using phonological awareness and phonological memory as clustering variables. It was hypothesized that linguistic subgroups would emerge and that some children with autism would perform as well as their language matched and age matched peers, whilst some would show marked deficits in phonological processing. The third aim was to examine the relationship between the linguistic abilities tested in the study and symptom severity by directly comparing the results from the language (CTOPP) and diagnostic tests, as well as examining autistic symptomology in the clusters created. It was hypothesized that symptom severity would be correlated with performance on linguistic measures, namely phonological awareness and phonological memory.

In the current study, the CTOPP was used to assess phonological awareness and phonological memory in the sample. The CTOPP has been used to assess phonological skills in children with autism in the past (see above) and has been shown to be a reliable measure of elison, sound matching, blending words , memory for digits and non-word repetition in this group. A comprehensive review of all studies, published from 1997 to the present day, that have used CTOPP as a measure of phonological ability in children with autism is presented in table 4-1. Google Scholar and PSYcINFO were used to inform this review, and key words included: CTOPP, autism and phonological processing. This search identified 147 results. A study was included in the table if it examined phonological abilities in children with autism compared to a control group(s). Many studies have used the CTOPP to establish diagnostic criteria or for matching purposes. These studies were not included in the table. Neither were studies where the CTOPP had been used to test the relatives of children with autism rather than the children themselves.

Table 4-1 Studies using the CTOPP to measure phonological processing in children with autism

Study	**Group Size**	**Study group**	**Comparison group**	**Age range**	**Tests used**

Newman et al. (2006)	41	ASD + HPL* , ASD - HPL†	AMC	3yrs-19:11yrs	CTOPP† , WJ-III†*, TVP-III†
Gabig (2008)	15	ASD*	AMC	5yrs-7:11yrs	PPVT* , CTOPP*, TOLD-P
Leyfer et al. (2008)	88	ASD*	SLI	6yrs-16yrs	CELF-III* , CTOPP*
Lindgren et al. (2009)	88	ASD + Li* , ASD – Li†	SLI	6yrs-16yrs	CELF-III† , CTOPP† , PPVT-III† , WJ-R*†
Smith-Gabig (2010)	14	ASD*	AMC	5yrs-7yrs	CTOPP*, WIST
Bartlett (2012)	55	ASD*	SLI	6yrs-15yrs	CTOPP* , CELF, CASL, WASI

Note: * † denotes significant differences found between groups on a standardized test

ASD + HPL- Autism Spectrum disorder with Hyperlexia; ASD – HPL -Autism Spectrum disorder without Hyperlexia; CASL - Comprehensive Assessment of Spoken Language; CTOPP - Comprehensive Test of Phonological Processing; CELF – Clinical Evaluation of Language Fundamentals; WASI - Wechsler Abbreviated Scale for Intelligence

RESULTS

Examining differences in Phonological Processing in Children with Autism and Controls

The means and standard deviations for standard scores on the CTOPP phonological awareness and phonological memory subsets for children with autism and controls are shown in table 4-2 below. All data were checked for normality using the Kolmogorov–

Smirnov test and revealed no violations of normality. All children were able to complete the test so no data were excluded from the analysis. No outliers were detected in the analysis.

Table 4-2 Results on the two subtests of the CTOPP, table shows means, (S.D) and *range* on each of the different subtests

	Phonological Awareness				Phonological Memory		
	Total*	Elison*	Sound Matching *	Blending words*	Total*	Non-word repetition *	Memory for digits*
Autism (n = 22)	88.8 (6.9) *73.5 - 95.5*	5.8 (2.6) *4.2 – 8.9*	6.0 (3.4) *4.5 – 9.3*	5.5 (2.8) *3.2 – 8.4*	79.4 (7.2) *68.5 – 90.5*	6.75 (.88) *5.2 – 8.5*	7.35 (.98) *5.8 – 9.6*
Lang Match (n = 16)	92.9 (6.4) 86.5 – 106.5	7.0 (1.6) 7.0 – 11.0	8.0 (2.1) *5.5 – 10.0*	8.5 (1.9) *6.0 – 9.0*	94.4 (8.2) *80.0 – 106.0*	8.58 (.79) *6.0 – 10.0*	9.01 (.83) *6.5 – 11.5*
Age match (n = 22)	98.0 (6.6) *83.5 – 107.5*	7.9 (1.8) *7.1 – 12.2*	8.8 (2.9) *6.0 – 10.5*	9.1 (2.4) *6.0 – 11.8*	97.2 (6.4) *82.0 – 107.0*	9.36 (.99) *7.5 - 11.5*	9.98 (.85) *8.0 – 12.0*

*significant differences were found here at p <.05 level

The phonological awareness and phonological memory data were analysed separately using a one way ANOVA, with group as the between subject variable. For the phonological awareness total score, there was a significant main effect of group F (2,32) = 38.24, $p < .001$. A post hoc tukey test revealed that children with autism performed at a significantly lower level than both age matched controls (p <.001) and language matched controls (p <.001). The performance of the two control groups did not differ (p =.89). The phonological memory total scores were analysed using a one way ANOVA, with group as the between subject variable, and this revealed a significant main effect of group F

(2,53) = 45.10, $p < .001$. As with the phonological awareness analysis, a post hoc Tukey test revealed that children with autism performed at a significantly lower level than both the age matched and language matched controls ($p < .001$). The performance of the two control groups did not differ ($p = .95$).

Further analyses, breaking down the total phonological awareness and total phonological memory scores into their individual components, revealed that the main effect of group reported above was seen across all three subtests. Children with autism differed from their age and language matched controls on the three subtests measuring different phonological processes. A mixed repeated measures ANOVA was conducted to measure the difference in performance between the subtests with group as the between factor, and phonological awareness subtests as the repeated measures factor with three levels: Elison, sound matching, and word blending. Both typical control groups were collapsed as one, since no difference was shown in the analysis above. Mauchly's test was non-significant so sphericity was assumed. Tests revealed a significant within-group effect F (2,106) = 23.538, $p < .001$, np^2=.308 and the group by subtest interaction was non-significant F (2,53) = .406, $p = .669$, np^2=.015. Whilst the autism group performed at lower levels than controls, the pattern of performance across subtests did not differentiate the three groups.

For the phonological memory subtests, a mixed repeated measures ANOVA was also conducted to measure the difference in performance between the subtests with group as the between groups factor, and phonological memory subtests as the repeated measures factor with two levels: non-word repetition, and memory for digits. Tests revealed a significant within-group effect F (1,53) = 8.603 , $p < .05$, np^2=.14 and the group by subtest interaction was non-significant F (2,53) = .106, p = .901, np^2=.004. As was the case for the phonological awareness subset, the pattern of performance across the phonological memory subtests did not appear to differentiate the three groups.

Examining the Existence of Subgroups in relation to Phonological Processing

In order to address the second aim of this thesis a cluster analysis was conducted to identify any subgroups within the autism sample. Matching the approach taken by Harper-Hill et al. (2013), the cluster analysis was carried out on the data from the total sample of children with autism and typical development. In the cluster analysis approach each isolated case is initially considered as a cluster after which the two cases with the highest similarity are clustered together to form a new cluster. The distance between this newly formed cluster and other cases is then recalculated and the procedure repeated. Small clusters may be clustered together and eventually become larger clusters and even, ultimately, one cluster. In the analysis reported here, participants' standard scores on the phonological awareness (total score) and memory subtest of the CTOPP were used to create the cluster analysis. These variables are referred to as clustering variables.

Matching the approach taken by Harper-Hill (2013) the final cluster solution was based upon the following parameters: two-step cluster analysis using Schwarz's Bayesian Criterion (BIC), the log-likelihood distance measurement, and automatic generation of the optimum number of clusters. Both the autism group and the control group data were included in the cluster analysis. The results indicated an optimum two-cluster solution as indicated by the BIC. The first of the two identified clusters (cluster 1) compromised 44 participants (73.2% of the whole group), while the second cluster (cluster 2) compromised 16 participants (26.8% of the whole group). Table 4-3 details the groups.

Table 4-3 Details of the number of children in each of the clusters formed

	N	Autism	Language match	Age match
Cluster 1 (CTOPP high)	44	6	16	22
Cluster 2 (CTOPP low)	16	16	-	-

Consideration of the CTOPP scores of the resulting two clusters revealed that one cluster (Cluster 1) had a higher mean score on the phonological awareness and phonological memory subsets of the CTOPP (henceforth this cluster will be referred to as CTOPP high cluster). The other cluster (Cluster 2) had a lower mean score on the phonological awareness and phonological memory subsets of the CTOPP (henceforth this cluster will be referred to as CTOPP low cluster). The CTOPP high cluster was comprised of children from all three groups. Thus, as anticipated, some of the participants with autism are clustered alongside their age and language matched peers and appeared to have similar phonological abilities. However the second cluster, CTOPP low cluster, is compromised only of children with autism. The symptom severity data for the six children with preserved phonological processing were then considered and are shown in table 4-4.

Table 4-4 shows symptom severity, phonological awareness, phonological memory, adaptive language and adaptive social skills (the latter two measured by the Vineland) profiles for the six children with autism who had been grouped into the CTOPP high cluster in the analysis.

Table 4-4 Individual profile of the six children that made it into the CTOPP high shows standard scores of GARS, CARS, phonological awareness (PA) and phonological memory (PM) subset standard score on the CTOPP and standard scores on the Language and social subsets on the Vineland

Child No.	GARS	CARS	PA	PM	Vineland	
					Lang	Social
1	88	40	95.5	82.5	31	20
2	85	30	93	80	18	25
3	75	33	84.5	88.5	24	33
4	125	42	78.5	90.5	21	14
5	100	38	83.5	90	16	30
6	80	32	91.5	82.5	28	28

SPSS offers a Predictor Importance view, which shows the relative importance of each clustering variable in estimating the model. This indicates how well the variable can differentiate different clusters. The higher the importance measure, the less likely the variation for a variable between clusters is due to chance and more likely due to some underlying difference (Field, 200).The predictor importance chart indicates the relative importance of each predictor in estimating the model. Since the values are relative, the sum of the values for all predictors on the display is 1.0. The range is between 0 – 1 and a variable that has a 1.0 predictor importance is considered an important variable in determining the clusters. With the aid of this view, the phonological memory achieved an importance of 1.0 and the phonological awareness subset achieved an importance of 0.8 in the predictor importance view.

Examining Symptom Severity in Relation to Language Abilities

In order to address the third aim of this thesis that examines the relationship between phonological processing and measures of symptom severity, a one way ANOVA was then conducted to compare the effect of cluster membership on performance on diagnostic tests, measures of standardized assessment of phonological processing, parental report of language ability (Vineland) and a measure of language and social functioning. The results from this analysis are shown in Table 4-5.

Table 4-5 Comparison between clusters of performance on diagnostic tests, measure of functioning , and measures of phonological processing

Sub/test	Clusters				Comparison	
	Cluster 1 (CTOPP High)		Cluster 2 (CTOPP Low)		df = (1 , 59)	
	M	SD	M	SD	F	Significance
GARSss	60.6	21.1	97.8	23.0	16.15	<.001
CARSss	19.2	7.5	34.3	10.1	16.61	<.001
PA	97.7	5.6	81.5	5.0	21.12	<.001
PM	96.6	6.2	70.3	5.0	21.24	<.001
Vineland Lang	36.4	10.5	26.2	7.3	20.73	<.001
Vineland Social	39.9	7.6	23.9	9.4	13.3	<.001

PA – Phonological Awareness
PM – Phonological Memory
GARSss – GARS standard score
CARSss – CARS standard score

It appears, from table 4-5 that CTOPP high and CTOPP low clusters differ on symptom severity. However it was relevant to consider whether one or more particular subsets of the GARS or the CARS drove the difference between the clusters. A one way ANOVA was conducted to compare the effect of cluster membership on the performance on subtests of diagnostic tests GARS and CARS. There was a significant effect of cluster membership on all dependent variables as shown in table 4-6. In the comparison section the table illustrates the F value and significance. In the GARS, Social interaction shows the highest F value, followed by communication and stereotyped behaviors were the most affected. This might indicate that since communication and social interaction scores were higher than stereotyped behavior scores, increased severity in these areas might contribute to lower CTOPP scores. In the CARS, the highest F value is shown in the nonverbal communication subtest, followed by verbal communication and social understanding.

Table 4-6 Standard Scores on the GARS and CARS and their subtests difference between CTOPP high and CTOPP low

Sub/test	Clusters				Comparison df = (1 , 59)	
	Cluster 1 CTOPP high		Cluster 2 CTOPP Low			
	M	SD	M	SD	F	Significance
GARSss :	60.6	21.1	97.8	23.0	16.15	<.001
Social Interaction	2.64	3.53	9.16	3.91	25.17	<.001
Communication	2.45	3.03	9.05	4.33	21.24	<.001
Stereotyped behavior	1.62	2.33	7.75	3.48	20.11	<.001
CARSss :	19.2	7.5	34.3	10.1	16.61	<.001
Relating to people	1.54	.64	2.53	.85	8.17	<.001

Social understanding	1.44	.61	2.38	.71	14.67	<.001
Emotional Regulation	1.55	.59	3.00	.75	14.11	<.001
Adaptation to change	.96	.31	2.01	.96	6.87	<.001
Visual response	.85	.40	3.10	.93	6.52	<.001
Listening response	.75	.32	2.98	.71	8.10	<.001
Fear or Anxiety	.73	.21	1.95	.75	5.03	<.001
Nonverbal communication	1.03	.81	3.23	.97	15.47	<.001
Verbal Communication	1.58	.74	2.56	.79	11.97	<.001
Level of intellectual response	1.18	.41	2.07	.87	9.87	<.001
Object use in play	1.01	.66	2.28	.75	10.47	<.001

GARSss – GARS standard score
CARSss – CARS standard score

Since the phonological memory subset was the most important clustering variable it was interesting to see what the clusters would look like based solely on phonological memory performance. Therefore further analysis was conducted and raw scores of non-word repetition and memory for digits subsets from the CTOPP were the clustering variables chosen. Both the autism group and the control group data were included in the cluster analysis. The results indicated an optimum two-cluster solution as indicated by the BIC. The first of the two identified clusters (cluster 1) comprised 27 participants (41.2% of the whole group), and the second cluster (cluster 2) comprised 29 participants (51.8% of the whole group). Consideration of the phonological memory scores of the children allocated to each cluster showed that cluster 1 had a higher mean on the phonological memory subsets of the CTOPP (henceforth, PM High), while Cluster 2 had a lower mean on the phonological memory subsets (henceforth, PM low). The PM high cluster was comprised of children from all three groups. Thus, as anticipated, six children with autism are clustered alongside their age matched and language matched peers and appeared to have similar phonological abilities. The second cluster, PM low cluster was also compromised of children from all three groups, thus some children from the language and age matched groups performed as badly as children with autism on the phonological memory subtest. Table 4-7 below shows performance on the GARS and CARS (standard scores), CTOPP subtests (raw scores) and Vineland adaptive language and social scales (raw scores) for the one child with autism who was included in the Phonological Memory high cluster.

Table 4-7 Performance of the one child with autism that was included in PM high group on diagnostic measures, CTOPP subtests and Vineland language and social scales

Child No.	GARS	CARS	PA	PM	NWR	Vineland	
						Lang	Social
1	125	42	78.5	90.5	8.5	21	14

A one way ANOVA was then conducted on the data from the whole group to compare the effect of cluster membership on performance on diagnostic tests, measures of standardized assessment of phonological processing, parental report of language ability (Vineland) and a measure of language and social functioning. As can be seen from table 4-7, there was a significant effect of cluster membership on all dependent variables at the p <.001 level F (1, 21) = 33.1, p < .001.

Table 4-8 Comparison between clusters of performance on diagnostic tests, measure of functioning , and measures of phonological processing

Sub/test	Clusters				Comparison
	Cluster 1 (PM Low)		Cluster 2 (PM High)		
	M	SD	M	SD	Significance
GARS	90.5	24.0	48.2	19.0	<.001
CARS	31.9	10.1	17.3	6.3	<.001
PM	80.7	7.0	98.7	5.1	<.001
Vineland Language	25.6	8.7	42.6	7.6	<.001
Vineland Social	27.5	8.7	41.8	8.9	<.001

PM – Phonological Memory

In order to further examine the relationship between symptom severity and linguistic measures, figure 4-1 shows a simple scatterplot exhibiting the relationship between measures of phonological awareness, phonological memory and performance on the GARSss and CARSss. Scatterplots showing relationship between phonological awareness composite and GARSss (above) CARSss (below) and phonological memory composite and GARSss (above) CARSss (below), the vertical dotted line indicates the cut off point for GARS and CARS for the possibility of autism. The horizontal dotted line indicates the cutoff score for weak phonological processes as detailed in the CTOPP manual.

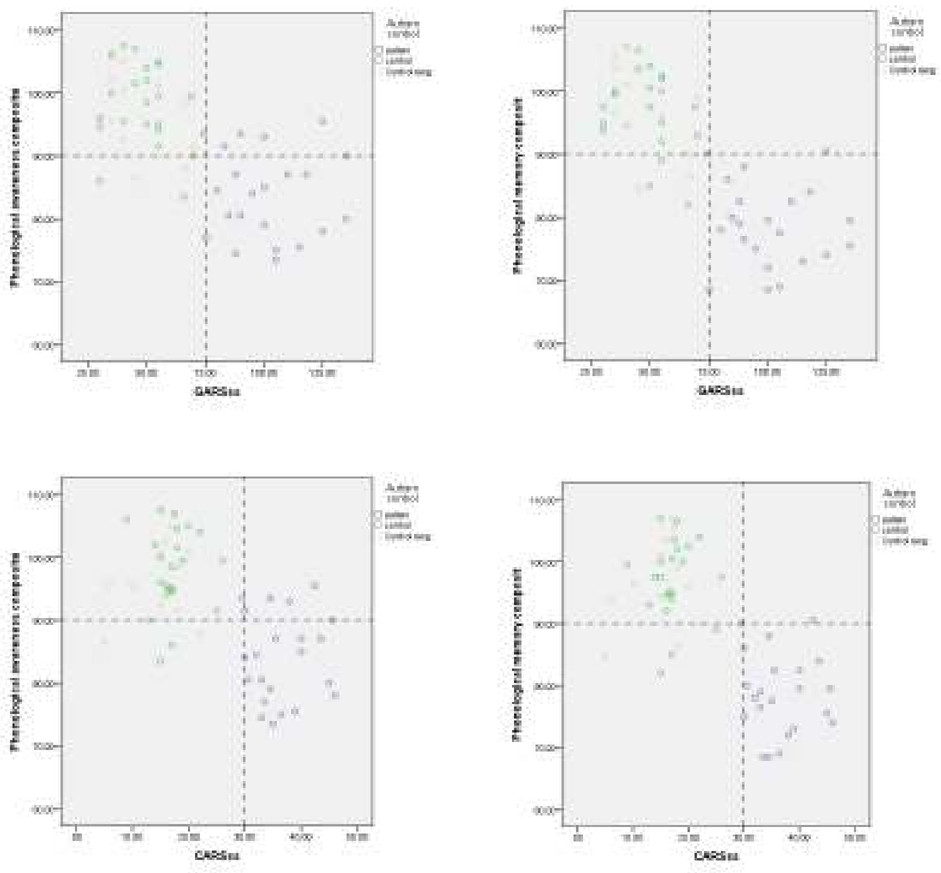


Figure 4-1 Scatterplots showing relationship between symptom severity as measured by the CARSss and the GARSss and a) phonological awareness composite b) phonological memory composite, vertical dotted line indicates the cut off point for GARS and CARS for the possibility of autism. The horizontal dotted line indicates the cutoff score for weak phonological processes as detailed in the CTOPP manual

To examine the relationship further, bivariate correlations were carried out to identify the relationship between symptom severity in children with autism and their performance on the measures of phonology, namely phonological awareness and phonological memory. The analyses were conducted using the Pearson product-moment correlation coefficient. The Bonferroni adjustment to the alpha value (α/No. of comparisons) resulted in α = .006. Table 4-9 shows a correlation matrix that examined correlations between raw scores on the phonological awareness subsets and standard scores on the GARS and CARS. Also, it shows the correlation between raw scores on the phonological memory subset and the standard scores on the GARS and CARS.

Table 4-9 Correlation matrix among the phonological awareness subtests , phonological memory subtests raw scores and the GARSss and CARSss

	Phonological Awareness Total	Elison	Sound Matching	Blendin g words	Phonological Memory Total	Non-word repetition	Memory for digits	GARSss	CARSss
Phonological Awareness Total	1	.43**	.52**	.38**	.32*	.24*	.30*	- .03	-.01
Elison		1	.41*	.51*	.12	.17*	.10	-.05	-.13
Sound Matching			1	.14**	.31**	.24*	.17*	-.03	-.08
Blending words				1	.43*	.39*	.20*	-.16	-.16
Phonological Memory Total					1	.32*	.54**	- .07	-.04
Non-word repetition						1	.21**	-.24*	-.25
Memory for Digits							1	-.17	-.14
GARSss								1	.49**
CARSss									1

* = p < .05 , ** = p < .001

Results revealed non-significant correlations between performance on the phonological awareness subtest and diagnostic measures of GARS and CARS. Moreover, none of the phonological awareness subtests were significantly correlated with these diagnostic measures for the children with autism.

Results also revealed non-significant correlations between performance on the phonological memory subtest and diagnostic measures of GARS and CARS. Furthermore, the memory of digits subtest of the phonological memory test showed no correlation with diagnostic measures. However, interestingly non-word repetition was significantly correlated with GARSss (r = .24 , $p < .01$).

To examine the relationship between non-word repetition and symptom severity further, non-word repetition raw scores, GARSss and CARSss scores were converted into z-scores for ease of comparison. Fig 4-2 shows the z-scores of these measures together. The x-axis shows the child's case number and the y-axis shows the z-scores. It is worth noting that a high level of difficulty is reflected by a low Z-score (below the mean and therefore showed a minus z-score) on the non-word repetition subset whereas high symptomatology is reflected in high CARSss and GARSss scores (a positive z-score)

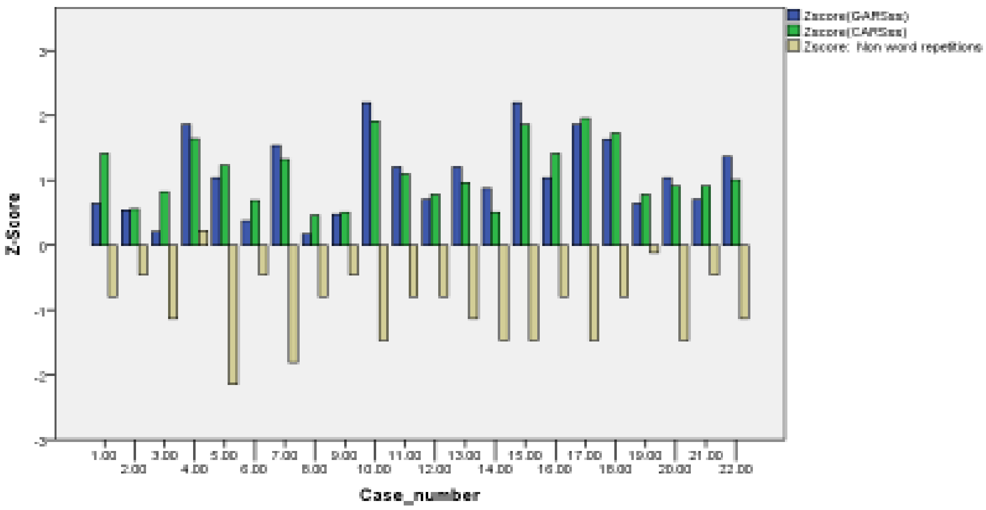


Figure 4-2 Z-scores of raw scores on the non-word repetition subtest of the CTOPP as well as GARSss and CARSss

DISCUSSION

The aim of this study was to compare children with autism and typical development on measures of phonological processing. It was hypothesized that children with autism would perform at significantly lower levels than their age matched and language matched typically developing peers when tested using standardized assessment tests that measure phonological awareness and phonological memory processes. To date no studies have examined the language abilities of English speaking children in the Arab world and this is the first study to apply western research methods to address his problem.

Western studies of phonological processing have typically investigated phonological awareness and phonological memory. Research into phonological awareness in autism has focused mainly on skills implicated in reading ability. Whilst this work has revealed intact phonological awareness in children with autism and co-occurring hyperlexia (Newman et al., 2007), those without hyperlexia generally obtain phonological awareness scores that are lower than those obtained by typically developing peers (Gabig, 2010). However, none of these studies have assessed phonological awareness skills in relation to other linguistic abilities, looked for phonological awareness subtypes or measured such skills against symptom severity.

In the current study, the children with autism performed at significantly lower levels than their age and language matched peers on phonological awareness tasks, including elison, sound matching and blending words and the results were consistent with studies carried out in the West.

In contrast to phonological awareness, phonological memory skills have been widely studied in autism. One reason for this may be that a phonological memory deficit, as measured by the nonword repetition task appears to be a psycholinguistic marker of the SLI phenotype (Bishop et al., 1996; Conti-Ramsden et al., 2001; Tager-Flusberg & Cooper, 1999) and is regarded as a core feature of SLI and researchers have been interested in linking the language deficit in SLI to that observed in some children with autism. This evidence has led a number of researchers to suggest that poor nonword repetition may act as a psycholinguistic marker of the SLI phenotype (Bishop et al., 1996; Conti-Ramsden et al., 2001; Tager-Flusberg & Cooper, 1999) and Tager-Flusberg & Joseph (2003) have proposed that there is subtype of children with autism who show the same neurocognitive phenotype children with SLI.

The results from the current study were consistent with previous findings revealing a deficit in phonological memory in children with autism (Kjelgaard & Tager-Flusberg, 2001; Gabig, 2008; Bishop, 2008). The children with autism obtained lower scores than both age and language matched groups and this highlights the extent of this difficulty in autism.

One important strand of previous work into phonological memory in autism has focused on identifying subgroups. Two contending hypotheses arise as to the nature of phonological memory defects seen in children with autism. On the one hand some researchers suggest that there is a subtype of children with autism who have a language impairment very similar to that seen in children with SLI, and that poor non-word repetition performance reflects such etiology (Tager-Flusberg & Joseph, 2003). On the other hand, some researchers suggest that such a difficulty might be due to output demands of the tasks. These researchers posit that the deficit in non-word repetition seen in children with autism and SLI is both different in nature and in cause, and that in autism it is directly related to autism symptomology (Whitehouse et al., 2007; Ronald et al., 2006).

Cluster analysis methods, carried out on the whole participant sample, were conducted in order to explore the existence of subgroups in the autism group. The results reveled the existence of CTOPP low and CTOPP high clusters. Whilst the CTOPP low cluster only included children with autism, the CTOPP high cluster included six of the 22 children with autism as well as children from the language and age matched control groups. These children had normal phonological memory abilities, and were clustered alongside their age and language matched peers. Although the autistic children in the CTOPP high cluster group also performed well on the phonological awareness tasks, phonological memory was most important in differentiating participants in the two clusters.

Differences between clusters revealed also significant differences in measures of symptom severity, and adaptive scales (Vineland social and language). Children in the CTOPP high cluster obtained lower skills on measures of symptom severity than the children in the CTOPP low cluster. However, a potential limitation of cluster analysis is that it will always identify clusters, and researchers who make claims about those same constructs that were used to create the clusters in the first place run the risk of tautological reasoning. Thus extra care should be taken when drawing conclusions from such a method. However, the fact that six out of the 22 children with autism were able to perform similarly to their age matched and language matched peers on a standardized measure of phonology assessment, does in fact offer an important insight into the language deficit seen in children with autism. Further analysis of the difference between the two clusters also enabled the comparison of their performance on measures of symptom severity. This showed that the GARS social interaction measures showed the highest difference between the two clusters followed by communication and stereotyped behaviour. This might indicate that since communication and social interaction scores were higher than stereotyped behavior scores, higher severity in these areas might contribute to lower CTOPP scores. In the CARS, the highest F value was in the nonverbal communication subtest, followed by verbal communication and social understanding. This might indicate that since nonverbal communication and verbal communication have the highest F values, higher severity in these areas might contribute to lower CTOPP scores.

Another aim of this study was to measure performance on standardized assessment measures against symptom severity where it was hypothesized that symptom severity would be directly related to measures of phonological processing. Previous research looking at symptom severity in relation to phonological processing in children with autism has revealed mixed results. So whilst some studies have shown that phonological memory deficits, namely non-word repetition, may be associated with substantial impairment in multiple autistic domains (Whitehouse et al., 2008), other studies show that phonological memory deficits (namely non-word repetition) do not correlate with symptoms of autism. In the current study, measures of phonological memory were correlated with measures of symptom severity. The results from this study revealed non-significant correlations between performance on the phonological memory total and the memory for digits subtest and the GARS and CARS. However, interestingly non-word repetition scores were significantly correlated with the GARS standard score but not with the CARS standard score. Although the phonological memory subtest and memory for digit subset compose the phonological memory subset individually they show different correlations with the GARS. This might be due to the fact that performance on the memory for digits subset masked the correlation between symptom severity on the GARS standard score and phonological memory as measured by non-word repetition.

Whilst this was the first study to use English tests of phonological processing with children with autism based in the Arab world, the results are broadly consistent with previous studies carried out in the West. The results confirmed the hypothesis that children with autism do differ from their age and language matched peers on phonological processing measures. However, results from a cluster analysis showing that some children with autism perform as well as their age and language matched peers on phonological processing tasks, are consistent with research identifying language subgroups within the autism spectrum. Finally, such performance did not correlate with symptom severity, although the non-word repetition subtest of the CTOPP did show a weak correlation with the GARS standard scores only and not with the CARS standard scores.

The following section will adopt a similar approach to investigate lexical processing, in autism and typical development.

LEXICALPROCESSING IN CHIDLREN WITH AUTISM

Lexical processing is one of the first aspects of language that the typically developing child acquires (e.g. Brown, 1973; Pinker, 1990). It is a set of processes that operate automatically to support the acquisition, production and recognition of spoken and written words (Altmann, 2001; Forster, 1990; Pinker, 1990; Yelland, 1994). The lexical processing system has at its core a memory system for storing the child's developing vocabulary (the lexical memory) (Oldfield, 1966; Yelland, 1994), and a set of processes for automatically storing and retrieving words from lexical memory (the lexical processors) (Atchison, 1987; Forster, 1990; Yelland, 1994). In the typically developing child the acquisition of vocabulary is relatively slow until around 24 months, when the child experiences a period of rapid development (Brown,1973; Pinker, 1990). Traditionally, lexical memory is thought to store a representation of the phonological structure (pronunciation), and the semantic (meaning) and syntactic properties of each word (Atchison, 1987; Forster, 1990; Yelland, 1994).

In children with autism, the second year of life marks the time when parents typically begin to show concern regarding their children's inability to produce words (Perkins, Dobbinson, Boucher, Bol & Bloom, 2006). However, amongst children subsequently diagnosed with autism, or ASD, some do not show any significant delay, some develop early language skills that then regress and some begin to speak late and develop speech at a significantly slower rate than typically developing children (Pickles, Simonoff, Conti-Ramsden, Falcaro, Simkin & Charman, 2009).

Whilst lexical processing has yet to be studied in children with autism who live in the Arab World, a number of such studies have been carried out in the West. Although this work has revealed great variability in lexical skills in autism, a number of studies have shown that intellectually high-functioning individuals (HFA) often acquire large vocabularies (Jarrold et al., 1997; Lord & Paul, 1997; Saldana, Álvarez, Lobatón, Lopez, Moreno & Rojano 2009), and consistently perform at age appropriate levels on standardized tests of vocabulary (Jarrold et al., 1997; Tager-Flusberg, 2001), single (written) word recognition and reading accuracy tests (Minshew, Goldstein, Taylor & Siegel, 1994).

A second strand of research has looked at the degree with which symptom severity is associated with lexical processing in children with autism. Prior, Leekam, Ong, Eisenmajer, Wing, Gould and Dowe (1998) were one of the first research groups to apply empirical clustering methods to reported symptoms and behaviours of children with autism. In their study of 135 children with varied autistic symptoms, verbal ability and age were selected as variables in the cluster analysis. The aim of the study was to discover whether they could identify a subgroup of children with Asperger Syndrome, or with other related disorders such as Pervasive Developmental Disorder- Not otherwise specified (PDD-NOS), using such empirical methods. The Peabody Picture Vocabulary Test – Revised, (Dunn & Dunn, 1993) (PPVT-R) was used to obtain a verbal mental age (VMA) and a standard score for receptive vocabulary language skills, while the "Sally-Anne" task (Baron-Cohen, Leslie & Frith, 1985) and the "Box of Smarties" task (Perner, Leekam & Wimmer, 1987) tasks were used to test theory of mind. "Second order" theory of mind was also tested using Perner and Wimmer's (1985) ice cream story paradigm. The Autism Spectrum Disorder checklist (Rapin, 1996) was used to measure the symptomatology of the children in the cohort. Cluster analysis based on autistic symptoms revealed three groups with varied percentages of autism symptoms: Cluster A included individuals described as autistic-like, cluster B included individuals described as Asperger-like and cluster C included individuals described as mild PDD-NOS.

Cluster A cases had the most frequent “autism-like” responses followed by clusters B and C. Additionally, cluster A cases had significantly lower PPVT standard scores and VMA and were more likely to show problems in communication and social interaction domains on the symptom checklist. The participants in cluster A also performed at lower levels than clusters B and C on “first order” theory of mind tasks, but not on “second order” theory of mind tasks. This study was one of the first to relate symptomology to verbal ability and theory of mind behaviours, and its results highlighted the associations between autistic symptomology and language development and use in these children.

Utilising similar methods, Stevens et al. (2000) conducted a longitudinal study aimed at identifying preschool behavioral, linguistic, and cognitive variables that would predict school-age outcome in 194 children with autism. Cluster analysis was used to explore empirical subtypes in the sample of preschoolers, and to determine the degree of overlap between preschool and school age group membership. In their study, non-verbal IQ as well as autistic symptomology was measured, along with receptive lexical skills as measured by the PPVT and adaptive skills as measures by the Vineland. These tests were administered twice, once at preschool age and again at school age. Cluster analysis suggested a division of the group into a low functioning cluster and a high functioning cluster. Three main variables were found to relate to group prediction. These were symptom severity (as measured by the Wing Autistic Disorder Interview Checklist, WADIC; social domain; Wing, 1985), PPVT (standard score) and the Vineland socialization domain (measuring social skills). School-aged clustering showed significant association with original level of functioning at the preschool stage. Most of the children in the low functioning cluster at preschool were still included in this cluster at school age testing and their language and social skills scores remained stable or had dropped significantly. At preschool age, the children in the lower functioning group showed significant abnormalities in all associated behavioural areas (social, communication and repetitive behaviours), as well as on cognitive and linguistic measures. Nonverbal IQ and social skills were moderately impaired and remained unchanged relative to peers. The development of language skills appeared to be arrested and actually declined relative to same-age typically developing peers. In contrast the children in the high functioning group showed highly significant gains as well as reductions in abnormal behaviours between preschool and school age. Whilst their linguistic and social behavioural abnormalities were almost equal to those of the lower functioning group at preschool, these had reduced by school age leaving only mild residual symptoms. For these children nonverbal IQ was within the average range at preschool and remained stable. PPVT scores and scores on the Vineland communication subset were mildly depressed at preschool but normalized by school age. This study provided important insights into the long term correlates of symptomology, as well as on the development of language and the progression of symptoms in children with autism.

Another study that looked at linguistic subtypes in children with autism was that of Kjelgaard and Tager-Flusburg (2001), who investigated language functioning in a group of 89 children diagnosed with autism. Along with other standardized measures the PPVT and the Expressive Vocabulary Test (EVT) (Williams, 1997) were used to measure lexical comprehension and expressive vocabulary, and the Clinical evaluation of language fundamentals (CELF) (Wiig, Secord, & Semel, 1992) was used to measure morphology, syntax and semantics. The scores on each of the language tests showed a wide variability among the children. To explore this variability three subgroups were created based on the children's PPVT scores: normal range, borderline (1 and 2 SD below the mean) and impaired (more than 2 SD below the mean). For each of these groups the pattern of scores on the EVT and IQ tests was examined. Children's EVT and IQ scores varied together and were lowest in the impaired group, closer to normal in the borderline group and highest in the normal group. A similar analysis was carried out on the CELF data, and revealed that the EVT and PPVT varied together and were lowest in the impaired group followed by the border line group and the normal range group. As a whole, children with autism showed no differences between receptive and expressive vocabulary knowledge on the CELF. Such results highlight the huge variability in the linguistic abilities of children with autism and suggest that articulation skills are spared but impairments are found in vocabulary and the higher order use of semantic skills. This study also revealed a subgroup of children with autism that performed within the normal range on linguistic measures of lexical skills, and this challenged claims that lexical deficits are universal in children with autism. Taken together, such studies suggest that lexical processing abilities vary markedly amongst individuals with autism and that this variation is influenced by levels of non-verbal IQ, adaptive functioning and/or symptom severity.

The first aim of the current study was to measure linguistic abilities in English speaking children with autism and their typically developing peers, all of whom lived in the Arab World. Lexical skills were assessed as part of the battery of standardized language tests that addressed this aim. It was hypothesized that children with autism would differ significantly from their age and language matched peers on measures of receptive lexical processing. The second aim of the study was to examine the existence of subtypes within the total sample using results on the PPVT as clustering variables. It was hypothesized that linguistic subgroups would emerge and that some children with autism would perform as well as their language and age matched peers, whilst others would show marked deficits in lexical processing. The third aim was to examine the relationship between the linguistic abilities tested in the study and symptom severity by directly comparing the results from the language (PPVT) and diagnostic measures, and examining autistic symptomology in the clusters created. It was hypothesized that symptom severity would correlate with performance on lexical processing.

In the current study, the PPVT was used to assess receptive vocabulary. The PPVT has been used to assess children with autism in the past (see above) and has been shown to be a reliable measure of receptive knowledge in this group. Table 4-10 below illustrates a comprehensive literature review of all studies that have used the PPVT as a measure of receptive lexical skills in children with autism. Studies were included from 1997- present. Google scholar and PSYc info were used to inform this review, and key words included: PPVT, autism, lexical processing and resulted in 450 results. A study was included in the table if it examined lexical processing abilities in children with autism compared to a control group(s). Many studies have used the PPVT to establish diagnostic criteria or for matching purposes. These studies were not included in the table below. Neither were studies where the PPVT had been used to test the relatives of children with autism rather than children with autism themselves.

Table 4-10 Studies using the PPVT to measure receptive lexical skills in children with autism

Study	Group Size	Study group	Comparison group	Age range	Tests used
Prior et al. (1998)	135	HFA	AS* PDD-NOS*	3yrs-21yrs	PPVT*
Stevens et al. (2000)	194	HFA	LFA*†	4yrs-9yrs (longitudinal)	PPVT* , VABS†
Kjelgaard & Tager-Flusberg (2001)	89	HFA	LFA1* , LFA2†	4yrs-14yrs	PPVT-III*†, EVT*†, GF*†, CELF-III*†, & RNW*†
Condouris et al. (2003)	44	ASD	ND*	4yrs-14yrs	PPVT-III* , CELF* , EVT* , MLU*
Browder et al. (2008)	24	SID , ASD	SID-A* , ASD-A†	4yrs-7yrs	PPVT-III*† , WLPB*†
De Pape et al. (2012)	12	ASD	AMC*	17yrs-34yrs	PPVT-III*
McGregor et al. (2012)	47	ASD	AMC*,SMC† , SLI⋆ ,ASDLI ®	9yrs-14yrs	PPVT-III†®⋆ , EVT-2†®⋆, CELF†®⋆
Mayo & Eigsti (2012)	41	ASD	AMC*	7:7yrs-17:2yrs	PPVT-III, EVT-2, CELF-4 ,
Kover et al. (2013)	49	ASD	AMC *	4yrs-11yrs	PPVT-III* , EVT-2*

Harper-Hill et al. (2013)	20	ASD	AMC*	9yrs-16yrs	PPVT-III , CELF-4,
Naigles et al. (2013)	45	ASD	AMC*, OO†	9:7yrs-17:11yrs	PPVT-III*†, TOPL , CELF

Note: * †® denotes significant differences found between groups on a standardized test

ASD – Autism Spectrum Disorder; ASD- A - Autism Spectrum Disorder After program introduction; AS – Asperger's syndrome; HFA – High functioning Autism; GF - Goldman-Fristoe; LFA – Low functioning Autism; LFA1- Low functioning autism (border line refer to Kjelgaard & Tager-Flusburg, 2001); LFA2- Low functioning autism (impaired refer to Kjelgaard & Tager-Flusburg, 2001) MLU – Mean Length Utterance; ND – Normative Data; RNW – Repetition of Nonsense Words; SID- Severe Intellectual Disability SID-A - Severe Intellectual Disability - After program introduction; VABS – Vineland Adaptive Behavior Scales

RESULTS

Examining Differences in Receptive Lexical Processing between Children with Autism and Controls

The means and standard deviations for standard scores and age equivalence scores on the PPVT are shown in table 4-11 below. All data were checked for normality using the Kolmogorov–Smirnov test and revealed no violations of normality. Also no missing data were reported for this test as all children were able to complete the test. No outliers were detected in the analysis.

Table 4-11 Standard scores and age equivalence scores on the PPVT for each participant group

	PPVT-4 Standard Score			PPVT-4 Age equivalence		
	Mean	S.D	N	Mean	S.D	N

Autism	79.1	14.8	22	56.7	11.0	22
Age Match	122.9	13.7	22	66.3	14.3	22
Lang Match	121.5	14.0	16	56.5	15.0	16

A one way ANOVA with group as the independent variable and PPVT standard score as the dependent variable was conducted. This revealed a significant main effect of group F (2, 59) = 62.39, $p < .001$. A post hoc tukey test was then carried out on the data, and showed that children with autism obtained significantly lower scores than their language matched ($p < .001$) and age matched ($p < .001$) controls. The typically developing groups did not differ from each other ($p = .97$).

A second ANOVA was carried out on the PPVT age equivalence scores across groups, and this again revealed a significant main effect of group F(2, 53) = 3.48, p < .05. A post hoc tukey test was then carried out, and revealed a significant difference between scores for children with autism and their age matched controls ($p < 0.05$). There was no significant difference between children with autism and their language matched controls ($p = 1.00$) and the two typically developing groups did not differ from each other ($p = 0.11$). As can be seen in table 4-11 children with autism achieved lower age equivalence scores ($M = 56.7$) than their age matched controls ($M = 66.3$) but similar age equivalence scores as their language matched controls ($M = 56.5$). This finding shows that the autism and younger typical groups, matched on language measured using the Vineland communication subset also showed similar levels of receptive vocabulary.

Examining the Existence of Subgroups in relation to Lexical Processing

In order to address the second aim of this thesis cluster analysis was conducted to explore the possible existence of subgroups in the sample. Matching the approach taken by Harper-Hill et al. (2013), and in the analysis of the phonological processing data described earlier in this chapter, the cluster analysis was applied to the total sample of participants.

The results from the cluster analysis indicated an optimum two-cluster solution as indicated by the BIC. The first of the two identified clusters (cluster 1) comprised 38 participants and made up for 63.3% of the whole group, and the second cluster (cluster 2) compromised 22 participants and made up for 36.6% of the whole group. From the children with autism four children were in the cluster 1, and 18 children were in cluster 2.

Consideration of the PPVT standard scores of the resulting two clusters revealed that Cluster 1 had a higher mean score on the PPVT standard scores (henceforth, PPVT high cluster), while Cluster 2 had a lower mean score on the PPVT standard scores (henceforth, PPVT low cluster). The PPVT high cluster was comprised of children from all three groups. Thus, as anticipated, some of the participants with autism are clustered alongside their age matched and language matched peers and appeared to have similar receptive lexical abilities. However the second cluster, the PPVT low cluster, included only children with autism and one typically developing child from the language control group.

It was noted that all four of the children with autism who were in the PPVT high cluster were also in the CTOPP high cluster. It is also interesting to observe that these children achieved high scores on measures of phonological memory on the CTOPP.

Table 4-12 shows symptom severity, phonological awareness, phonological memory, adaptive language and adaptive social skills (the latter two measured by the Vineland) profiles for the four children with autism who had been grouped into the PPVT high cluster.

Table 4-12 Individual profiles of the six children included in the PPVT high cluster their standard scores on Phonological Awareness, Phonological Memory, GARS, CARS, PPVTss and standard scores on the Language and social subsets on the Vineland

Child No.	GARS	CARS	PA	PM	PPVTss	Vineland	
						Lang	Social
1	88	40	95.5	82.5	120	31	20
2	85	30	93	80	98	18	25
3	75	33	84.5	88.5	100	24	33
4	80	32	91.5	82.5	110	28	28

Examining Symptom Severity in Relation to Language Abilities

In order to address the third aim of this study, which was to investigate the relationship between symptom severity and language skills, a one way ANOVA was conducted to compare the effect of cluster membership on performance on diagnostic tests, measures of standardized assessment of phonological processing, parental report of language ability (Vineland) and a measure of language and social functioning. There was a significant effect of cluster membership on all dependent variables as shown, in table 4-13.

Table 4-13 Comparison between clusters of performance on diagnostic tests, measure of functioning, of phonological processing, and receptive lexical processing

Sub/test	Clusters				Comparison df = (1 ,59)	
	Cluster 1 (PPVT High)		Cluster 2 (PPVT Low)			
	M	Sd	M	Sd	F	Significance
GARS	52.8	21.1	102.8	19.0	38.21	<.001
CARS	18.2	7.2	37.0	5.5	46.02	<.001
PA	96.0	6.9	84.1	8.0	43.88	<.001
PM	94.7	6.2	80.3	5.0	47.25	<.001
Vineland Lang	40.2	10.5	22.1	7.3	149.07	<.001
Vineland Social	40.7	7.6	22.6	9.4	24.78	<.001
PPVTss	120.3	14.2	73.9	10.7	26.17	<.001

From table 4-13 it appears that symptom severity is apparent in the PPVT low cluster. However this cluster includes a large proportion of the children with autism, so this result is unsurprising. However, an interesting question was whether one or more particular subsets of the GARS or the CARS drove the difference between the clusters. Subset data for the PPVT high and PPVT low clusters are shown in Table 4-14.

Table 4-14 Scores on the GARS and CARS and their subtests difference between PPVT high and PPVT low

Sub/test	Clusters				Comparison	
	Cluster 1 PPVT High		Cluster 2 PPVT low			
	M	Sd	M	Sd	F	Significance
GARS	52.8	21.1	102.8	19.0	38.24	<.001
Social Interaction	2.52	2.64	10.61	2.67	68.98	<.001
Communication	2.72	3.82	9.61	2.60	43.74	<.001
Stereotyped behavior	2.00	3.1	8.12	2.80	46.09	<.001
CARS	18.2	7.2	37.0	5.5	46.03	<.001
Relating to people	1.55	.71	2.68	.62	30.90	<.001
Social understanding	1.20	.51	3.38	.71	36.13	<.001
Emotional Regulation	1.10	.43	2.30	.75	32.43	<.001
Adaptation to change	1.10	.41	2.71	.96	10.73	<.001
Visual response	1.13	.40	2.10	.93	9.87	<.001
Listening response	1.18	.32	2.28	.71	24.58	<.001

Fear or Anxiety	1.23	.21	1.95	.75	14.31	<.001
Nonverbal communication	1.63	.59	3.46	.59	56.04	<.001
Verbal Communication	1.57	.74	2.71	.60	44.72	<.001
Level of intellectual response	1.23	.41	3.07	.87	33.43	<.001
Object use in play	1.30	.60	2.93	.64	29.17	<.001

A one way ANOVA was conducted to compare the effect of cluster membership on the performance on subtests of diagnostic tests GARS and CARS. There was a significant effect of cluster membership on all dependent variables as shown in table 4-14. In the comparison section the table illustrates the F value and significance. For the GARS, Social interaction shows the highest F value, followed by stereotyped behaviours and communication being the most affected. This might indicate that since social interaction scores and stereotyped scores were higher than communication scores, higher severity in these areas might contribute to lower lexical processing skill, indicated by lower PPVT scores. In the CARS, the highest F value is shown in the nonverbal communication subtest, followed by verbal communication and social understanding.

In order to further examine the relationship between symptom severity and linguistic measures, Fig 4-3 shows a simple scatterplot exhibiting the relationship between measures of receptive lexical processing and performance on the GARSss and CARSss. The scatterplots below show the relationship between PPVT standard scores and (a) GARSss (b) CARSss. The vertical dotted line indicates the cut off point for GARS and CARS for possibility of autism. The horizontal dotted line indicates cutoff score indicating weak receptive communication as indicated by the PPVT manual.

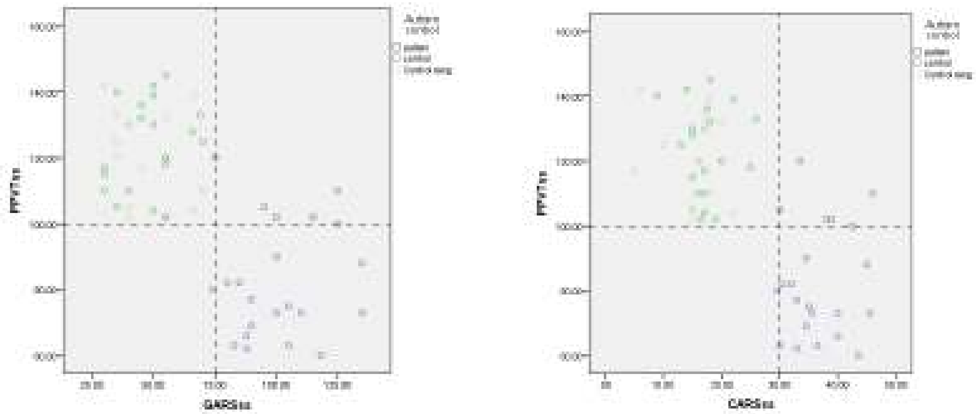


Figure 4-3 Scatterplots showing relationship between a) PPVTss and GARSss and b) PPVT and CARSss

To examine the relationships further, bivariate correlations were carried out to identify the relationship between symptom severity in children with autism and their performance on the measures of receptive lexical knowledge namely PPVT. The analyses were conducted using the Pearson product-moment correlation coefficient. Results revealed significant correlations between performance on the PPVT and diagnostic scores on the GARS for children with autism (r =.23, $p < .05$). Bivariate correlations were also carried out to identify the relationship between performance on the CARS and performance on the PPVT. The analyses were conducted using the Pearson product-moment correlation coefficient. Results revealed non-significant correlations between performance on the PPVT and diagnostic scores on the CARS (r =.48, $p < .05$).

To examine the significant relationship between results on the GARS standard score, CARS standard score and PPVT standard score, PPVT standard raw scores, CARS and GARS for the children with autism, scores were converted into z-scores for ease of comparison as shown in figure 4-4. The x-axis shows the child’s case number and the y-axis shows the z-scores. High GARS and CARS scores indicate high severity while a low PPVT score indicates deficits in receptive vocabulary. The significant relationship between GARS and performance on the PPVT can be seen in cases 10, 11 and 14. It also shows that with lower symptoms performance on the PPVT tends to be higher (e.g., case 3). However such a relationship is not evident with the CARS.

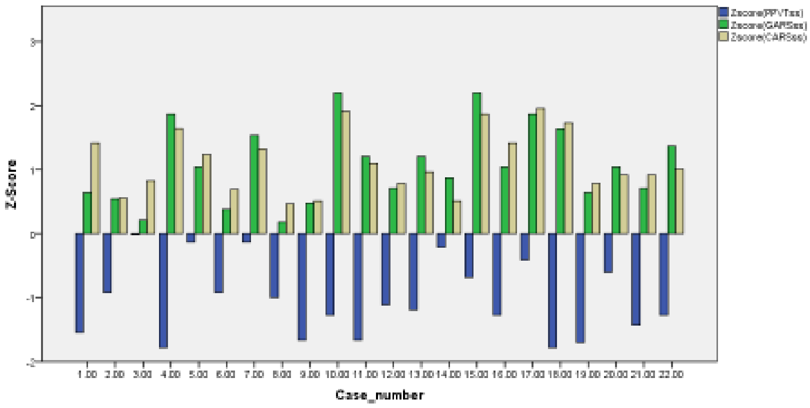


Figure 4-4 Z-scores for the children with autism on the GARSss, CARSss and PPVTss. The x-axis shows the child’s case number and the y-axis shows the z-scores

Examining the Relationship between Phonological and Lexical Processing

The relationship between phonological processing and lexical processing has gained increased attention recently, especially in regards to their role in word learning and language acquisition. This association between lexical and phonological development is observed in children with both typical and delayed language development (Stoel-Gammon & Dale, 2011). Children who know many words tend to produce a greater variety of sounds and sound combinations, whereas children who know few words tend to produce a limited variety of sounds and sound combinations (Storkel & Morrisette, 2002). For example, there appears to be a potentially robust relationship between the phonological characteristics of first words and babble, suggesting an intimate connection between word learning and productive phonology (Storkel & Morrisette, 2002).

In addition to descriptive evidence, experimental studies provide further support for the hypothesis that lexical and phonological development influence one another. For example, one study of young children with expressive language delay demonstrated that treatment focused on increasing a child's expressive vocabulary led to subsequent improvements in phonological diversity (Vellemen, 2011). This finding suggests that the breadth of a child's lexical knowledge may influence phonological acquisition. In this case, an increase in vocabulary went hand in hand with an expansion of the sound system. In complement to this study, there is experimental evidence that phonological characteristics may influence lexical acquisition. For example, infants have been shown to produce novel words composed of sounds that are in their phonetic inventory, more frequently than novel words that are composed of sounds that are not in their phonetic inventory. This study showed that the child's phonetic inventory influenced the acquisition of new words (Bleses, 2010).

Research looking at language abilities in children with autism has also shown a clear link between these two processes (McCann et al., 2007, Kjelgaard et al., 2001, Condouris et al., 2003). In these studies phonological processing and lexical processing measured using standardized tests showed a significant correlation.

Taken together, descriptive and experimental evidence suggests that phonological development and word learning mutually influence one another in typically developing children and those with delayed language development. Therefore bivariate correlations were carried out to test the relationship between results on the PPVT and results on subsets of the CTOPP; namely phonological awareness and phonological memory. For children with autism scores on the PPVTss were significantly correlated with phonological memory scores (r =.53, p < .05) and phonological awareness scores (r = .39, p < .05). To examine the relationship further, scores on the CTOPP subtests and PPVTss were converted to z-scores as shown in fig 4-5 below.

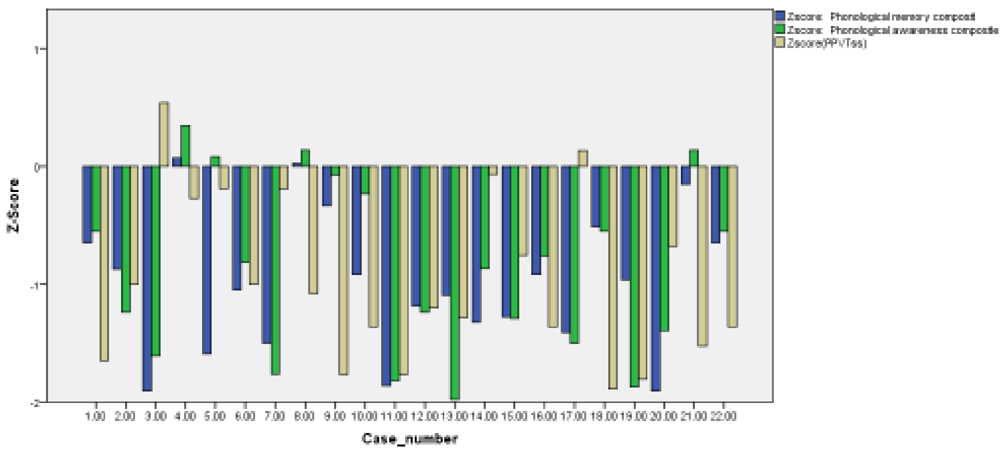


Figure 4-5 Z-Scores on the phonological memory and phonological awareness composite as well as standard scores on the PPVT for each child with autism

As figure 4-5 shows, there is mostly what seems to be a clear relationship between performance on the PPVT and CTOPP as shown by cases 11 and 12. However, some cases (3, 4, 5, 8, 9, 17 and 21) show a clear deviation from this relationship.

Given two clusters were identified in the analysis of the CTOPP data, indicating phonological awareness and memory, and a bivariate correlation did exist between the CTOPP standard score and PPVT standard score. The cluster analysis was applied to the autism and control participants as one whole group. The scores obtained by participants on the subsets of the PPVT and the CTOPP were used to create the clusters. The results indicated an optimum two-cluster solution. The first of the two identified clusters (cluster 1) comprised 40 participants (66.6% of the whole group), and the second cluster (cluster 2) comprised 20 participants (33.3% of the whole group).

Consideration of the PPVT and CTOPP standard scores of the resulting two clusters revealed that one cluster (Cluster 1) had a higher mean score on the PPVT and CTOPP standard scores (henceforth, PPVT + CTOPP high cluster). The other cluster (Cluster 2) had a lower mean score on the PPVT and CTOPP standard scores (henceforth, PPVT + CTOPP low cluster). As before, the PPVT + CTOPP high cluster was comprised of children from all three groups. Thus, as anticipated, some of the participants with autism are clustered alongside their age matched and language matched peers and appeared to have similar receptive lexical abilities. However the second cluster, PPVT +CTOPP low cluster, is compromised only of children with autism and only one child from the language matched group.

Examination of the profiles of the three children with autism who were included in the PPVT + CTOPP high cluster revealed that they were also in the CTOPP high cluster and PPVT high cluster when these were considered separately. Table 4-15 shows symptom severity, phonological awareness, phonological memory, adaptive language and adaptive social skills (the latter two measured by the Vineland) profiles for the three children who had been grouped into the PPVT + CTOPP high cluster.

Table 4-15 Symptom severity, phonological awareness & memory, adaptive language, and adaptive social skills of children in the PPVT + CTOPP high cluster

Child No.	GARS	CARS	PA	PM	PPVTss	Vineland	
						Lang	Social
1	88	40	95.5	82.5	120	31	20
2	75	33	84.5	88.5	100	24	33
3	80	32	91.5	82.5	110	28	28

DISCUSSION

The aim of the second assessment described in this chapter was to assess lexical skills in children with autism and age and language matched typically developing children and to explore the relationship between these skills and measures of symptom severity and adaptive functioning. To date no study has tested lexical processing in children with autism living in the Arab World and this study employed methods used in studies into these processes in the West.

In this study, the PPVT-III was used to assess receptive vocabulary in children with autism, and age and language matched typically developing controls. The language matched children were matched to children with autism using the communication subset of the Vineland. Results revealed significantly poorer standard scores on the PPVT-III in children with autism compared with language and age matched controls and these results are consistent with previous studies, carried out in the West, that have revealed a deficit in receptive vocabulary abilities in children with autism (Mayo & Eigsti, 2012). The fact that children with autism also differed significantly from their language matched group on this measure highlights the degree of deficiency that is present in receptive vocabulary abilities in children with autism.

The second aim of this chapter was to examine the existence of linguistic subtypes in the sample using cluster analysis. Previous studies, carried out in the western world have employed clustering methods and have shown that subgroups of children with autism perform as well as their age matched controls on standardized assessments measuring receptive communication skills (Kjelgaard & Tager-Flusberg, 2001, McGregor et al., 2012). In the current study, clustering methods were employed to examine the possible existence of subgroups in the sample tested. Matching the approach taken by Harper-Hill et al. (2013), the cluster analysis was carried out on the total sample and the results indicated an optimum two-cluster solution: PPVT high and PPVT low. In line with previous studies carried out in the west (Harper-Hill et al., 2013) a subgroup of participants with autism were clustered alongside their age matched and language matched peers and appeared to have similar receptive lexical abilities. The results also revealed significant differences between clusters on diagnostic tests, measures of standardized assessment of phonological processing, parental report of language ability (Vineland) and a measure of language and social functioning. In relation to symptom severity, the clusters differed significantly on all subset of the GARS and CARS, although this was likely to result from the high proportion of autistic children in the low cluster group. However the analysis was informative in showing that the most highly significant differences between clusters were on the social interaction subtest from the GARS and the non-verbal communication subtest from the CARS. This suggests that social interaction deficits and nonverbal communication deficits might be key factors in explaining why children with autism perform poorly on linguistic tests, in this case those measuring receptive vocabulary.

An important aim this study was to measure performance on standardized assessment measures against symptom severity where it was hypothesized that symptom severity will be directly associated with performance on the measures of lexical processing. Previous research relating autistic symptomology to lexical processing abnormalities has shown that children with less severe autism symptoms tend to achieve higher scores on standardized measures of lexical assessment, while children with more severe symptoms tend to perform poorly on such measures (Prior et al., 1998, Charman et al., 2004, Luyster, Qiu et al., 2007). However, some studies have found that autistic symptoms do not correlate with or contribute to any variation in the performance of children with autism on linguistic measures (Leyfer et al., 2008). A more recent study conducted by Kjellmer Hedvall, Fernell, Gillberg & Norrelgen (2012) revealed that a very small portion of the variance in verbal language skills was accounted for by severity of autism symptoms, as measured by the Autistic Behavior Checklist (ABC) (Krug, Arick, & Almond et al., 1978, 1980). This finding is interesting since in clinical practice verbal language deficits are sometimes believed to be directly associated with, or even explained by the autism itself and particularly the degree of the autism symptoms seen. Moreover, both Charman et al. (2005) and Luyster et al. (2007) found that low receptive and expressive language at young ages was related to increased autism symptom severity in the early school years. In contrast Kjellmer et al. (2012) suggested that verbal language levels in young children with ASD are likely explained by concurrent autism symptom severity. Taken together, these results might suggest that severity of autism symptoms may be more strongly associated with the development of non-verbal than verbal communication skills in ASD. However, these studies do not always employ the same assessment and analysis methods and firm conclusions about the results should be made with caution.

The current study was the first to investigate associations between symptom severity and receptive vocabulary skills in children with autism in the Arab world. The results revealed significant correlations between performance on the PPVT and diagnostic scores on the GARS but not on the CARS. The GARS and CARS have a high correlation and supposedly measure the same deficits that contribute to the triad of deficits seen in children with autism namely: social interaction, communication and stereotyped behaviours. However, these tests are scored and scaled differently and so might result in different correlations with a third dependent variable. Further examination of the z-scores for the PPVT, CARS and GARS showed that the performance of the children on the PPVT did vary with performance on the GARS although this was only true for a small number of cases. Finally, theoretical justification was offered that sheds light on the relationship between phonological processing and consequent lexical acquisition in children with typical development (Stoel-Gammon & Dale, 2011; Storkel & Morrisette, 2002) and children with autism (McCann et al., 2007, Kjelgaard et al., 2001, Condouris et al., 2003) in studies in the west. In the current study results showed that for children with autism, scores on the PPVTss were significantly correlated with phonological memory scores and phonological awareness scores. Since a bivariate correlation between the CTOPPss and the PPVTss was observed, the presence of clusters in relation to the performance of children on both linguistic tests was analyzed and resulted in two identified clusters, a PPVT + CTOPP high cluster and a PPVT + CTOPP low cluster. As anticipated, some of the participants with autism were clustered alongside their age matched and language matched peers and appeared to have similar receptive lexical abilities (PPVT + CTOPP high). However the second cluster, PPVT + CTOPP low, was comprised primarily of children with autism and only one child from the language matched group. Examination of the profiles of the three children with autism who were included in the PPVT + CTOPP high revealed that they were also in both the CTOPP and PPVT high clusters. Examination of their symptom severity, phonological awareness, phonological memory, adaptive language and adaptive social skills (the latter two measured by the Vineland) profiles showed that these children had higher scores on all the assessments than the children in the lower group.

Taken together these results confirm the hypothesis that children with autism do differ from their age and language matched peers on lexical processing measures. However not all children with autism show deficient lexical processing, and while some children did poorly on such measures, others were able to perform as well as their age and language matched peers as evidenced by cluster analysis. Also, such performance did not correlate with symptom severity on the CARSss, although it did correlate with symptom severity on the GARSss. The results from this clinically referred sample of children from the Arab World are thus broadly in line with research carried out in the West examining lexical processing using these tests. Finally, results from phonological and lexical assessments were similar, some but not all of the children in the CTOPP high cluster were in the PPVT high cluster as well. This finding is also broadly in line with findings from studies carried out in the Western world. Chapter five will consider analyses in line with those reported here for a further two linguistic domains, specifically syntax and pragmatics.

Chapter 5 : SYNTAX AND PRAGMATIC SKILLS

ABSTRACT

This chapter is made up of two sections that follow the same structure, one focused on syntax abilities in children with autism and the other on the pragmatic abilities of children with autism. Each section begins with a literature review and will highlight the threefold aims of this chapter in relation to this thesis. Results will then be outlined relating to the thesis aims, these include examining differences between children with autism and the two control groups, examining the existence of subgroups in relation to linguistic abilities and analysing association between symptom severity and performance on measures of language abilities; outcomes will be highlighted accordingly. Finally, the results will be discussed within the relevant linguistic framework of previous research and its relation to current findings.

SYNTAX PROCESSING IN CHIDLREN WITH AUTISM

The studies described in chapter four investigated phonological and lexical processing using standardized tests and revealed mixed outcomes in the children with autism. As previously suggested, language can be seen as rule-based and syntax refers to the rules determining how words and word combinations are ordered to form phrases and sentences. Syntactic skills rely upon an understanding of how words are ordered as well as the organization of phrases and sentences. Moreover, the ability to use increasingly complex sentences improves as language develops (Law et al., 2004).

Children with syntactic deficits experience difficulties in acquiring and using the rules that govern word formation and phrase/sentence formation (syntactic structures). At the word level, these children may use plural forms or verb tenses incorrectly, and at the phrase or sentence level, they may use incorrect word order, leave out words, or use a limited number of complex sentences, such as those that contain prepositional clauses. Such a deficit might also result in the use of a limited number of grammatical markers (e.g., –ing, a, the, possessive 's, be verbs), a limited understanding and use of plural forms, difficulty understanding and using past, present and future verb tenses and poor performance on story retell tasks (Law et al., 2004).

To date, no studies have investigated syntax abilities in children with autism in the Arab world, and those carried out in the western world have shown mixed results. These latter studies have looked at the profiles of syntactic difficulties in these children and have focused on different aspects of syntactic knowledge or ability. These are reviewed below.

The first of such Western studies was carried out by Kjelgaard et al (2001), who administered the Clinical Evaluation of Language Fundamentals (CELF): Preschool or III (Wiig, Secord, & Semel, 1992). The CELF is designed to measure morphology, syntax, and semantic knowledge. In one subset, the picture comprehension task, children are presented with four pictures and asked to indicate which picture goes with a sentence containing a grammatical construct. The results from the study showed that like typically developing age-matched controls, children with autism followed subject-verb object (SVO) order when interpreting sentences (Kjelgaard, 2001). In another study, Riches, Loucas, Baird, Charman and Simonoff (2010) used repetition of sentences involving long-distance dependencies to investigate complex syntax in adolescents with specific language impairments (SLI), language impairment and co-morbid autism and typically developing adolescent controls. Participants were required to repeat sentences containing relative clauses that varied in syntactic complexity. The results showed that adolescents with SLI experienced greater syntactic difficulties than the adolescents with autism and language impairment. These difficulties were manifested in higher error rates on the more complex object relative clauses, and a greater tendency to make syntactic changes during repetition (Riches et al., 2010).

In a study by Kelley, Paul, Fein and Naigles, et al. (2006), investigating the potential persistence of language deficits in children with autism, with optimal outcomes, clinically referred children who had undergone extensive Applied Behaviour Analysis (ABA) therapy (Lovaas, 1993) for a period of two-four years prior to the study, were administered 10 language tests. The group was comprised of fourteen, five to nine year old children, with a prior diagnosis of autism and IQ scores in the normal range. According to parental and teacher reports, the groups' language, social interaction skills and adaptive functioning had shown such significant increases that their social and academic functioning was comparable to that of their typically developing peers. At the time of testing, all of these children had been mainstreamed into chronological age-appropriate classrooms. The results from the study showed that the grammatical capabilities of these optimal outcome children with autism were mostly indistinguishable from those of their age and gender matched typically developing peers (Kelley et al. 2006). Botting and Conti-Ramsden (2003) administered the children's Non-word repetition task (CNRep; Gathercole & Baddeley, 1996), the Past Tense Task (PTT; based on Marchman, Wulfeck & Weismer, 1999), the Clinical Evaluation of Language Fundamentals (CELF, Semel, Wiig, Secord, 1987), the Expressive Vocabulary Test (EVT; Williams, 1997), the test of receptive grammar (TROG), and the Children's Communication Checklist (CCC; Bishop 1998) to groups of children with SLI, autism , and pragmatic language impairment (PLI), who did not have an ASD diagnosis. The primary aim of the study was to determine whether the groups could be distinguished using linguistic clinical markers. The results from the study revealed a group difference on the CNRep, and the CELF with poorest test performance observed for the SLI group. Group differences were also observed on the EVT, the TROG and the CCC. Children with SLI obtained lower scores than the PLI and ASD groups on the EVT and TROG. However children with ASD and PLI obtained lower scores than the SLI group on the CCC. The linguistic markers were able to discriminate between all three types (autism, SLI, PLI) of communication impairments, with the CNRep being the most efficient marker for all groups. When the PLI group was subdivided into a group with PLI pure and a PLI with some autistic like behaviours (referred to as PLI plus by Bishop, 1998), these groups could be accurately discriminated using the CNRep and the TROG. This study revealed the utility and precision of such linguistic tests in distinguishing clinical groups.

These studies show that children with autism may develop syntactic abilities that are similar to those of their peers and that they perform better than children with SLI on standardized assessment tests. However, not all studies have revealed such robust results. Norbury and Bishop (2002) set out to explore story comprehension abilities in groups of children with typical specific language impairment (SLI-T), pragmatic language impairment without autism (PLI), high functioning autism (HFA) and age matched typically developing controls. Background assessment tests were conducted including nonverbal ability measured by the Raven Progressive Matrices test (Raven, 1936), pragmatic impairment (measured by the CCC), receptive vocabulary (measured by the BPVS), receptive grammar (measured by the TROG), and expressive vocabulary measured by the CELF-R. Autistic symptomatology was measured by the SCQ (Berument, Rutter, Lord, Pickles & Bailey, et al. 1999), and the ADOS-G (Lord, Risi, Lambrecht, Cook Jr., Leventhal, DiLavore, Pickles & Rutter, 2000). The results failed to reveal a significant difference between the three clinical groups on the TROG and all groups performed at a significantly lower level than typical controls. There was also a significant group difference on the receptive and expressive language measures (BPVS, CELF-4), with lower receptive and expressive scores in the SLI-T group compared with the PLI, HFA and typically developing groups. Additionally, the control children obtained higher scores on story comprehension than the three clinical groups and the clinical group means did not differ. Correlation performed on test scores and symptom severity revealed a higher rate of symptom severity in children with autism who achieved lower TROG scores (receptive grammar). However, symptom severity did not correlate with receptive and expressive vocabulary scores for this group.

Whitehouse & Bishop (2008) sought to compare the language profiles, oral motor skills, and autism-related behaviours of subgroups of children with autism and SLI.

Previous research had identified poor performance on the non-word repetition task in groups with SLI and autism and the authors aimed to determine whether or not this reflected a similar deficit across these groups. In the study, children with autism with poor (Apoor) and age-appropriate (Aapp) structural language skills, and children with SLI were compared. Participants were administered a battery of standardized language and memory tests, including the TROG-E (TROG-electronic), Children's Communication Checklist (CCC), the Expression, Reception and Recall of Narrative Instrument (ERRNI, Bishop, 2004) and subsets of the NEPSY that measured oro-motor competence and short term memory. Children in the Apoor and SLI groups performed similarly on the TROG-E, while children in the Aapp group performed better than both Apoor and SLI groups on the TROG-E. Results revealed that although there were some similarities in the language profile of the SLI and Apoor groups, the two groups differed on the tests of oromotor ability and verbal short-term memory and also showed a different pattern of errors on the non-word repetition task. Further analyses of the data led the researchers to suggest that the non-word repetition deficits observed in some children with autism may arise when there is substantial impairment in multiple autistic domains.

In summary, the results from some studies using TROG to test syntactic abilities in children with autism have shown that performance is poorer than that of typical peers, that levels of performance may be associated with the degree of symptom severity observed, and that levels of performance may also depend upon whether or not a language deficit is part of the child's symptom profile. Such results are contradictory to other previous findings showing that children with autism perform as well as typically developing children on measures of syntax abilities. However, such a discrepancy in results between these studies may reflect the use of different types of assessments that measure different aspects of syntax. Thus whilst studies have shown that children with autism are able to adhere to correct structural syntax and follow subject – verb order (SVO), they show a deficit in receptive grammar as measured by the TROG. Although the TROG has a component that measures SVO use, it also measures other constructs such as negations, relative clauses and singular/plural inflection. This might explain some of the discrepancy seen in these results. Secondly, not all studies use language matched or age matched controls when comparing children with autism on standardized measures, and a number of these studies only compared children with autism and SLI and thus provide no comparison to a typical control group. While such studies are important in elucidating links between the language deficits seen in these two disorders, they fail to provide a rigorous analysis of syntactic skills in children with autism.

The first aim of the current study was to measure syntax abilities in children with autism and their typically developing peers living in the Arab world. It was hypothesized that children with autism would differ significantly from their age matched and language matched peers on measures of receptive syntax. The second aim of the study was to examine the existence of subtypes within the cohort of children with autism using the results from the TROG as clustering variables in the analysis. It was hypothesized that linguistic subgroups would emerge and that children with autism would perform as well as their language and age matched peers. The third aim of the study was to examine the relationship between syntactic abilities and symptom severity by directly comparing the results of diagnostic tests with the results from the standardized language test and examining autistic symptomology in the clusters created. It was hypothesized that symptom severity would correlate with performance on the measure of syntax.

In the study, the TROG-2 was used to assess receptive grammar in the sample. The TROG-2 has been used to assess children with autism in the past (see above) and has been shown to be a reliable measure of receptive syntax as shown in table 5-1 below. This table illustrates a comprehensive literature review of all studies that have used the TROG as a measure of receptive syntax skills in children with autism. Studies were included from 1997- present. Google Scholar and PSYcINFO were used to inform this review, and key words included: TROG, autism, syntax and resulted in 150 results. A study was included in the table if it examined syntax abilities in children with autism compared to a control group(s). Many studies have used the TROG for matching purposes or to confirm diagnostic criteria in children with SLI. These studies were not included in the table below since they did not focus on measuring linguistic skills in children with autism. Neither were studies where the TROG had been used to test the relatives of children with autism rather than children with autism themselves included in the summary table.

Table 5-1 Studies using the TROG to measure receptive syntax skills in children with autism

Study	Group Size	Study group	Comparison group	Age range	Tests used
Jarrold et al. (1997)	120	ASD	STN*	5yrs-19yrs	BPVS* , TROG* , WFT* , APTI* & APTG*
Norbury& Bishop (2002)	56	HFA	SLI® , PLI† , AMC*	6yrs-10yrs	BPVS®* , TROG®* , CCC®* ,
Botting& Conti-Ramsden (2003)	67	ASD	SLI® , PLI†	10yrs-12:6yrs	EVT®† , TROG®† , CCC®†, CNRep , PTT, CELF
Whitehouse & Bishop (2008)	68	ASD + LI* , ASD –LI ®	SLI	6yrs-15yrs	TROG-E® , CCC*®,

					ERRNI® , NEPSY*®
Paynter& Peterson (2010)	64	HFA	AS® , AMC*	4-13yrs	PPVT®* , TROG-2®* , ToMT®*

Note: * † ® denotes significant differences found between groups on a standardized test
AMC- Age matched controls; APTI & APTG - Action Picture Test Information and grammar scales; AS – Asperger's Syndrome ; ASD - Autism Spectrum Disorder; ASD + SLI - Autism Spectrum Disorder with language impairment; BPVS - British picture vocabulary scale; CELF – Clinical Evaluation of Language Fundamentals; CNRep – Children's Non-Word Repetition; ERRNI - Expression Reception and Recall of Narrative Instrument; HFA- High Functioning Autism; NEPSY – A Developmental NEuroPSYchological Assessment ; SLI- Specific Language Impairment; STN – Standardized Test Norms; ToMT – Theory of Mind Tasks ; PLI- Pragmatic Language Impairment; PTT- Past Tense Task ; TROG- Test of Reception of Grammar; WFT- Word Finding Test

RESULTS

Examining differences in Syntax between Children with Autism and Controls

All data were checked for normality using the Kolmogorov–Smirnov test and revealed no violations of normality. All participants successfully completed this assessment so there were no missing data points. Means and standard deviations for TROG-2 standardized (mean 100; SD 15) and age equivalence scores (months) are shown in table 5-2 below. No outliers were detected in the analysis.

Table 5-2 Mean and standard deviation obtained on the TROG-2 for each participant group, the table shows the standard score (ss) and age equivalency (ae) score

	TROG ss			TROG ae		
	Mean	S.D	N	Mean	S.D	N
Autism	82.8	14.6	22	55.1	12.7	22
Age match	125.9	14.4	22	63.5	14.2	22
Language match	96.7	13.4	12	56.7	12.2	12

A one way ANOVA was applied to the data to compare performance of the three groups on the TROG-2 standard score. This revealed a significant main effect of group F (2, 53) = 36.46, $p < .001$. A post hoc tukey test showed that age matched typically developing children performed at a significantly higher level than language matched typically developing children ($p < .001$) and that children with autism performed at a significantly lower level than their age matched ($p < .001$) but not language matched peers ($p = .067$).

As each block of the TROG measures a different syntactic skill, these were examined separately. Figure 5-1 shows scores for the three groups across the blocks of the TROG-2.

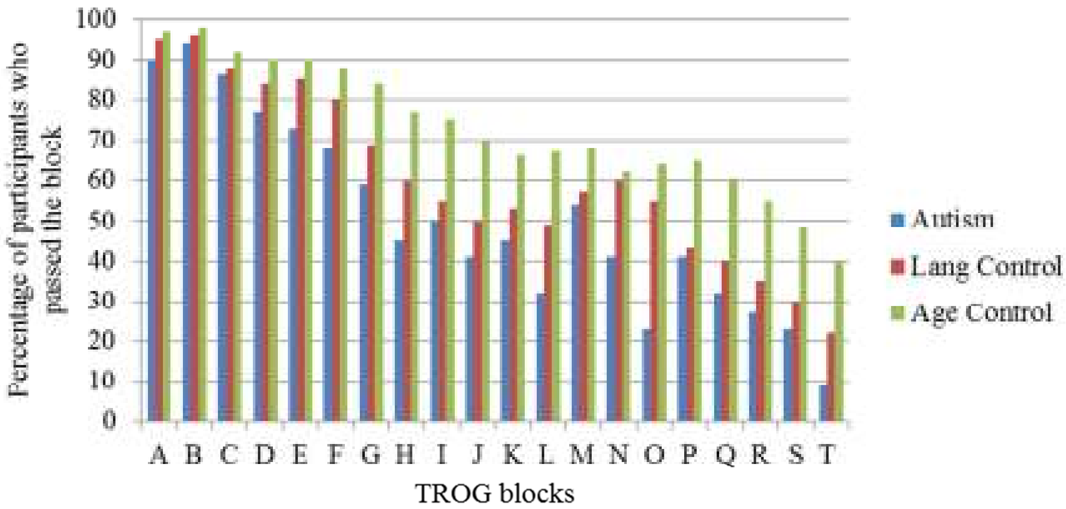


Figure 5-1 Percentage of children in each participant group who passed each of the TROG-2 blocks

As figure 5-1 shows, there was generally a trend towards a decrease in the number of children in each group who passed the blocks as the grammatical constructs became more complex. Although the pattern of performance across the blocks appeared to be more uneven for the children with autism compared to their language matched and age matched controls, this group also showed a trend towards a decrease in performance across the blocks. Looking more closely at the individual data of children with autism on the TROG-2 , and exploring possible differences in performance, Table 5-3 shows the individual profiles for the children with autism on the TROG-2.

Table 5-3 Individual profiles of children with autism on the TROG-2, a zero indicates a failed block and a one indicates a passed block

	TROG-2 Blocks																				
Participant	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	Total
1	1	1	0	1	1	1	0	0	0	0	0	1	0	1	0	0	0	0	1	0	8
2	1	1	0	1	1	1	0	1	0	0	1	0	1	1	1	1	0	1	0	0	12
3	1	1	1	0	1	0	1	0	1	0	1	1	0	0	0	1	0	0	0	0	9
4	0	1	1	1	1	1	0	1	0	0	0	0	1	0	1	0	1	0	1	0	10
5	1	1	1	0	1	1	0	1	1	1	1	1	0	1	1	1	0	0	0	0	13
6	1	1	1	1	0	1	1	0	1	0	0	0	1	0	0	1	0	0	0	0	9
7	1	1	1	1	0	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	8
8	1	1	1	1	1	0	1	0	1	1	1	1	1	0	1	1	1	1	1	0	16
9	1	1	0	1	1	1	0	0	1	0	1	0	0	0	0	1	0	0	0	0	8
10	1	1	1	1	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	8
11	1	1	1	1	1	0	1	1	1	0	1	1	1	1	0	0	0	1	1	0	14
12	1	0	1	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	7
13	1	1	1	1	1	1	0	1	0	0	0	0	0	1	0	1	1	0	0	1	11
14	1	1	1	0	1	1	1	0	1	1	1	0	1	0	1	0	0	0	0	0	11
15	1	1	1	1	0	0	1	1	1	1	0	0	1	1	0	0	0	0	0	0	10
16	1	1	1	1	1	0	1	0	0	0	0	1	1	0	0	1	1	1	1	1	13
17	0	1	1	1	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	7
18	1	1	1	1	1	0	1	1	0	1	1	1	0	0	0	0	0	1	0	0	11
19	1	1	1	0	1	1	1	0	0	0	0	0	1	1	0	1	1	0	0	0	10
20	1	1	1	1	0	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	8
21	1	1	1	1	1	0	1	0	1	0	1	0	0	0	0	0	1	1	0	0	8
22	1	1	1	0	1	1	0	1	0	1	0	0	1	1	0	0	1	0	0	0	10
Total	20	21	19	17	16	15	13	10	11	9	10	7	12	9	5	9	7	6	5	2	

As table 5-3 shows, there was wide variability in the total number of blocks passed by each participant with autism. Such variability might be due to several factors which will be further considered Firstly, previous evidence shows that some children with autism do not present with a language deficit or difficulty, and secondly, such language difficulty may be directly related to symptom severity as measured by diagnostic assessments. These potential sources of variability will be tested in the sections that follow.

Examining the Existence of Subgroups in relation to Syntactic Processing

Matching the approach taken by Harper-Hill et al. (2013), and consistent with the data analysis in chapter four, cluster analysis was applied to the autism and both control groups as one whole group. The results indicated an optimum two-cluster solution as indicated by the BIC, Table 5-4 below shows the details of both clusters.

Table 5-4 Details of the number of children in each of the clusters formed

	TROG High		TROG low	
	Size	Percentage	Size	Percentage
Autism + Control	N = 36	60%	N = 24	40 %

Cluster	Total N	Autism	Lang Control	Age match
		N	N	N
Cluster 1 (TROG High)	24	-	6	18
Cluster 2 (TROG Low)	36	22	10	4

Consideration of the TROG scores of the resulting two clusters revealed that one cluster (Cluster 1) had a higher mean standard score on the TROG (henceforth this cluster will be referred to as TROG high cluster). The other cluster (Cluster 2) had a lower mean standard score on the TROG (henceforth this cluster will be referred to as TROG low cluster).

As shown above, the TROG low cluster included children from the autism, language control and age matched typical groups whilst the TROG high cluster included only children from the two typically developing groups. As none of the children from the autism group were included in the TROG high group, and many language control children were included in the TROG low group, it was hypothesized that syntax reception might be age sensitive. Bivariate correlations, using the Pearson product-moment correlation coefficient, were therefore carried out to identify such a relationship. Results revealed non-significant correlations between performance on the TROG and age for the age matched control group (r =.01, p = .97). In contrast, this correlation was significant for the language matched control group (r = .23, p <.05) and the autism group (r = .44, p < .05). This suggests that in typical children, chronological age is more strongly associated with good receptive syntax at earlier than at later developmental. The pattern of correlation for the autism group was similar to that of the younger rather than chronological age matched children and this will be further considered in the subgroup analysis.

Expanding the analysis to include data from the previous chapter, and examining the relationship between the different linguistic components measured, Table 5-5 shows measures of symptom severity, phonological awareness, phonological memory, performance on the PPVT, adaptive language and adaptive social skills as measured by the Vineland for the participants in clusters one and two.

Table 5-5 Comparison between clusters of performance on measures of measures of standardized assessment of phonological processing, parental report of language ability (Vineland) and a measure of language and social functioning

Sub/test	Clusters				Comparison	
	Cluster 1 (TROG High)		Cluster 2 (TROG Low)		df = (1, 59)	
	M	Sd	M	Sd	F	Significance
PA	98.6	6.9	88.3	8.7	15.05	<.001

PM	97.2	6.6	85.3	10.8	12.24	<.001
Vineland Lang	42.7	6.6	29.4	11.4	20.55	<.001
Vineland Social	40.7	7.6	22.6	9.4	13.37	<.001
PPVTss	127.7	11.6	94.2	21.8	13.75	<.001

PA- Phonological Awareness subset
PM – Phonological Memory subset
PPVTss- PPVT standard score

Independent samples t-tests were conducted to compare the effect of cluster membership on performance on standardized measures of phonological processing, parental report of language ability (Vineland) and a measure of language and social functioning. Bonferroni corrections were carried out, with the p value set at 0.05/5 = .01. Data were also checked for normal distribution and equality of variance. There was a significant effect of cluster membership on all dependent variables, as shown in Table 5-5 above.

Examining Symptom Severity in Relation to Language Abilities

The final aim of the study was to investigate the relationship between syntactic ability and symptom severity. Symptom severity data for TROG high and TROG low clusters are shown in Table 5-6 below.

Table 5-6 Standard Scores on the GARS and CARS and their subtests for TROG high and TROG low clusters

Sub/test	Clusters		Comparison
	Cluster 1 TROG High	Cluster 2 TROG low	df (1, 59)

	M	Sd	M	Sd	F	Significance
GARSss	50.0	12.1	79.7	32.4	16.15	<.001
Social Interaction	2.52	2.64	10.61	2.67	25.20	<.001
Communication	1.57	0.61	6.60	5.05	20.81	<.001
Stereotyped behaviour	1.01	0.8	5.34	4.30	20.69	<.001
CARSss	17.5	3.7	28.4	11.9	16.87	<.001
Relating to people	1.40	.51	2.11	.94	8.18	<.001
Social understanding	1.34	.51	2.53	.89	14.67	<.001
Emotional Regulation	1.23	.43	2.06	.75	14.11	<.001
Adaptation to change	1.04	.41	1.77	.96	13.69	<.05
Visual response	1.00	.30	1.72	.93	18.89	<.05
Listening response	1.38	.49	2.71	.98	27.12	<.001
Fear or Anxiety	1.01	.19	1.67	.72	10.12	<.001
Nonverbal communication	1.98	.50	3.00	1.25	28.56	<.001
Verbal Communication	1.16	.22	2.88	.71	20.39	<.001
Level of intellectual response	1.38	.49	3.05	.91	13.41	<.001
Object use in play	1.05	.21	1.75	.78	12.35	<.001

As table 5-6 shows, symptom severity was higher in the TROG low cluster. However, as none of the children with autism were included in the high cluster this result was expected, and the focus of interest in the analysis was on investigating differences in symptom severity subdomains across the two clusters. An independent samples t-test was conducted to compare the effect of cluster membership on the scores of diagnostic measures. Bonferonni corrections were carried out, with the *p* value set at 0.05/15 = .003. Data were also checked for normal distribution and equality of variance, and no violations of normality were reported. There was a significant effect of cluster membership on all diagnostic measures and subsets of the CARS and GARS, as shown above. In the GARS, Social interaction, followed by communication and stereotyped behaviours, were the most affected. This might indicate that since communication and social interaction scores were higher than stereotyped behaviour scores, higher severity in these areas might contribute to lower TROG scores. In the CARS, the highest F value is shown in the nonverbal communication subtest, followed by listening response and verbal communication.

In order to further address the third aim of the study, that examines the relationship between syntax abilities and symptom severity in children with autism, and in order to show the individual profile of the children's scores on the diagnostic measures in relation to the control groups, Fig 5-2 shows a simple scatterplot exhibiting the relationship between the standard score of the TROG-2 performance on the GARSss and CARSss for both control groups and children with autism. Scatterplots showing relationship between standard scores on the TROG-2 and GARSss (right) and CARSss (left), the vertical dotted line indicates the cut off point for GARS and CARS for possibility of autism. The horizontal dotted line indicates cutoff used indicating impairment (2SD below the population mean) as per the TROG-2 manual (Bishop , 2003).

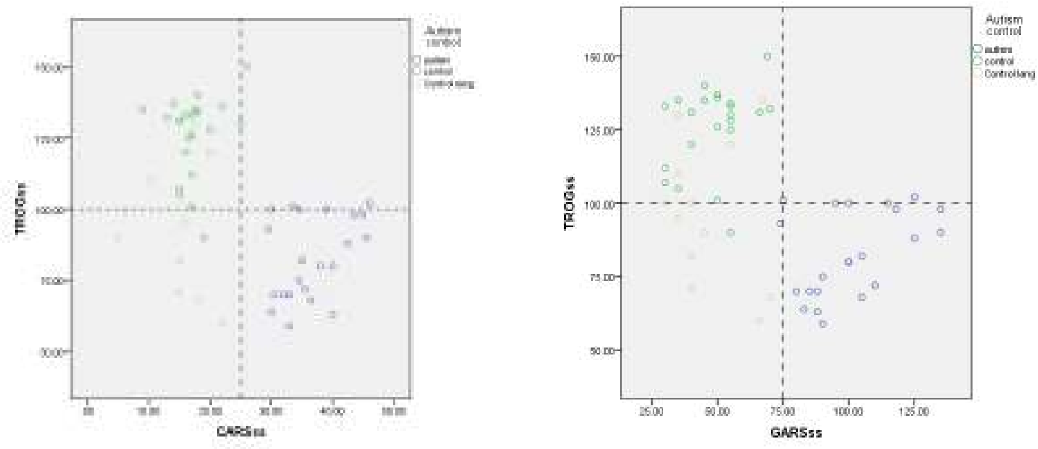


Figure 5-2 Scatterplots showing relationship between the a) TROGss and CARSss b)TROGss and GARSs

To examine the relationship between symptom severity and syntactic skills in children with autism, correlations were carried out using the Pearson product-moment correlation coefficient. Bonferonni corrections were carried out, with the *p* value set at 0.05/3 = .016. Table 5-7 shows a correlation matrix that examined correlations between raw scores on the TROG-2 and standard scores on the GARS and CARS. Results revealed significant correlations between performance on the TROG-2 and symptom severity as measured by the GARSss and the CARSss, however the correlation with the GARSss was not significant.

Table 5-7 Correlation matrix exhibiting relationship between diagnostic measures and performance on the TROG

	GARSss	CARSss	TROGss
TROGss	-.39*	-.47**	1
CARSss	.49**	1	
GARSss	1		

* = p < .05 , ** = p < .001

Finally, the relationship between performance on the TROG-2 and symptom severity was considered for individual children with autism. TROG-2 standard scores, GARSss and CARSss scores were converted into z-scores for ease of comparison. Fig 5-3 shows the z-scores of these scores together. The x-axis shows the child's case number and the y-axis shows the means of z-scores. It is worth noting that many scores on the TROGss subset were below the mean (and therefore show a minus z-score). High CARSss and GARSss scores indicate high severity while a low TROGss score indicates a deficit in receptive syntax knowledge.

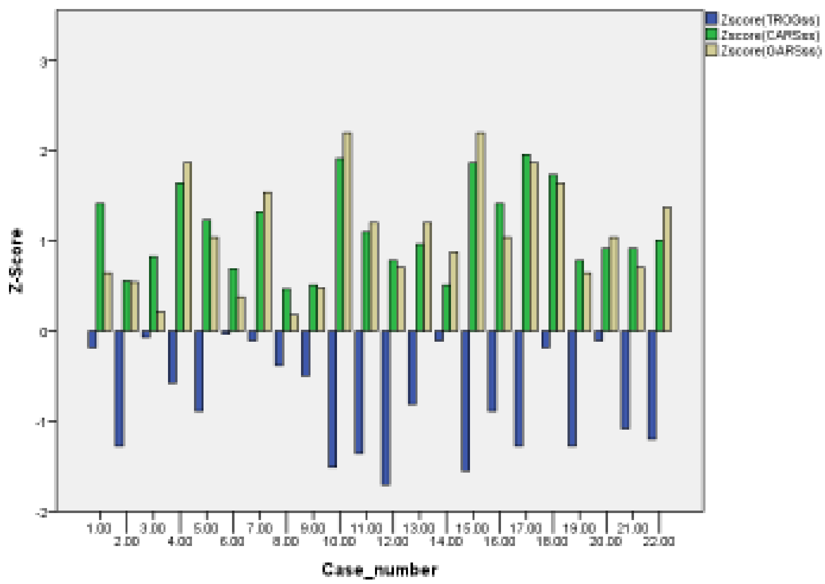


Figure 5-3 Z-scores of TROGss with GARSss and CARSss

As apparent from the graph, lower scores on the TROG-2 corresponded with higher scores on the CARS and GARS as apparent in cases 10, 15 and 17. At the same time higher scores on the TROG-2 corresponded with lower scores on the CARS and GARS as apparent in cases 6, 8 and 9. However some cases did show high TROG scores and moderate/high symptom severity as apparent for 7, 14 and 20.

DISCUSSION

The aim of the study was to carry out a detailed investigation of syntactic skills and their cognitive and clinical correlates in children with autism. Results from western studies of syntax in children with autism have revealed mixed results. For example, Kjelgaard et al. (2001) reported unimpaired appreciation of subject verb order (SVO), Riches et al., (2010) reported superior performance on measures testing sentences containing relative clauses that varied in complexity in autism compared with SLI, and Botting & Conti-Ramsden, (2003) reported superior TROG scores in autism compared with PLI. Finally, a study conducted by Kelley et al. (2006) revealed that children with autism who are in mainstream education and achieve optimum outcomes do not obtain lower scores than their peers on syntax tests (Kelley et al., 2006). However, whilst these studies might suggest that syntactic deficits are not a universal correlate of autism, they may be limited in having examined only a single aspect of syntax production or knowledge (Kjelgaard et al. , 2001) or they may have carried out a cross-syndrome comparison and failed to include age or language matched typically developing groups (Botting & Conti-Ramsden, 2003, Riches et al., 2010). Although the study carried out by Kelley et al.,

(2006) revealed unimpaired syntax in the participants with autism, the children were educated in mainstream schools and were likely to have had higher IQ's , social skills and/or language abilities than many children with autism, at the point of school entry. While it is important to study high functioning children with autism, studies including a broader range of children are more likely to increase our understanding of heterogeneity in linguistic skills in this group.

In the current study, children were recruited on the basis of their referral to a diagnostic clinic. This meant that the group was not entirely comprised of intellectually high-functioning children. The analysis of the data from TROG-2 allowed for comparisons on different constructs of syntax knowledge since it has 20 blocks, each assessing a different aspect of syntax, and the use of two control groups enabled a closer examination of the extent of language delays and/or deficits in the children with autism. Results from this study, which is the first to examine language abilities in children with autism in the Arab world, showed that children with autism performed at lower levels than their age matched peers on the TROG-2, but did not differ from their language matched peers. Whilst this result supported the experimental hypothesis that children with autism would show syntax deficits relative to chronological age, the non-significant difference between the autistic and language matched children suggests a delay rather than a deficit. This suggestion was supported by the significant age and syntax score correlation, observed for the autistic and language matched children, but not in the older, chronological age matched children.

Inspection of the individual data revealed wide variability in the total number of blocks passed by each participant with autism. A number of factors could explain this variability. Firstly, previous evidence shows that some children with autism do not present with a language deficit or difficulty, and second, such language difficulty may be directly related to symptom severity as measured by diagnostic assessments. These potential sources of variability were examined in the data analysis. Inspection of test scores across the individual blocks of the TROG-2, revealed a similarity in the autistic and language matched children's profile of performance and whilst the correlation between TROG-2 and age scores was not significant for the older, age-matched typically developing children, it was significant for autistic and language matched children. Whilst this result may suggest that acquisition of syntax is delayed rather than deviant in autism, there was considerable variability within the autism group and developmental delay may explain the results from some individuals but not others. Developmental studies will be important in enabling researchers and clinicians to map acquisition of syntax and other language components in autism, and, to this end, a longitudinal study of the children described in this thesis is planned.

Questions about heterogeneity in language skills in autism have been the focus of several recent studies and were also addressed in this chapter. For example, in a study of children with autism, Whitehouse et al. (2008) reported the existence of distinct subgroups groups of children with and without structural language difficulties, measured using the TROG-E. These groups also differed on measures testing phonology, lexical knowledge and pragmatics. The subgroup analysis carried out in this chapter adopted the cluster analysis approach described by Harper-Hill et al. (2013) and used in chapter four to test phonological memory and perception. The cluster analysis was applied to the autism and both control groups as one whole group and indicated an optimum two-cluster: TROG high and TROG low solution. However, contrary to the hypothesis, none of the children with autism were included in the TROG high group, but were clustered with their language matched peers in the TROG low cluster. For both of these groups, TROG scores were significantly correlated with age whilst the correlation was not significant for the older, age-matched typically developing children. Further exploration of differences across TROG clusters revealed poorer performance in the TROG low group on measures of phonology (CTOPP) and lexical comprehension (PPVT) as well as on adaptive language and social skills.

The final aim of the first study described in this chapter was to examine the relationship between syntax abilities and symptom severity in children with autism. Previous research on this area has shown that autistic symptomatology, as measured by standardized diagnostic tools, is negatively correlated with performance on the TROG (Norbury & Bishop 2002 ; Whitehouse et al 2008). Consistent with previous research, the results from this study revealed a similar association. Bivariate correlations highlighted a significant relationship between both diagnostic measures (GARSss and CARSss) and the TROGss. Further examination of the results showed that for CARS, the nonverbal communication subtest followed by listening response and verbal communication subtests had the highest F values in relation to determining group membership (TROG high or TROG low), while in the GARS the highest was communication followed by social interaction deficits and stereotyped behaviour. These results show that higher severity in these areas is associated with lower TROG scores in children with autism.

These results contribute to the sparse existing western literature examining the association between syntax ability and symptom severity in autism. Crucially, this study is the first to examine such a relationship using Western assessment tools to test children living in the Arab world. The results from the study were consistent with Western studies showing an association between symptom severity and impoverished syntax processing, although the comparison with language matched children also highlighted the importance of considering developmental delay when considering syntax acquisition in autism. The implication of the results will be further discussed in chapter seven.

A fourth and final aspect of language to be examined in this chapter, is pragmatics, defined as the ability to use language in a social context. The aim of the second study is to investigate pragmatic skills in children with autism and their typically developing peers.

PRAGMATIC ABILITIES IN CHIDLREN WITH AUTISM

Typically developing children usually begin to communicate by combining gestures with speech-like vocalizations at the age of 12 months, and this initiates their link to the social world. The average rate of communication at this age is one communication per minute (Tager-Flusberg, Rogers, Cooper, Landa & Lord, 2009) and children start to communicate verbally as well as non-verbally around this time. This is also the point at which children begin to adapt their own behaviour in response to the emotional reactions of others. For example, they may imitate an event that they found funny (Hobson & Hobson, 2008). By the age of 18 months, the average rate of communication is two communications per minute. Requests and comments predominate as gestural communication decreases, and children use their vocal approximations and words to solicit another's attention and to request action or assistance. Infants then begin to direct other people's attention to an object by pointing and providing a vocalization or word approximation (also known as joint attention). They also begin to acknowledge other people's speech by making eye contact, vocally responding, or repeating back words that have heard (Hobson & Hobson, 2008).

By the age of 2-3 years, the child's average rate of communication increases to 5-10 communications per minute, as s/he begins to ask questions and convey new information (Tager-Flusberg et al. 2009). Word combinations then predominate as the child engages in short dialogues. As the child's verbal skills increase s/he becomes able to introduce and change topics for discussion, express emotions, use language in imaginative ways, and provide descriptive details to facilitate comprehension (Bishop 2003). During pre-school and school years, children start talking about past and future events and acquire a repertoire of social skills. They begin to use code switching (using simpler language) when talking to very young children. Imaginative play also develops, where children assume the role of another person in play, begin using language for fantasies, jokes, and teasing, and use more filler words such as "um" to acknowledge a partner's message and a listener's point of view (Bishop, 2003). Important behaviours like projecting (giving promises), narrating (re-telling of stories), and imagining begin to develop, and children become skilled part-takers in conversations and start understanding basic social cues (Tager-Flusberg, 2000). Between the ages of 3-6, typical children also start to develop the capacity to attribute mental states (Wellman & Liu, 2004), becoming aware that they, and others, have desires, beliefs, false beliefs and may tell lies. These abilities are essential for the use of language in a social context.

In children with autism, pragmatic difficulties seem to be a primary deficit that emerges most strongly in conversations and other discourse contexts. Pragmatic difficulties are believed to be a clinical marker, distinguishing children with autism from children in other clinical groups (Reisinger, Cornish & Fombonne , 2011). A huge body of research, dating back to the early 1990s, has revealed that children with autism show limitations in their range of speech acts (Norbury , 2013), impoverished communicative gestures (Watson et al., 2013), and impaired conversational and narrative skills (Tager-Flusberg, 2001). However, the inclusion of Social (Pragmatic) Communication Disorder in DSM-5,and the proposed inclusion of Pragmatic Language Impairment (PLI) to ICD-11 (World Health Organization, 2013) has served to fine-tune the diagnostic status of children with atypical pragmatic and social difficulties and challenged the assumption that all children with such difficulties are autistic.

Consideration of subgroups and the inclusion of symptom severity data in the analysis of pragmatics was first used by Norbury and Bishop (2002). Bishop (1998) had used the terms ‘semantic-pragmatic disorder’ and ‘pragmatic language impairment’ to describe children with pragmatic difficulties who did not exhibit symptoms of autism. Norbury and Bishop (2002) compared children with Pragmatic Language Impairment (PLI) with a group with typical SLI and found that whilst they did not differ on scales assessing social relationships, they did differ on scales assessing pragmatic aspects of communication. Using the Children’s Communication Checklist (CCC) as a method to identify children with PLI, Norbury and Bishop (2002) then measured autistic symptomology using the ADOS-G , the ADI-R and the social communication checklist SCQ, in groups with PLI, typical SLI , high functioning autism and typical development.

The results showed that five out of 31 cases of children with PLI met criteria for autistic disorder on both parental report (ADI-R or SCQ) and clinical observation (ADOS-G). Many of the other children with PLI showed some autistic features, but failed to meet criteria for autism or Pervasive Developmental Disorder (PDD-NOS). These children tended to use stereotyped language with abnormal intonation/prosody, but they appeared to be sociable and communicative, had normal nonverbal communication skills, and showed few abnormalities outside the language/social communication domains. Interestingly, for many children, autistic symptomology varied with age, so that a child who might have met criteria for autism at age 3yrs scored well below cutoff when the symptoms were recomputed on the basis of current behaviour. When comparing autistic symptomology to scores on the CCC, a significant correlation was found between those two measures, and close examination of the relationship showed that whereas most children with high ADOS-G impairment scores had a low pragmatic composite on the CCC, the converse was not true. Many children who failed to meet criteria for autism on ADOS-G, exhibited pragmatic impairments as assessed by the CCC. Furthermore, no significant relationship was found between these two instruments and the SCQ diagnosis of children. Norbury and Bishop (2002) then extended their analysis to determine whether specific autistic features could be identified within language subgroups, and children were re-categorized according to their scores on the diagnostic instruments. This resulted in five groups; HFA (children with high function autism), PLI-high (children with PLI who scored above cutoff for autism on diagnostic tests), PLI-low (children with PLI who scored below cutoff on for autism on diagnostic tests), and SLI-T (children with SLI who scored below cutoff for autism on diagnostic tests). The data analysis showed that whilst the SLI-T group obtained lower CCC scores than the other groups, there was no significant difference between either of the PLI groups and the children in the HFA group on this test. These results showed that autistic symptomology can be independent of performance on the CCC, and confirmed the existence of a group of children with significant pragmatic difficulties who did not meet criteria for autism.

In a further study of children with communication difficulties Botting (2004) assessed pragmatic abilities in a sample of 161 eleven year old children with a history of communication disorders using the CCC. Four different clinical groups were examined: ASD , SLI , LILow IQ (generally impaired), and PLI. The results showed that those with SLI and LIlow IQ were less impaired than the other groups on the CCC pragmatic scale. There was a trend for those with autistic spectrum disorders (ASD) to score lowest on this scale, and they were followed, in order, by the PLI group, the LIlow IQ group and the SLI group. As expected, the children with ASD obtained the lowest overall scores on the CCC pragmatic scale. Importantly, their scores were significantly lower than those of their peers with PLI despite very similar referral pathways in the clinical study. These results were at variance from those obtained by Norbury and Bishop (2002) who reported that children with autism and PLI did not differ, and they lend support to the argument that children with PLI are clinically different from their peers with autism. However, as symptom severity was not the focus of the study, symptom severity was not measured.

Some investigations into the relationship between symptom severity and CCC performance used different clustering methods to distinguish symptom severity in clinical groups. For example, Verte, Geurts, Roeyers, Rosseel, Oosterlaan, and Sergeant (2006) compared groups of children with high functioning autism (HFA), Asperger syndrome

(AS), and pervasive developmental disorder not otherwise specified (PDD-NOS) using the CCC. The study also investigated whether empirically derived autistic subgroups could be identified with a cluster analytic method based on the ADI-R. Fifty-seven children with HFA, 47 children with AS, 31 children with PDD-NOS, and a typically developing control group of 47 children aged between 6 and 13 years participated in the study. The results showed that children with HFA, AS, and PDD-NOS showed pragmatic communication deficits in comparison to typically developing controls. Little difference was found between the three ASD subtypes with respect to their CCC profiles and a three-cluster solution best explained the data from the CCC. The HFA cluster showed most autism characteristics and obtained the highest scores on the CCC; this was followed by the combined HFA + AS cluster, and then the PDD-NOS cluster. These results suggest that autistic symptomatology might affect the performance of children with communication difficulties on the CCC.

In a study that closely investigated the effect of autistic symptomatology on pragmatic skills, Loucas, Charman, Pickles, Simonoff, Chandler and Meldrum (2008) sought to determine whether the co-occurrence of ASD and language impairment is associated with differences in severity, or pattern of autistic symptomatology or language profile. 97 children with autism were divided into those with a language impairment and those without, creating three groups: children with ASD and a language impairment (ALI), children with ASD and but no language impairment (ANL) and those with language impairment but no ASD (SLI). The children were assessed using the British Picture Vocabulary Scale (BPVS; Dunn et al., 1997) to measure receptive vocabulary and the Clinical Evaluation of Language Fundamental 3rd Edition UK (CELF; Semel, Wiig,

& Secord, 2000) to comprehensively measure semantics, syntax and morphology in the receptive and expressive domains. Pragmatic skills were measured using the parent-completed Children's Communication Checklist (CCC), and the ADI-R and ADOS-G were used to measure autistic symptomatology. Contrary to predictions, the results failed to reveal increased current autistic symptoms in the children with ALI compared with the children with ANL, and children with SLI were well below the threshold for ASD. However, whilst social adaptation scores were higher in the SLI compared with both ASD groups, their scores were still nearly 2 s.d. below norms reported in the test. In the ALI group, the combination of autism symptoms and language impairment was associated with weaker functional communication and more severe receptive language difficulties than those found in SLI. Receptive and expressive language were equally impaired in ALI, whereas receptive language was stronger than expressive language in SLI. Performance on the CCC suggested that the SLI group was below the average range suggested by Bishop and Baird (2001) and well above the cut-off for pragmatic impairment. Co-occurrence of ASD and language impairment was not associated with increased current autistic symptomatology but appeared to be associated with greater impairments in receptive language and functional communication as measured by the BPVS, CELF and CCC.

As seen above, studies into the association between symptom severity and pragmatic ability measured using CCC, have yielded mixed findings, with some studies showing that autistic symptomatology affects performance (Verte et al., 2006) and others showing that increased autistic symptoms are not associated with increased pragmatic difficulties (Loucas et al., 2008). In relation to the identification of subgroups within cohorts, several studies have been successful in identifying a sub-group of children who exhibit pragmatic difficulties without meeting criteria for autism (PLI) (Norbury & Bishop, 2002). However, to date no western studies have examined the existence of subgroups within an ASD population with varied pragmatic skills, investigated the extent that these vary with increases in autistic symptomatology or included language and age matched control groups in the analysis. Moreover, pragmatic skills have yet to be investigated in children with autism living in the Arab world. This will therefore be the first investigation to use a Western assessment measure to investigate pragmatic skills in autistic children living in the Arab world.

In the current study, the CCC-2 was used to assess pragmatics. This test has been used to assess children with autism in the past (see above) and has been shown to be a reliable measure of receptive knowledge. Table 5-8 below illustrates a comprehensive literature review of all studies that have used the CCC as a measure of pragmatic skills in children with autism. Studies were included from 1997- present. Google scholar and PSYc info were used to inform this review, and key words included: CCC, autism, pragmatic skills and resulted in 178 results. A study was included in the table if it measured pragmatic abilities in children with autism compared to a control group(s). Many studies have used the CCC to establish diagnostic criteria or for matching purposes. These studies were not included in the table below. Neither were studies where the CCC had been used to test the relatives of children with autism rather than children with autism themselves.

Table 5-8 Studies using the CCC to measure pragmatic skills in children with autism

Study	Group Size	Study group	Comparison group	Age range	Tests used
Bishop & Baird (2001)	119	ASD	ASP*, PLI ®, PDD-NOS⋆ , ADHD†, SLD⋆	5yrs-17yrs	CCC⋆†
Norbury& Bishop (2002)	32	ASD	PLI* , SLI†	6yrs-9yrs	CCC*†
Botting (2004)	161	ASD	SLI*	11yrs	CCC*
McCann et al. (2005)	31	ASD	VMAM*	6yrs-13yrs	BPVS , TROG* , CELF* , GFTA-2*
Norbury (2005)	94	ASD	AMC* , LI®	8yrs-15yrs	CCC*® , BPVS*®, CELF-2*
Verte et al. (2006)	135	ATS*, ASP® , PDD-NOS†	AMC	6yrs-13yrs	CCC*®†
Fiddler &Hippburn (2007)	44	ASD	AMC* , WS®	6:2yrs-12:5yrs	CCC*®
Loucas et al (2008)	97	ASD + LI *, ASD-LI ®	SLI	9yrs-14yrs	CCC*® , BPVS, CELF-2*
Geurts&Embrechts (2008)a	87	ASD	ADHD* , AMC®	7-14yrs	CCC*®
Geurts&Embrechts (2008)b	65	ASD	SLI®	4yrs-7yrs	CCC®
Whitehouse & Bishop (2008)	68	ASD + LI* , ASD –LI ®	SLI	6yrs-15yrs	CCC*® TROG-E*® ,
Volden& Philips (2010)	16	ASD	AMC*	6yrs-10yrs	CCC* , TOPL* , CELF-4
Pexman et al. (2010)	54	ASD	AMC* , VMAM®	6yrs-12yrs	CCC*® , TOLD-P*

Note: * † ® denotes significant differences found between groups on a standardized test
AMC - Age matched controls; ASD - Autism Spectrum Disorder; ASP - Asperger's disorder; ATS – Autism ; ASD + SLI - Autism Spectrum Disorder with language impairment ; BPVS - British picture vocabulary scale; CCC - Children's communication checklist , Bishop ; CELF - Clinical Evaluation of Language Fundamentals; GFTA-2 - Goldman Fristoe-2 Test of Articulation; LI-Language Impaired; PDD-NOS - Pervasive developmental disorder, non-otherwise specified; PEPS-C - Profiling Elements of Prosody in Speech-Communication; SLD - Specific Learning Disability; SRS - Social Reciprocity Scale ; TOLD-P (Test of Language Development-Primary; TROG - Test for reception of grammar; VMAM - Verbal Mental Age Matched; WS - Williams syndrome

The first aim of the study was to measure pragmatic performance in children with autism and their typically developing peers living in the Arab world. It was hypothesized that children with autism would perform at significantly lower levels than their age matched and language matched peers on the CCC-2. The second aim of the study was to examine the existence of subtypes within the cohort of children with autism using the results from the CCC-2 as a clustering variable in the analysis. It was hypothesized that children with autism would not exhibit skills that would allow them to be clustered along with their typical peers (i.e., that they would form a separate cluster from the typical groups). The third aim of the study was to examine the relationship between pragmatic abilities and symptom severity by directly comparing the results of diagnostic tests with the results from the CCC-2 by examining autistic symptomology in the clusters created. It was hypothesized that symptom severity would correlate with performance on the CCC-2.

RESULTS

Examining differences in Pragmatics between Children with Autism and Controls

Means and standard deviations for standard scores on the CCC-2 are shown in table 5-9 below. Scores on the Pragmatic Composite of 132 or less are an indication that a child has pragmatic difficulties (Bishop& Baird, 2001). All data were checked for normality using the Kolmogorov–Smirnov test and revealed no violations of normality. All parents were able to complete the questionnaire so there was no missing data. No outliers were detected in the analysis.

Table 5-9 Means and standard deviations on each of the CCC subscales and the pragmatic composite for the three participant groups

Subscales of the CCC (Children's Communication Checklist)				
	Subscale	Autism	Lang Match	Age Match
A	Speech	30.1 (4.5)	32 (4.7)	36 (5.1)
B	Syntax	30.3 (1.6)	31.5 (2.1)	32 (2.2)
C	Inappropriate initiation	25.0 (3.3)	27.5 (3.6)	30 (2.4)
D	Coherence	23.6 (3.1)	30 (2.4)	36 (4.4)
E	Stereotyped conversation	21.4 (4.9)	27 (3.6)	30 (2.0)
F	Use of context	22.3 (4.3)	28 (3.6)	32 (2.9)
G	Rapport	25.0 (4.7)	30 (3.4)	34 (2.9)
H	Social relationships	25.3 (4.0)	30 (4.2)	33 (3.6)
I	Interests	28.3 (2.1)	30 (2.3)	34 (2.1)
	Pragmatic composite: subscales C to G	119.6 (12.6)	135 (10.4)	158(10.3)

An initial ANOVA was carried out on the Pragmatic composite score and revealed a significant main effect of group $F(2, 53) = 19.27$, $p < .001$. A post hoc tukey test was conducted, and showed that children with autism performed at significantly lower levels than both age matched ($p < .001$) and language matched ($p < .05$) groups. As would be expected, the two typically developing groups also differed, with the older (age matched) group performing at a significantly higher level than the younger (language matched) group ($p < .05$). Bivariate correlations were then carried out to determine the relationship between age and performance on the pragmatic composite of the CCC. This was non-significant for the autism group $r = .012$, $p = .927$, and the age matched group $r = .023$, $p = .145$. However the correlation between the language matched group and age reached significance $r = .31$, $p = .05$.

Additional analysis was conducted to compare the subscales that make up the pragmatic composite (C-G). Specifically, a mixed repeated measures ANOVA was conducted to measure the difference in performance between the subtests with group as the between factor, and CCC subtests as the repeated measures factor with seven levels. Mauchly's test was non-significant so equal variances were assumed. Tests revealed a significant within-group effect $F\ (6, 80) = 54.678$, $p < .001$, $np^2=.308$ suggesting that the reported behavior of children differed on the seven subtests. A group*subtest interaction was also significant $F\ (6, 53) = 30.9$, $p < .005$, $np^2=.405$.

A series of independent sample t-tests were conducted with a Bonferroni correction (.05/7 = .007). These revealed that the parents of children with autism rated there children as significantly lower than their language matched peers on the subtests measuring context ($p < .001$) coherence ($p <.001$), stereotype ($p < .001$) and initiation ($p <.001$). However the ratings for these two groups did not differ on subtests measuring rapport, social relationships or interests. Children with autism significantly differed from their age matched peers on all subtests. Fig 5-4 below shows a graphical representation of the results.

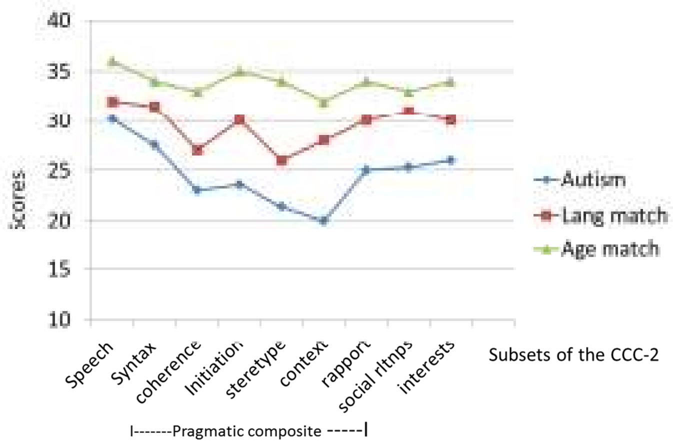


Figure 5-4 Reported abilities on each subtest of the CCC (including the Pragmatic Composite) for the three participant groups.

Examining the Existence of Subgroups in relation to Pragmatic Abilities

Matching the approach taken by Harper-Hill et al. (2013), and consistent with the data analysis in chapter four, cluster analysis was applied to the autism and both control groups as one whole group. The results indicated an optimum two-cluster solution as indicated by the BIC. Table 5-10 below shows the details of both clusters.

Consideration of the CCC pragmatic composite scores of the resulting two clusters revealed that one cluster (Cluster 1) had a higher mean standard score on the CCC (henceforth this cluster will be referred to as CCC high cluster). The other cluster (Cluster 2) had a lower mean standard score on the CCC (henceforth this cluster will be referred to as CCC low cluster).

As shown below, CCC high did not include any children with autism, while CCC low included all of the children with autism, as well as a number of children from the typically developing control groups.

Table 5-10 Details of the number of children in each participant group in each of the clusters formed

	CCC High		CCC low	
	Size	Percentage	Size	Percentage
Autism + Control	N = 25	42%	N = 35	58 %

Cluster	Total N	Autism	Lang Control	Age match
		N	N	N
Cluster 1 (CCC Low)	35	22	7	6
Cluster 2 (CCC High)	25	-	9	16

In order to further explore the data, age, phonological processing, PPVT and TROG scores were compared for the CCC high and CCC low clusters.

Table 5-11 Comparison on age and linguistic assessments between the two clusters for the whole sample

Sub/test	Clusters				Comparison df = (1 , 59)	
	Cluster 1 (CCC low) n = 25		Cluster 2 (CCC high) n = 35			
	M	Sd	M	Sd	F	Significance
Age	63.7	14.1	64.3	15.1	0.009	.925
PA	88.6	8.4	99.3	7.2	21.92	<.001
PM	85.6	10.6	97.7	7.1	10.54	<.001
PPVTss	94.2	20.5	131.1	8.9	20.52	<.001
TROGss	88.9	18.5	129.7	20.6	13.81	<.001

PA- Phonological Awareness
PM- Phonological Memory
PPVTss- PPVT standard score
TROGss- TROG standard score

An independent samples t-test was conducted to compare the effect of cluster membership on the performance on measures of standardized assessment of phonological processing, PPVT (that tests lexical processing), TROG (that tests syntax abilities), parental report of language ability (Vineland) and a measure of language and social functioning (Vineland). Bonferonni corrections were carried out for repeated testing and the new *p* value was 0.05/5 = .01. Data were also checked for normal distribution and equality of variance and no violations were reported. There was a significant effect of cluster membership on all dependent variables as shown above.

Given that the CCC has not previously been used to test children living in the Arab world and a surprisingly high number of typically developing children were included in the CCC low group a second analysis was carried out on the data from the typical children. These data are shown in table 5-12 below.

Table 5-12 Comparison on age and linguistic assessments for the control group children following the repeated cluster analysis

Sub/test	Clusters				Comparison df (1, 37)	
	Cluster 1 (CCC low) Lang & Age match only n = 13		Cluster 2 (CCC high) Lang & Age match only n = 25			
	M	Sd	M	Sd	F	Significance
Age	63.4	15.1	58.5	13.6	0.95	.335
PA	95.6	4.8	99.3	7.2	2.88	.099
PM	95.9	6.0	97.7	7.1	0.581	.451
PPVTss	111.4	9.9	131.1	8.9	36.62	<.001
TROGss	97.8	12.7	129.7	20.6	30.82	<.001

PA- Phonological Awareness
PM- Phonological Memory
PPVTss- PPVT standard score
TROGss- TROG standard score

The data were analysed using independent samples t-tests with Bonferonni corrections (0.05/5 = *p* .01). Data were also checked for normal distribution and equality of variance and no violations were reported. There was a significant effect of cluster membership only on scores on the PPVTss (that tests lexical skills) and TROGss (that tests syntax processing), and this result was different from the one that included the children with autism. As the table above shows, the effect of age, PA and PM no longer reached significance when the children with autism were excluded. For typical children, significant differences were observed with PA, PM and PPVT in the different clusters.

Examining Symptom Severity in Relation to Language Abilities

Finally, an analysis was carried out on the symptom severity data for the CCC high and CCC low groups. As the autistic children were all clustered in the CCC low group, symptom severity was inevitably higher in this cluster. However, the focus of the analysis was to compare the subsets of the GARS and CARS across the groups.

Table 5-13 Differences in symptom severity as shown by the GARS and CARS subsets between the two clusters

Sub/test	Clusters				Comparison df (1,59)	
	Cluster 1 CCC Low		Cluster 2 CCC high			
	M	Sd	M	Sd	F	Significance
GARSss	78.4	31.9	49.5	13.0	14.19	<.001
Social Interaction	6.89	5.00	1.01	0.61	20.96	<.001
Communication	6.56	4.71	1.53	0.55	16.87	<.001
Stereotyped behaviour	5.08	4.33	1.05	0.84	15.95	<.001

CARSss	17.0	4.7	29.5	11.4	16.26	<.001
Relating to people	1.40	.51	3.00	1.10	21.22	<.001
Social understanding	1.21	.45	2.98	.90	17.31	<.001
Emotional Regulation	1.21	.43	2.55	.85	13.24	<.001
Adaptation to change	1.05	.22	1.73	.87	11.00	<.005
Visual response	1.05	.20	1.77	.74	15.40	<.005
Listening response	1.04	.20	1.74	.69	10.63	<.001
Fear or Anxiety	1.00	.10	2.05	.82	10.32	<.001
Nonverbal communication	1.53	.50	2.50	1.20	18.83	<.001
Verbal Communication	1.16	.22	2.98	1.32	15.67	<.001
Level of intellectual response	1.01	.44	1.70	.89	13.56	<.001
Object use in play	1.55	.22	1.96	.78	15.79	<.001

Independent samples t-tests were conducted to compare the effect of cluster membership on the performance on measures of standardized assessment of phonological processing, PPVT (that tested lexical skills), TROG (that tested syntax processing), parental report of language ability (Vineland) and a measure of language and social functioning (Vineland). Bonferroni corrections were applied to the data (0.05/15 = *p* .003). Data were also checked for normal distribution and equality of variance, and no violations were observed. There was a significant effect of cluster membership on all dependent variables, as shown in Table 5-13 above. In the CCC low group, GARS scores were significantly higher, indicating greater symptom severity in this group. Specifically, social interaction and communication scores were higher than stereotyped behaviour scores suggesting that higher severity in these areas might contribute to lower CCC scores. As for the CARS scores in the CCC low group, CARSss scores were significantly higher indicating greater symptom severity in this group. Specifically, the highest difference was in the relating to people, followed by social understanding, and nonverbal communication subtests.

In order to further address the third aim of the study that examines the relationship between pragmatic abilities and symptom severity in children with autism. Fig 5-5 shows a simple scatterplot exhibiting the relationship between the standard score of the CCC performance on the GARSss and CARSss for both control groups and children with autism. This also shows the individual profile of the children's scores on the diagnostic measures in relation to control group. Scatterplots show the relationship between pragmatic composites (pc) on the CCC and GARSss (right) and CARSss (left),

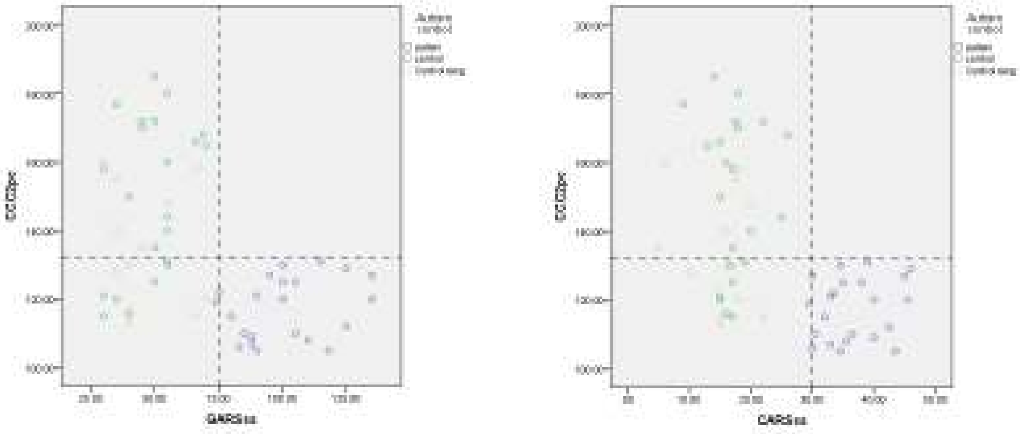


Figure 5-5 Scatterplots showing the relationship between the GARSss and the CCCpc and the CARSss with the CCCpc the vertical dotted line indicates the cut off point for GARS and CARS for possibility of autism, the horizontal dotted line indicates the score on the Pragmatic Composite of 132 or less which are an indication that a child has pragmatic difficulties (Bishop & Baird 2001)

To further examine the relationship between symptom severity in children with autism and their reported abilities on the CCC, bivariate correlations were carried out. The analyses were conducted using the Pearson product-moment correlation coefficient. Table 5-14 shows a correlation matrix that shows correlations between the pragmatic composite of the CCC and standard scores on the GARS and CARS for the children with autism. Results revealed significant correlations between reported abilities on the CCC pragmatic composite and symptom severity as measured by the GARSss and the CARSss.

Table 5-14 Correlation matrix exhibiting the relationship between diagnostic measures and reported abilities on the CCC pragmatic composite for children with autism

	GARSss	CARSss	CCCpc

CCCpc	-.443**	-.524**	1
CARSss	.49**	1	
GARSss	1		

** = p < .001

Given that this test has not previously been used to test pragmatic skills in typical children living in the Arab world, and that a substantial proportion of the typically developing children obtained low ratings on the CCC, the correlations were also carried out on their data. Table 5-15 below shows a correlation matrix that examined correlations between the pragmatic composite of the CCC and standard scores on the GARS and CARS for the typically developing children. As shown in the table below, the correlations between the pragmatic composite of the CCC and standard scores on the GARS and CARS were not statistically significant for the typically developing children.

Table 5-15 Correlation matrix exhibiting relationship between diagnostic measures and reported abilities on the CCC pragmatic composite for the typically developing children

	GARSss	CARSss	CCCpc
CCCpc	.15	-.21	1
CARSss	.22	1	
GARSss	1		

Finally, the relationship between reported abilities on the CCC and symptom severity was considered for individual children with autism. The pragmatic composite scores for the CCC, GARSss and CARSss were converted into z-scores for ease of comparison. Fig 5-6 shows the z-scores of these scores together. The x-axis shows the child's case number and the y-axis shows the means of z-scores. It is worth noting that many scores on the CCC pragmatic composite were below the mean (and therefore showed a minus z-score). High CARSss and GARSss scores indicate high severity while a low CCC pragmatic composite score indicates deficits in pragmatic abilities.

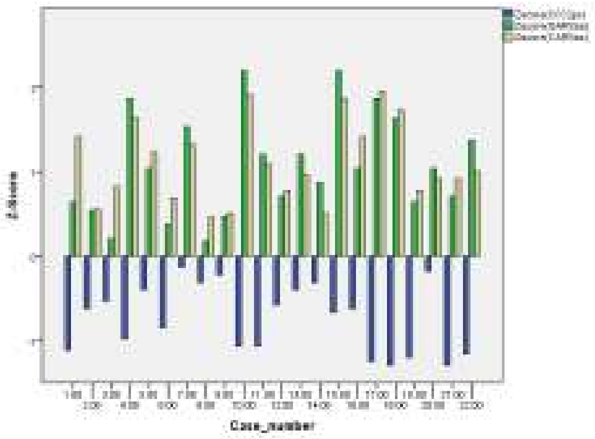


Figure 5-6 Z-scores of CCCpc with GARSss and CARSss

As can be seen from the graph, a range of patterns of scores were apparent. For example, lower scores on the CCC corresponded to higher scores on the CARS and GARS in cases 15, 17 and 18. At the same time higher scores on the CCC corresponded with lower scores on the CARS and GARS in cases 8 and 9. However at the same time some cases (7, 14 & 20) did show high CCC scores and moderate/high symptom severity.

DISCUSSION

The first aim of the second study presented in this chapter was to compare children with autism and language and age matched controls living in the Lebanon on a test of pragmatics using a measure widely used in the West. In autism, pragmatic difficulties are most noticeable in conversations and other discourse contexts and some studies have suggested that such deficits represent clinical markers that distinguish children with autism from children in other clinical groups (Botting & Conti-Ramsden, 2003; Reisinger et al., 2011). As there is a substantial body of evidence showing that significant pragmatic deficits can be observed in children who do not meet criteria for a diagnosis of autism (e.g. Norbury & Bishop, 2002), and with the recent introduction of Pragmatic Language Impairment (PLI) to the DSM-5, it is now clear that pragmatic deficits do not necessarily signal the presence of autism. However, pragmatic deficits do appear to be a fundamental deficit in individuals with this diagnosis (see Norbury 2013, for a review).

It was hypothesized that the children with autism would differ significantly from their age matched and language matched groups on the CCC measuring pragmatic skills. The results showed that children with autism performed at significantly lower levels than both age and language matched peers and the data analysis revealed particular difficulties with the context, coherence, stereotyped conversation and initiation subsets of the CCC.

Additionally, the results revealed a significant difference between the two typically developing groups, with the older (age matched) group performing at a significantly higher level than the younger (language matched group). However, bivariate correlations were non-significant between age and reported abilities on the CCC for the control groups. However, when separate correlations were carried out for the two control groups, age and CCC scores correlations reached significance between the language matched group and age.

There may be a number of reasons why the children from the younger language matched group obtained lower reported skills on the CCC than the age matched older children. The mean age of the language matched group was 4 years, 6 months and some items may be particularly age sensitive. For example, in the rapport subset, items such as "makes good use of gestures to get his point across" , and in the stereotypical conversations items such as : "will suddenly change the topic of conversation" may be more likely to be identified as behaviours that not yet been observed by parents of very young children. However, when ANOVA was used to analyse performance on the subtests no specific subtests appeared to be particularly problematic for the younger typically developing children. It is also important to note that none of the children in the language matched group reached the cut-off point for pragmatic abnormalities as reported in the CCC manual, and symptom severity scores were not correlated with the CCC scores for those children.

The second and third aims of the study were to look at the existence of subgroups in relation to pragmatic skills and investigate the relationship between pragmatic abilities and measures of symptom severity in children with autism. Previous studies have shown that there is a clear link between autistic symptomology and pragmatic difficulties. In their study Norbury and Bishop (2002) reported that most children with high ADOS-G impairment scores had a low pragmatic composite score on the CCC. However, not all children who had high CCC scores had high ADOS-G scores as their cohort encompassed children with PLI who had pragmatic difficulties but scored low on autistic symptoms. Verte et al. (2006) used cluster analysis with a group of children with HFA, AS and PDD-NOS who were assessed on the CCC. The analysis showed that a three-cluster solution explained the data best, with an HFA cluster showing the most autism traits and achieving the lowest score on the CCC, followed by a combined HFA + AS cluster , and finally the PDD-NOS cluster. Such studies exhibit the effect of autism symptomatology on pragmatic ability in children with this disorder. However, not all studies have shown such a strong link. For example, Loucas et al. (2008) found that while greater impairment in receptive language and functional communication, as measured by the BPVS and CELF, was directly related to impairments on the CCC, autistic symptomatology was not. Their study showed that children with autism and language impairment did not show more autistic symptoms than children with autism without language impairment and symptom severity measured by the ADOS-G did not correlate with reported skills on the CCC.

In the current study, CCC high (with a higher mean score on the CCC) and CCC low (with a lower mean score on the CCC) clusters were identified. The CCC high cluster included children from the age and language matched control groups and no children with autism. All of the children with autism and a number of typical children were included in the CCC low cluster. When the two clusters were compared on age and language variables, higher PPVTss (lexical measure) and TROGss (Syntax measure) were reported for the CCC high group, whilst there was no group difference on age or on measures of phonological awareness, or phonological memory. Firstly, this might mean that age was not an important factor in determining cluster membership, and this was also apparent in the correlations conducted with age (although they did reach significance with the language matched group). Secondly, this might also mean that phonological processing was not an important factor either in determining group membership, and is not directly related to performance on the CCC. However, such an interpretation of results cannot be made with certainty since a good proportion of the CCC low group was made up of children with autism.

Poor scores on the CCC may also be a cultural artifact as parents in Lebanon might interpret the questions in a different way to parents in the West. The results that scores on the CCC were unrelated to symptoms of autism in the typical children support this suggestion. However, whilst these scores are not associated with autism symptoms they may be associated with age in this sample. The implications of findings showing low CCC scores in typical children living in Arab countries will be further discussed in chapter 7.

The final aim of the study was to examine the relationship between symptom severity and pragmatic skills across the three groups. Given that all of the children with autism were included in the CCC low cluster, the total group difference on CARSss and GARsss was unsurprising. However, the analysis of the subsets revealed a more interesting finding: GARS scores were significantly higher in the low cluster, indicating greater symptom severity in the CCC low cluster. Specifically, social interaction and communication scores were higher than stereotyped behaviour scores indicating that higher severity in these areas might contribute to lower CCC scores. As for the CARS scores, CARSss scores were significantly higher in the low cluster indicating greater symptom severity in the CCC low cluster. Specifically, the highest difference was in the relating to people subtests and this was followed by the social understanding, and nonverbal communication subtests.

The scatter plots also showed the individual data from the children with autism and the two control groups and highlighted the relationship between high symptoms and low reported skills on the CCC-2 for both the CARS and GARS. They also revealed the high variability in scores for the children with autism, although they all scored below the cut-off point on the CCC-2 (indicating a deficit in pragmatic skills) and above the cut-off point on the CARS and GARS (indicating a diagnosis of autism).

Correlations were conducted for the three participant groups separately, and revealed significant correlations between reported skills on the CCC-2 and symptom severity for children with autism. They also revealed non-significant correlations between reported skills on the CCC-2 and symptom severity for children in the typically developing groups separately.

Taken together, the results revealed significant deficits on the CCC-2, in children with autism compared with their age and language matched peers. When cluster analysis was carried on the CCC-2 data, no child with autism was included in the CCC high group. In the autism group, pragmatic skills were associated with scores on tests of receptive vocabulary and syntax but not on age or phonological processing. For typical children pragmatic skills were associated with syntax skills (TROG) and lexical skills (PPVT). Investigation of the symptom severity data showed a positive association between symptom severity and reported skills on the CCC for children with autism but not for the typical groups. In sum, the findings of the standardized language assessments show that children with autism do differ from their language and age matched peers however not on all linguistic skills, and also show great variability in results. In the following chapter two studies will investigate two strategies of language acquisition; the noun-bias and subject-verb order in sentences.

Chapter 6 : EXPERIMENTAL MEASURES OF ASSESSMENT

ABSTRACT

The experiments described in this chapter utilized a paradigm that has previously been used to investigate the noun and subject-verb order biases in sentence processing, in children with autism. To test these crucial components of language learning, participants were presented with an audio and two contending visual stimuli within intermodal preferential looking paradigms (IPLs). The first paradigm tested the children's ability to attribute a novel word to a noun rather than a verb. The second paradigm tested comprehension of the subject-verb order frame of a sentence. Performance on the paradigms was examined for group differences and the data were correlated with measures of symptom severity and performance on standardized measures of language skills. The results from the studies showed that children with autism show a noun bias and a subject-verb order bias and that performance on experimental tests of these biases was not correlated with measures of symptom severity. The use of experimental methods for investigating language abilities within an Arab clinical setting are discussed.

Theoretical justification of experimental testing

The previous chapters presented data from standardized language assessments widely used to test children with autism in the Western world. In the West, clinicians rely on standardized assessment tests to diagnose children with language delay, and to design and monitor treatment programs, whilst researchers may use standardized assessment tests to document their participant's language status, to match groups of participants, or to investigate specific aspects of language in different populations. A major advantage of standardized assessment tests is that they are norm-referenced and provide a relatively quick means for comparing a child to his/her age-matched peers. When tests have been normed on similar samples, they also allow one to compare a child's performance across different tests to yield a profile of language performance across language domains. This type of analysis was carried out in chapters four and five on a Lebanese sample of English speaking children with and without autism.

However, in the structured context of standardized assessments, factors such as a child's test-taking skills, attention, or motivation to interact with the examiner may also contribute to language test scores. Social interaction and attentional difficulties, as well as difficulties in complying with task demands, are characteristic in autism and well-designed experimental paradigms may provide a useful tool for researchers wishing to examine components of language in a manner that allows for scientific enquiry and manipulation. To date, experimental studies have been used to assess a range of language skills, including phonology, lexical knowledge, syntax and pragmatics, in children with autism (Condouris, Meyer, & Tager-Flusberg, 2003). The following sections will describe two experimental paradigms that were designed specifically to examine lexical processing mechanisms and syntax knowledge. Both paradigms examine linguistic constructs using Intermodal Preferential Looking paradigms (IPL) used in a previous study by Swensen, Kelley, Fein and Naigles (2007).

Intermodal Preferential Looking paradigm (IPL)

The IPL paradigm was developed to investigate linguistic knowledge through the assessment of language comprehension rather than production (Hirsh-Pasek & Golinkoff, 1996). The IPL paradigm tests comprehension by showing children side-by-side dynamic videos depicting different objects, actions, or more complex events. The two video clips are presented concurrently with an audio clip that is congruent with only one of the two videos clips shown. It is argued that if children understand the language in the audio clip, they will look longer at the matching video. Thus, this method uses the child's patterns of eye-movements or head turn preference as an indicator of comprehension. In studies carried out in the western world, the IPL method has been used to study novel word acquisition (Arias-Trejo, Falcón, &Alva-Canto, 2013; Naigles & Tovar, 2012; Swensen, Kelley, Fein, & Naigles, 2007) and knowledge of grammatical constructs (Candan, Küntay, Yeh, Cheung, Wagner, & Naigles, 2012; Naigles, Kelty, Jaffery, & Fein, 2011) in children with autism. An advantage of the IPL paradigm is that it does not necessarily require participants to make verbal or other types of deliberate responses and can therefore be used with intellectually lower functioning children, or children with social interaction difficulties. Another further advantage is that the linguistic stimulus is projected from a central speaker rather than from a person, and this reduces the degree of social interaction required of the child. Finally, experimental stimuli may be relatively short in duration (depending on the paradigm the maximum duration is under 6 minutes), and this may reduce task demands for children who experience attentional difficulties. Given the potential advantage of IPL paradigms for use in a clinical setting, they were used in both experiments described in this chapter.

Experiment One: Noun Bias

According to Swensen et al. (2007), research on language acquisition in typical children and children with autism can focus on the products or the process of such acquisition.

According to these researchers, product oriented research assesses the extent to which children produce or understand specific language constructs. For example, such research investigates children's lexical knowledge and receptive comprehension (as measured by standardized measures of assessment). In contrast, process-oriented research investigates the processes by which these aspects of language are acquired. Thus they investigate processes such as the extent to which maternal input predicts subsequent variation in children's use of their lexicon; the patterns of emergence of specific linguistic constructs; whether children use specific biases or strategies when learning new words; and whether or not children's acquisition of linguistic forms depends upon their ability to produce such forms (Swensen et al., 2007).

Product oriented research investigating lexical knowledge in children with autism has shown that children with high functioning autism perform well on standardized vocabulary tests, and exhibit similar superordinate- and basic-level organization of their lexicons (Kelley et al., 2006;Kjelgaard&Tager-Flusberg, 2001). However, children with autism also use a markedly limited range of morphological and syntactic forms in their spontaneousspeech (Fein et al., 1996; Scarborough, Rescorla, Tager-Flusberg, Fowler, & Sudhalter, 1991) and their word meanings do not appear to be as detailed and well integrated across lexical domains as those of typically developing children (Dunn & Rapin, 1997; Fein et al, 1996; Kelley et al., 2006; Minshew, Meyer, & Goldstein, 2002).

In contrast, process oriented research has looked at word learning strategies in children with autism, and such research has shown that children with autism have difficulty following a speaker's gaze to determine the referent of a novel word. For example, in one study, Baron-Cohen, Baldwin and Crowson (1997) found that children with autism failed to monitor referential intent in a word learning situation. In their study, the experimenter gave each child a new, unnamed and unfamiliar novel object, waited until the child attended to this object, and then uttered a novel word. However, when the experimenter uttered the novel word she was looking at a different novel object held in her own hand. Normally developing 24-month-old children did not map the word to the item they themselves were looking at, but rather followed the experimenter's gaze, applying the word to the item within the experimenter's line of sight. Children with autism instead mapped the word to the item that was within their own line of sight and failed to use gaze as a referential cue. However, Preissler and Carey (2005) replicated Baron-Cohen et al.'s experiment but added a new condition. In this condition they presented pictures of a familiar object alongside a picture of an unfamiliar, object and the child was asked to point to the picture that corresponded with "blicket", a new unfamiliar word. This condition showed that whilst children with autism have trouble mapping the speaker's intent, they do assume that novel words refer to unfamiliar rather than familiar objects.

IPL paradigms have also been used to measure new word learning strategies in typically developing children and children with autism. Such studies have investigated the shape bias (Tek, Jaffery, Fein, & Naigles, 2008), the noun bias (Swensen et al., 2007), and syntactic bootstrapping (Naigles et al., 2010). One study, carried out by Tek et al., (2008) was motivated by results showing that some children with autism acquire a sizeable lexicon, and aimed to determine whether these children understood and/or stored the meanings of words differently from typically developing children. One of the mechanisms that help typically developing children to learn novel words is the shape bias, in which the referent of a noun is mapped onto the shape of an object, rather than onto its colour, texture, or size. Tek et al. (2008) hypothesized that children with autism would show a reduced or absent shape bias. Using the IPL paradigm, to investigate the shape bias, they compared the performance of young children with autism and typically developing children, across four different time points. Neither group showed a shape bias at Visit 1, when half of the children in both groups produced fewer than 50 nouns. Only the typical group showed a shape bias at Visits 2, 3, and 4 and a growth curve analysis, based on the number of nouns acquired across the time period, showed that the rate of increase in shape bias scores over time was significant for the typical children. In contrast the children in the autism group failed to show the same increase in shape bias scores. The authors of the study concluded that a shape bias can be observed at 24 months of age in typical development and is closely linked to subsequent increases in nouns. Whilst this pattern was not observed in the children with autism, they nevertheless possessed a sizeable vocabulary, and this suggests that there may be an association between vocabulary size and biases typically involved in language acquisition in these children.

The noun bias has been proposed as a strategy for early vocabulary acquisition (Golinkoff, Mervis, & Hirsh-Pasek, 1994). The principle is that when a child hears a new word, their preference is to map that word onto an as-yet-unnamed object, rather than the colour, texture or associated action of that object. This is further illustrated in the fact that typically developing toddlers generally produce many more nouns than words in any other form class, and have been shown to prefer to map novel words onto novel objects rather than onto novel actions or properties (Hollich, Hirsh-Pasek, &Golinkoff, 2000;

Waxman,2004). In a study of lexical acquisition, Swensen et al.(2007) investigated the noun bias in 13 children with autism and 10 younger typically developing children, language matched using the Bates – MacArthur Child Development Inventory(CDI) (Fenson et al., 1994). Using an IPL paradigm they measured the children's tendency to map a novel word to either a noun or an action via their looking preferences. In the experiment children were presented with a new word and were simultaneously shown a video clip of a novel object and a video clip of a novel action. The children's looking preference was filmed and analyzed and the analysis of these data showed that both groups of children behaved as if a novel word referred to a novel object rather than a novel action. The researchers concluded that the children appeared to be using a principle of noun bias when first confronted with a novel word and two possible referents. Such a finding confirms results obtained by Preissler and Carey(2005), showing that children with autism do in fact rely on noun acquisition processes that are similar to those used by typical children. However, a limitation in this research is that it does not inform our understanding about whether such early use of a noun bias is related to vocabulary growth, or if close to normal performance on some standardized assessment tests is associated with an early noun bias in autism (Tager-Flusberg et al., 2001). Another important question that this research failed to address concerns the relationship between the use of seemingly typical language acquisition biases and symptom severity and/or adaptive functioning in autism. These questions will be addressed in the studies presented in this chapter.

While the first two aims of the current thesis, were to compare language abilities in children with autism and their peers using standardized assessments, and to explore the relationship between scores on these assessments and measures of symptom severity (addressed in chapters 4 and 5), the final aim of this thesis, and the focus of the current chapter, was to evaluate the use of experimental methods in measuring language related skills in English speaking children with autism and age and language matched typical children living in Lebanon. The two studies presented in this chapter will therefore use experimental methods to determine whether language acquisition processes distinguish children with autism from those with typical development. The language and clinical correlates of biases involved in language acquisition will also be investigated. It was hypothesized that in autism a noun-bias would be positively associated with scores on standardized language assessments and scores on measures of adaptive functioning. In contrast, the presence of a noun-bias would be negatively associated with measures of symptom severity. The following sections will detail the construction of the paradigm, the piloting of materials, the data collection, and the results.

Paradigm construction

The Intermodal Preferential Looking paradigm (IPL), devised by Golinkoff, Hirsh-Pasek, Cauley and Gordon (1987), was originally developed for the purpose of investigating language abilities in 1-and 2-year-old children. In IPL studies children are presented with two videos scenes, placed side-by-side, that differ on a single linguistic construct. A linguistic audio clip that is congruent with one of the video clips is also presented. It is assumed that children who understand the linguistic audio clip will look longer at the congruent than the incongruent video clip. Researchers film the children’s eyes while they view the two videos, and later code their eye movements and head turn preferences to determine their direction of looking to each video. In order to control for stimulus salience, test trials (with audio) are always compared with earlier (video only) trials (Piotroski & Naigles, 2012).

The paradigm used in the current study was a modified version of the one used by Swensen et al. (2007), to investigate the noun bias in children with autism and typical development. Two main limitations in the Swensen et al., study were addressed. First, the participants in the Swenson et al. study were tested in their own homes, and as the authors acknowledged, this introduced a number of uncontrolled and potentially confounding variables. To solve this problem, all data collection was conducted either in the same clinical setting for children with autism (figure 6-1-a), or in the same school setting for typical children (figure 6-1-b). All distractions were kept to a minimum across all testing sessions. Secondly, Swensen et al. collected their data after the children with autism had been exposed to therapy, and as the extent of this varied across children, it could not be controlled in the study. This limitation meant that it was difficult for the researchers to draw firm conclusions about the results of their study. In the current study, the standardized assessments (reported in chapters 4 and 5) and experimental studies (reported in this chapter) were carried out in the period before children were allocated to different therapists and enrolled on their therapy programs in the Lebanese clinic. This ensured that performance on the IPL and standardized tests was not influenced by any therapeutic intervention already (or concurrently) received.

a b

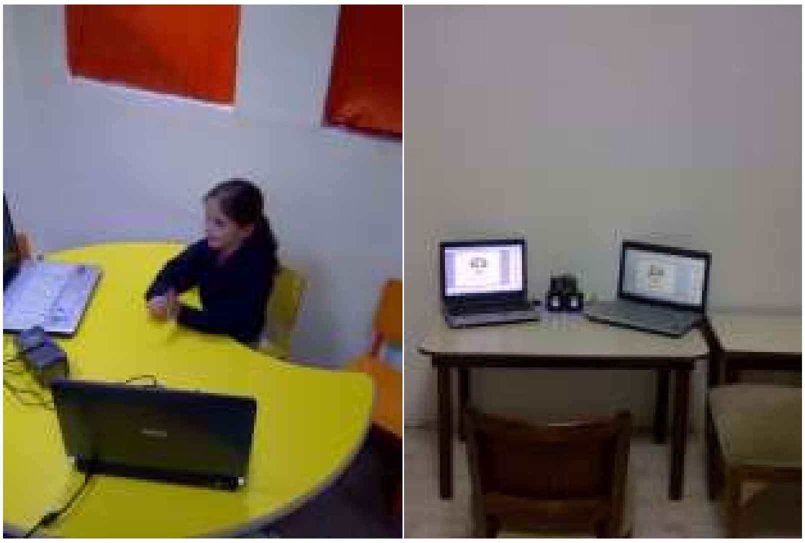


Figure 6-1 IPL paradigm used in this study a) testing done with typical children b) set up for children with autism

As seen in figure 6-1, a chair was placed 2.5 to 3 feet from the camera, and immediately in front of the video screens. The child was invited to sit on the chair, or on the parent's lap. If on parent's lap, the parent was given an mp3 player and ear buds. Children were then encouraged in general terms to "watch the movie”. The experimenter ensured that the child's face could be recorded by the camcorder, and this was re-checked whenever the child moved around.

The experiment consisted of 10 blocks of five trials. Each video clip (trial) was presented for approximately six seconds with a three seconds interval between blocks. This resulted in a total of 36 seconds per block and 3.5 minutes for the entire video. All videos were presented on a laptop computer and the audio was presented via speakers (see fig.4-1). All sessions were filmed to code for head turn preference. The children were asked if they needed a break after each block and were rewarded with a small gift at the end of the session.

The visual stimuli used in the experiment were a group of five glove puppets as seen in figure 6-2 a. The visual stimuli differed from that used in the study by Swenson et al., in which they used a possum puppet which they assumed was unfamiliar and unnamed to the children in the study (shown in figure 6-2 b).

a)

b)

Figure 6-2 a) the five puppets that were used in this thesis in the noun bias paradigm, and b) the possum puppet used in the Swensen et al (2007) experiment

The auditory stimuli were a group of five novel *non-words; toopen, piffen, gippen, blacken and zellen. The children were first presented with a novel unfamiliar puppet and novel un-familiar word, paired with a novel unfamiliar action. The order of presentation of trials replicated Swensen et al.'s study, and an example of one block of trials is shown* table 6-1 (Swensen et al.) and figure 6-3 (the current study).

Table 6-1 Block trial of the Swensen et al. study

Video 1	Audio	Video 2
1 Possum puppet digs with nose	Here's TOOPEN!	BLACK
2 BLACK	See, TOOPEN!	Possum puppet digs with nose
3 Possum puppet digs with nose	Look, TOOPEN!	Possum puppet digs with nose
4 Possum sways side to side	(NO AUDIO)	Beetle digs with nose
5 Possum sways side to side	TOOPEN?	Beetle digs with nose

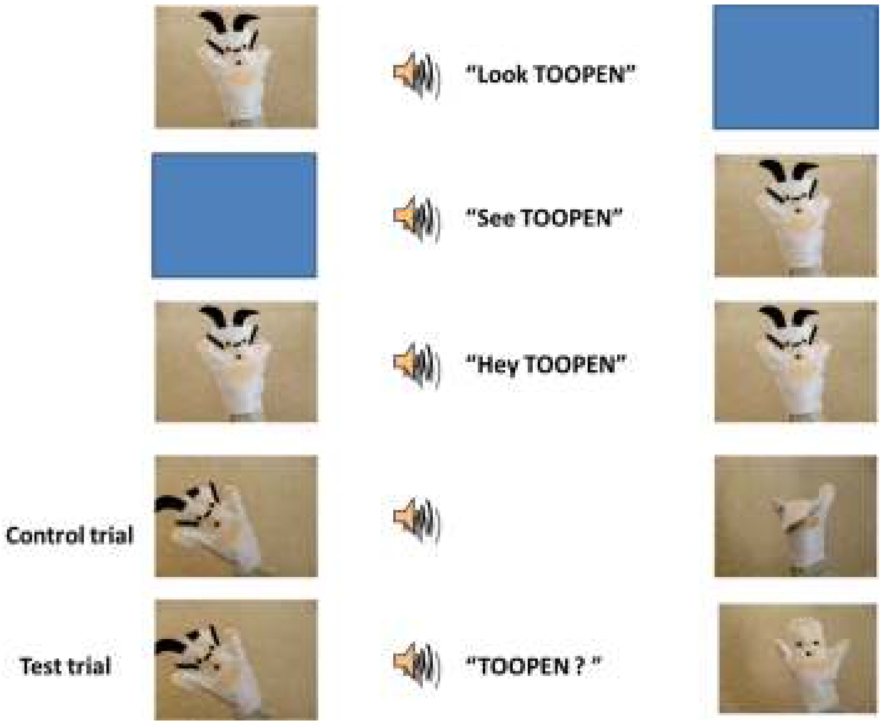


Figure 6-3 An example of the videos viewed by the children in the noun bias study in the current study

As figure 6-3 shows, each block included five trials. In the first three (teaching) trials, children were presented with the novel word (e.g. Toopen) paired with a puppet (e.g. possum) digging with his nose, on one of the two screens. At the end of trial three it is unclear whether Toopen refers to a noun (the novel character) or a verb (the action - digging with nose). Trial four is silent and the noun and verb are presented separately. On one screen the puppet that had been viewed in trials 1-3 performs a novel action (sways from side to side) and the second screen shows the action viewed in trials 1-3 (digging with the nose), performed by a new character. As this trial lacks an audio stimulus it serves as a baseline trial (i.e. control trial). The visual stimuli in the fifth trial is the same as in trial four, it is accompanied by the auditory stimuli (novel word). This is the test trial and shows whether the child has mapped the novel word onto the novel object (noun bias) or the novel action (verb bias).

Coding and scoring

All films were imported and coded by the examiner into a nonlinear editing program. The onset of trial four (baseline) and trial five (test trial) were identified by adding a red circle to the frame. The child's film was screened and the frames where the child heard the test audio were identified. A red circle was added to that frame at the inter trial interval, before each target trial (*i.e.,* there is no tone and the centering light is presented; the child should be centering or looking away). This red circle indicates to the coders that they should record each change of gaze as L (to the left), R (to the right), C (to the center) or A (away: up, down, far left, far right, back).Extra attention was taken to ensure that coders were unaware of the nature or location of the stimuli presented on each given trial. The video film was coded without sound and red circles indicated the onset and offset of each trial. The coders assessed the child's duration and direction of looking during each coded trial. Ten percent of the videos were second coded for reliability and these results will be presented in the section below. The two coders were volunteers from the American University of Beirut nutrition and health faculty research institute and were trained on video coding before commencing coding.

Data collected from trials four (baseline) and five (test trial) were taken as an indicator of the children's looking preference in the experiment. The rationale is that children who show a noun bias would switch their gaze to the object (puppet) once the test trial began and would also look at the object for longer in the test trial than in the baseline trial.

When testing very young participants and/or children with developmental delays, it is inevitable that some individuals will not look at either scene for some proportion of each trial, and on some trials, they may not look at either scene at all. According to Naigles and Tovar (2012), the following conventions may be applied in these cases of lapsed attention: (a) Children need to look to at least one scene for a minimum of 0.3 sec for that trial to be included in the data analysis. Otherwise, it must be considered to be a missing trial; (b) Children need to provide data for more than half of all the test trials in the ten blocks of trials, for their data to be included in the final dataset; and (c) Missing trials are replaced with the mean score across children in that age group/condition for that item.

Participants

Participants in these studies were the same ones that completed the studies described chapters 4 and 5. However, some individuals were unable to complete testing and details of excluded participants and missing data are shown below.

Results

Reliability between coders was calculated and showed that the correlation averaged .89 (SD = .10); Cohen's k calculations yielded .93 agreement.

The percentage of excluded trials for the noun bias experiment was 4.5% for the children with autism and 7.9% for the typical group. These exclusion percentagesare very similar to those reported in previous studies using IPL paradigms (Swensen et al., 2007; Naigles& Tovar 2012).

Examining differences in Performance between Children with Autism and Controls

The proportion of the time the children spent watching the videos was calculated against the total time they spent in the testing room after the videos began to be presented. The percentage of time the children spent attending to the noun bias video was 58% for the autism group, 69% for the language matched group and 75% for the age matched group. Thus, the three groups watched the videos more than half the time.

Fig 6-4 shows the mean percentage of looking time to the matching screen for the control (blue shaded) and test trials (green shaded) for the autism and typical groups. As can be seen from this figure, the children looked longer at the match during the test trials compared to the control trials.

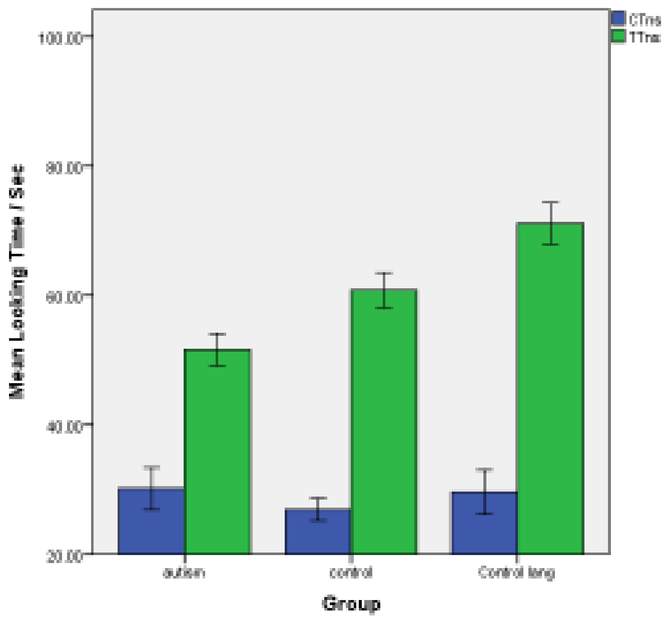


Figure 6-4 Mean looking time to match for noun bias video data from baseline and test trials blue bars represent control trial, green bars represent test trials error bars: -/+ 1 SE

To consider the relationship between test performance and measures of symptom severity and standardized language test performance, a new dependent variable (difference score) was calculated. Here the looking time to baseline trials was subtracted from looking time to test trials. This means that if child A's score was 8/10 on the test trials, and 3/10 on the baseline control trials, his/her final score would be 5.

Table 6-2 shows the Mean, SD and range of difference scores and baseline and test trial scores (in seconds) for the participants in the three groups. As mentioned in chapter two missing data was treated with list-wise deletion and the analysis was conducted without the missing data.

Table 6-2 Mean, SD and range of difference scores and baseline and test trial scores (in seconds) in the noun bias paradigm for individual participants within the three groups tested

	Autism n = 21 Mean (SD)	Age matched n = 20 Mean (SD)	Language matched n = 15 Mean (SD)
Test Trial (Sec)	52 (12.4)	60 (10.1)	72 (8.5)
Baseline trial (Sec)	31 (10.4)	25 (6.5)	29 (9.9)
Difference score	3.70 (2.75)	5.31 (1.99)	4.05 (1.64)

A mixed ANOVA with group as the between-subject factor and trial as the within-subject factor was carried out on the baseline and test trial scores. This revealed a significant main effect of trial F (2, 56) = 14.25, $p < .001$ with increased looking time in the test trial compared with the control trial. There was also a significant effect of group F (2, 56) = 10.66, $p < .001$, and a significant group* trial interaction F (2, 56) = 3.86, $p < .05$.

One way ANOVA was carried out with group as the independent variable on the difference score data revealed a significant main effect of group F (2, 59) = 3.38, $p < .05$ and post hoc comparisons using Tukey HSD test indicated that the mean difference score for children with autism (M = 3.70, S.D = 2.75) was significantly lower than that of the age matched group (M= 5.31, S.D = 1.99). However, the difference score for the autism group was not significantly different from that of the language matched group (M= 4.05

S.D = 1.64). The mean difference scores for the two control groups did not differ from each other.

Pearson correlations were conducted to examine any associations with difference scores from the noun bias paradigm and age. This was significant for the autism group (r = .31, $p < 0.05$), but not for the language matched group (r = .42, p =.19) or the age matched group (r = .26, p = .61).

Correlations were then conducted to examine the relationship between performance on the PPVT, the standardized assessment measure of receptive vocabulary, and the difference scores from the noun-bias paradigm. The PPVT was selected for inclusion in this analysis because it measures the linguistic ability most closely linked to the linguistic bias measured in the experiment. The correlation was significant for the autism group (r = .51, p <.05) and the language matched control group (r = .21, p < .05), but not for the age matched control group (r = .15, p = .11).

Finally correlations were conducted on difference scores from the experimental paradigm and symptom severity scores as measured by the CARS and GARS for the children with autism. Pearson correlations were conducted and revealed non-significant correlations for both the CARS (r = -.34, p = .51) and the GARS (r = -.41, p = .46). The data are insufficient to provide clear evidence of a relationship between levels of symptom severity and noun-bias in children with autism, though the large negative values for r suggest that an effect may be present, but which did not reach significance due to the limited sample size in the autism group.

Discussion

Previous research on components of word acquisition in children with autism has been inconclusive and while some studies have revealed an inadequate utilization of word learning mechanisms in these children (Tek et al., 2008), others have reported similar performance to age and/or language matched typical children (Preissler & Carey, 2005; Swensen et al., 2007).Whilst the confusion in the literature may specifically reflect inadequate participants matching procedures, which will be further discussed, these studies have also failed to inform our understanding about whether underutilization of word learning strategies is associated with symptom severity, or performance on standardized assessment tools measuring lexical knowledge. The aim of the first experimental study was therefore to compare the use of the noun-bias strategy in children with autism with age and language matched controls and to interpret their results in the context of measures of symptom severity and performance on standardized measures of language.

In experiment one, the group analysis showed that children with autism performed as well as the language matched group, but were poorer than the children in the age matched group. Correlation analyses, carried out on the difference scores and age, were significant for the autism group but not for the language or age matched control groups. When the difference scores were correlated with the scores from the PPVT, these were significant for the autism group and the younger control group but not for the older control group. Thus for children with autism and young typically developing children, the strength of the noun bias was positively associated with the extent of their receptive vocabulary. One very interesting finding to emerge from the analysis was that measures of symptom severity were not correlated with the difference scores in the autism group. However as mentioned earlier, a non-significant result might be due to a small sample size rather than the lack of a relationship especially that the r value in the correlation was large.

As previously suggested, studies of the noun bias in autism have yielded somewhat mixed results. Swensen et al. (2007) tested children with autism and typical controls on a novel word learning paradigm and reported a similar use of the noun bias in both groups. However, in that study participant groups were matched for language level and controls were, on average, one year younger than those in the autism group. In experiment one, the comparison of the autism and language matched groups yielded similar findings to those obtained by Swensen et al. However, when the autism and age matched groups were compared a significant difference was revealed and showed that the noun-bias is not age appropriate in autism.

Taken together these results suggest that acquisition of the noun bias in autism is characterized by developmental delay. Their noun bias increased with age, and was positively associated with their level of receptive vocabulary. In the study reported by Tek et al. (2008) children with autism differed from their age-matched controls in failing to exhibit a shape bias at 24 months, although older groups of children with autism were not tested in the study. On the basis of the results from experiment one, it may be hypothesized that information processing biases emerge at later developmental stages in autism. Longitudinal studies, testing the emergence of a range of biases in children with autism are planned. Following the approach taken in experiment one, experiment two will examine a second important language acquisition strategy, one that is vital in syntax development and appropriate sentence structure construction.

Experiment two: Subject Verb Object

The second experiment investigated an additional process that is essential in language acquisition. The Subject Verb Object (SVO) bias is implicated in the comprehension and construction of sentences that adhere to grammatical concepts. More specifically the SVO refers to the child's ability to distinguish the subject of a sentence, its verb, and the object of the verb. For example: "The girl eats the apple." Children who comprehend that sentences are arranged in such a basic way are then able to construct further more complex sentences that adhere to specific grammatical constructs.

Investigations into SVO in children with autism have tended to conclude that they are well able to apply this rule in their sentence construction. For example, Eigsti et al. (2007) examined the spontaneous speech of 16 children with autism while they were playing games, and analyzed them for their mean length of utterances (MLU), index of productive syntax (IPSyn), and complexity of syntactic structure. The results showed that children with autism produced language that was significantly less complex than might be expected for their developmental level, revealing shorter MLUs than typically developing children who were matched on lexical knowledge and non-verbal IQ. The data from the IPSyn showed that children in the autism group were not progressing along a typical pathway from simpler forms to increasingly complex ones. However, the evidence showed that sentences produced by those with autism adhered to the SVO structure, and this suggested that the autism group were likely to have acquired their syntactic abilities via an atypical developmental pathway.

In a study that investigated the effect of sentence context on looking preference, Brock, Norbury, Einav and Nation (2008) tracked the eye movements of children with autism while they were listening to sentences. Previous work studying sentence context in typical children has shown that eye-movements are sensitive to both semantic and phonological cues. For example, on hearing the phrase ‘‘eat the cake”, participants tend to look towards a picture of a cake even before the onset of the word ‘‘cake”, also on hearing ‘‘beetle”, they look more at a beaker than at a phonologically unrelated object. In their study, Brock et al. examined whether or not the type of the verb embedded in the sentence influenced the children’s looking preference to the object of the sentence. They found that children with autism had earlier/faster eye gaze to the target object (e.g., a hamster) for specific (e.g., *stroke*) than for general (e.g., *choose*) verbs, and this pattern was the same as that observed in their typically developing peers. Brock et al. , therefore concluded that the children with autism were clearly interpreting the verbs with possible direct objects in mind and that this meant that they paid attention to the sentence context and the SVO arrangement.

Further experimental research on the syntactic abilities of children with autism, looked at syntactic bootstrapping, which is the integration of syntactic and visual/spatial information during word learning. An example of this would be “She is blicking the dolly” to describe a child carrying a doll. Here *blick* means ‘carry’. To engage in syntactic bootstrapping during verb learning, children need to abstract sentence frames adhering to SVO structure. Neigles, Jeffery and Fein (2011) examined the use of syntactic bootstrapping and understanding of SVO in children with autism during novel verb learning. The results from the study showed that children with autism used syntactic bootstrapping while learning novel words. Like typically developing children, they were able to use the meaning of the sentence to extract clues about the meaning of the novel verb. This research showed that children with autism were able to abstract correct sentence frames (SVO) and extract meaning for their newly learnt verb.

Swensen et al. (2007) also investigated comprehension of the SVO structure in children with autism and their typically age matched developing peers. They obtained two measures: 1) spontaneous speech of children collected during play, and 2) data from an IPL paradigm that tested whether children understood SVO sentence arrangement. In the ILP paradigm the children heard a sentence e.g., “the boy is hitting the girl” and saw two videos side-by-side; one of which matched the sentence heard (boy is hitting the girl vs. girl is hitting the boy). Head turn preference to the scene that matched the sentence was taken as evidence that the child understood the SVO sentence arrangement. The results failed to reveal a group difference and the authors concluded that children with autism understand SVO order as well as their typically developing peers. However, their spontaneous speech production showed that they weren’t using complex sentences containing three words or more. These data appear to show a discrepancy between receptive and expressive communication skills and the findings were interpreted as revealing a gap between what children with autism know and what they use.

This research has been vital in illuminating strategies of word learning and syntactic abilities in children with autism. Most of the studies described above have shown that children with autism utilize such strategies in similar ways to their typical peers, but are less successful at implementing their knowledge in their own speech output. This raises interesting questions about associations or dissociations between intact language acquisition strategies and symptom severity in autism. The aim of this experiment is to replicate the SVO paradigm used in Swensen et al. (2007) and correlate performance with a standardized measure of associated language skill and measures of symptom severity.

Paradigm Construction

The paradigm used in the study was a modified version of the subject-verb-object IPL paradigm developed by Swensen et al. (2007). New videos were filmed and the experimental paradigm constructed mimicked the apparatus in the Swensen et al. (2007) study. Two videos were shown to the children. Both were constructed along a similar pattern: Trials were 6 s long, preceded by a 3-s inter-trial interval when only the red centering light was visible. Two or three introductory trials were presented first, followed by one salience trial and one test trial. The sides of the matching screen were counterbalanced in an LRRLLR pattern. The audios were presented first during the inter-trial interval and then repeated when the videos appeared. All audios were presented in American English Child-Directed Speech.

In this paradigm a total of four familiar verbs were introduced, and then tested for word order understanding. The aim of the paradigm was to test if the child understood the difference between “A verbs B” (the girl is tickling the boy) and “B verbs A” (the boy is tickling the girl). All videos were filmed at the Lebanese evangelical school, where typical children who did not participate in the testing were the actors. The set up for the experiment was the same as for the first IPL experiment.

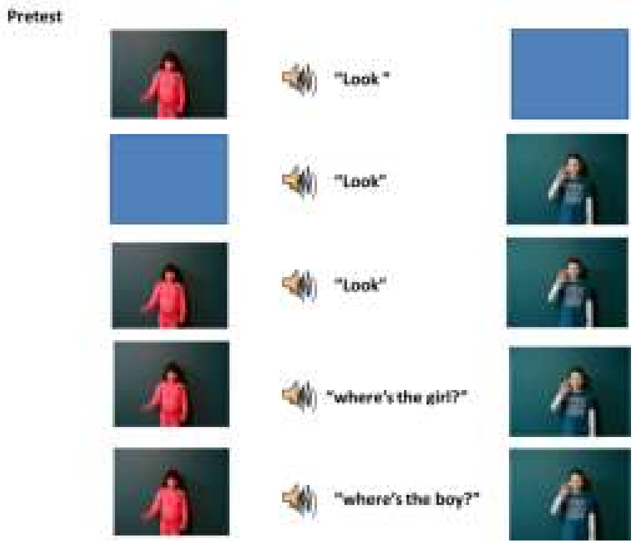
Table 6-3shows the sequence of trials in the experimental blocks.

Table 6-3 Sequence of presentation in a block of trials in the subject-verb order experiment, P represents the Pre-test trials and test trials are numbered 1-4

Video 1	Audio	Video 2
P Girl waves	Look!	Blank
P Blank	Look!	Boy waves
P Girl waves	Look!	Boy waves
P Girl waves	Where's the girl?	Boy waves
P Girl waves	Where's the boy?	Boy waves
1 Girl hugs Boy	Look, hugging	Blank
2 Blank	See, hugging	Boy hugs Girl
3 Girl hugs Boy	Hey, hugging	Boy hugs Girl
4 Girl hugs Boy	Look, the girl is hugging the boy	Boy hugs Girl

Pretest trials (labeled "P")were included to ensure that the child understood the difference between the labels 'boy' and 'girl'. In pretest trial 3 the action is shown simultaneously (on both screens) to provide a baseline measure of stimulus salience. The trial labeled 4 is the test trial, in which the audio clip matches only one of the two video clips. This trial tested whether the child understood the difference between (the girl tickling the boy) and (the boy tickling the girl). In total six familiar verbs (hugging, tickling, kissing, pushing, riding, and washing) were introduced, and then tested for word order understanding. Thus each child saw two variations of the subject-verb object sequence(e.g., the girl tickling the boy, and the boy tickling the girl) presented in random order. An example of a pretest and test trial video used in the experiment is shown in Figures 6-5 a) and b) respectively.

a)



b)

Figure 6-5 a) Example pre-test trial of the subject verb order paradigm b) example test trial of the subject verb order paradigm

Coding and scoring

The coding and scoring procedures were the same as those conducted on the videos from the noun-bias paradigm (experiment one, reported in this chapter).

Participants

Participants in these studies were the same ones that completed the studies described chapters 4 and 5. However, some individuals were unable to complete testing and details of excluded participants and missing data are shown below.

Results

Reliability between coders was calculated and the correlation averaged .85 (SD = .23); Cohen's k calculations yielded .91 agreement.

The percentage of excluded trials for the noun bias video was 9% for the children with autism and 7.9% for the typical group. These percentage exclusions are similar (and slightly lower) to those reported in previous research using IPL paradigms (Swensen et al., 2007; Naigles & Tovar 2012).

Examining differences in Performance between Children with Autism and Controls

Time spent watching the videos was calculated by measuring the time the children spent watching the video in proportion to the total time they were in testing the full number of test trials. The percentage of time the children spent attending to the noun bias video was 60% for the autism group, 65% for the language matched group and 71% for the typical group. Thus, both groups watched the videos more than half the time.

Figure 6-6 shows the mean percentage of looking time to the matching screen for the control (blue shaded) and test trials (green shaded) for the autism and typical groups. As can be seen from this figure, the children looked longer at the match during the test trials compared to the control trials.

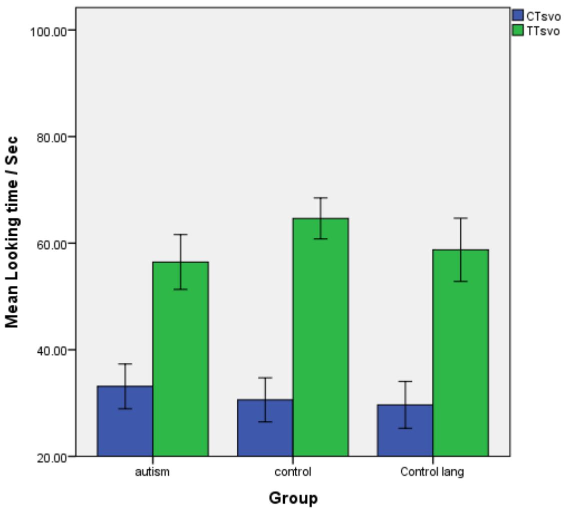


Figure 6-6 Mean looking time for SVO video the Control Trial subject verb order (svo) marked in blue act as the baseline trial and the test trial subject verb order (svo) marked in green act as the test trials, error bars: +/- 1 SE

Consistent with the analysis of experiment one, a new dependent variable (difference score) was calculated and was used to further explore the significant interaction.

Table 6-4 shows the Mean, SD and range of difference scores and baseline and test trial scores (in seconds) for the participants in the three groups. As mentioned in chapter two missing data was treated with list-wise deletion and analysis was conducted without the missing data.

Table 6-4 Mean, SD and range of difference scores and baseline and test trial scores (in seconds) in the SVO paradigm for individual participants within the three groups tested

	Autism n = 21 Mean (SD)	Age matched n = 20 Mean (SD)	Language matched n = 15 Mean (SD)
Difference score	3.52 (2.44)	4.05 (2.01)	3.65 (1.64)
Baseline trial (Sec)	35 (11.1)	28 (10.5)	26 (12.4)
Test Trial (Sec)	57 (15.9)	63 (18.1)	59 (10.8)

A mixed ANOVA with group as the between-subject factor and trial as the within-subject factor was carried out on the data. This revealed a highly significant main effect of trial $F\ (2, 60) = 10.25$, $p < .001$ with longer looking times in the test trials. The main effect of group was not significant $F\ (2,56) = .86$, $p = .43$, but there was a significant group* trial interaction $F\ (2,56) = 2.35$, $p < .05$.

A one-way ANOVA was also carried out on the difference scores and failed to reveal a statistically significant difference across groups $F\ (2, 56) = .36$, $p = .29$.

As the noun bias data were significantly correlated with age in the autism group in experiment one, Pearson correlations were conducted to examine potential associations between difference scores on the SVO paradigm and age in the three groups. This correlation was significant for the autism group (r = .48, $p < 0.05$) and the language matched group (r = .37, $p < .05$) but not for the age matched group (r = .39, $p = .29$).

In order to examine the relationship between performance on the SVO paradigm and receptive grammar skills, difference scores were correlated with scores from the TROG. These failed to reach significance for the autism group (r = .41, $p = .06$), the language matched group (r = .40, $p = .57$) or the age matched group (r = .35, $p = .73$). However as mentioned above, the non-significance might be a sample size effect, as the value of the r is large.

Finally, the relationship between performance on the SVO paradigm and measures of symptom severity were explored for the autism group. These analyses showed that the difference scores were not significantly correlated with scores on the (CARS; r = -.20, $p = .15$) or the GARS (r = -.38, $p = .20$). Again , this non-significance might be due to sample effect size.

Correlation of difference scores across experiments one & two

The results from the two IPL paradigms yielded different results, in terms of group differences, age correlates and associations with performance on standardized tests of related language skills. Therefore Pearson correlations were conducted to examine performance across the noun bias and SVO paradigms for the three groups. The correlation using difference scores was significant for the autism group (r = .29, $p < 0.05$), but not for the language matched group (r = .29, p = .16), or the age matched group (r = .18, p= .41).

Discussion

The results from experiment two, which investigated the SVO bias failed to show a significant difference between participants with autism and either age or language matched typically developing groups. Whilst all groups showed significantly longer looking times to test than to control trials, this effect did not appear to differ across groups. Correlations carried out on the difference scores and age were significant for the children with autism and the language matched group, although an increased SVO bias was not associated with higher receptive vocabulary scores, measured using the TROG, in any of the groups tested. Neither of these correlations reached significance for the older control group.

The aim of experiments one and two was to evaluate the use of experimental methods used in Western studies of children with autism, and the paradigm used in experiment two was an adapted version of that used in the study by Swensen et al. (2007). Whilst the results from experiment two failed to reveal a difference between children with autism and their language matched controls, and so are broadly in line with the results from Swensen et al.'s study, the results from the analysis of the data from the experiment two suggest that the SVO paradigm may be a less useful research tool than the noun bias paradigm used in experiment one. This will be further considered in a comparison of the results from the two experimental studies.

In experiment one, that investigated the noun bias, the ANOVA revealed a significant effect of condition, indicating longer looking during test trials than during control trials. The main effect of group was also significant, and when looking times to control trials were subtracted from looking times to test trials (difference score), the results failed to reveal a difference between the autism and language matched groups. For the children with autism, difference scores increased with age and for both this group and the language matched control group difference scores were positively associated with receptive vocabulary scores. Consistent with experiment one, the ANOVA carried out on the data from experiment two also revealed a significant main effect of condition, with longer looking during test trials than during control trials. Although the ANOVA failed to reveal a significant effect of group, correlations carried out on the difference score and age were significant for the children with autism and language matched controls, suggesting that within these groups the bias increased with age. Previous studies have shown that children with autism understand SVO structure in the frames of sentences (Eigisti et al.,2007) and pay attention to SVO order during language comprehension tasks (Fischer, 2002), and the results from experiment two are consistent with these results.

The most significant problem with experiment two was that the SVO difference scores did not correlate with receptive grammar scores for the autism group or either of the control groups. This is difficult to explain and raises questions about the usefulness of this paradigm for testing these age groups in an Arab clinical setting. However, such a non-significant finding might be due to sample sizes, since the r in most of these correlations was large. This relationship will be further investigated in future studies with larger group sizes.

Also, for children with autism, performance on the two experimental tasks was correlated, and the bias tested in experiment one was positively associated with acquisition of receptive vocabulary. It was also noted that the scores from the two experiments were not correlated with measures of symptom severity. Further research into the use of PL paradigms in this setting may then be warranted. For the two control groups performance on the two experimental tasks was not significantly correlated and for the older age matched control group, there was no association between task performance and language skills on either experiment. This raises questions about developmental changes in associations between the biases tested in experiments 1 and 2, and the language skills with which they are linked. Planned longitudinal studies investigating the emergence of language processing biases and associated language skills in autism will aim to include younger cohorts of typically developing typical children to further investigate this question in this population.

The results from experiments one and two will be further discussed in chapter 7.

Chapter 7 : DISCUSSION

ABSTRACT

The studies presented in this thesis investigated symptom severity and language skills in clinically referred children with autism in Beirut, Lebanon and compared them to age and language matched typically developing children. Four main aims were tested using standardized measures of assessments as well as experimental paradigms. The first of

these was to explore language skills in clinically referred children with autism and compare them to typically developing comparison children living in Beirut, Lebanon using diagnostic and language assessment methods used in autism research in the Western world. The second aim was to explore heterogeneity and potential language subgroups in the autism group in the context of similar work carried out in the Western world. Aim three was to explore the relationship between measures of symptom severity and language skills in the autism group in the context of similar work carried out in the Western world, and aim four was to evaluate the use of experimental methods, used in the Western world, to measure the mechanisms implicated in language acquisition in the children with autism and typically developing comparison children. In the following discussion, results from the individual studies reported in the thesis will be discussed within the context of these four main aims.

Diagnostic measure and Adaptive functioning measures

Chapter three presented the first set of results in this thesis and was focused on establishing diagnostic criteria as well as assessing adaptive functioning in children with autism. As mentioned in chapter three, Western diagnostic measures have been used extensively in the Arab world, and have even been translated into Arabic: GARS-Arabic version (Al-Jaberi, 2008) and CARS and Arabic version of CARS-2 (Al Khoury-Dirani et al., 2013). However these diagnostic measures have yet to be validated in the context of the Arab world, and to date, no studies have examined the relationship between scores on these diagnostic tools and measures of adaptive functioning or language ability in Arabic children.

The results reported in chapter three are drawn from the analysis of the GARS-2 (Gilliam, 2000) and the CARS (Schopler et al., 1988) data for the sample of Lebanese children tested in the study. The results from the analysis of the GARS data revealed percentages of diagnostic probability that were very close to the expected norms suggested by the manual. Further, percentages of severity, as assessed by the Autism Index (AI) of the test, were similar to those reported by Hussein et al. (2001) who used the GARS for diagnostic purposes in an Arab clinical context. However, the results do differ from those reported in some studies conducted in the Western world. For example, South et al. (2002) reported lower percentages of symptom severity in their study, and argued that the GARS has a low sensitivity to detect autism in children. When the individual data for the sample of Lebanese children were inspected, considerable variability was observed on the different components of the GARS, with the greatest difference being on the communication subset.

The analysis of the data from the CARS revealed different percentages of severity to those reported by the GARS. On the basis of the GARS assessment it was tentatively suggested that children with autism living in the Arab world might present with more severe symptoms of autism than their peers in the Western world. However, the results from the analysis of the CARS data did not support this suggestion, and a 'mild-moderate' probability of an autism diagnosis was reported for most children. These results contrasted with a study carried out in the West by Rellini et al. (2004), who administered the CARS and observed a higher percentage of individuals achieving 'severe autism' criteria. Unfortunately, the CARS has not been used in any published studies conducted in the Arab world so the current results cannot be considered in this context. The analysis of the subsets of the CARS showed increased severity on the verbal and non-verbal communication subsets and this result was consistent with results from the GARS analysis showing that deficits were most marked on the communication subset.

One reason for this discrepancy between the GARS and CARS scores could be that the GARS is a measure of parent report while the CARS relies on clinician observations. It may then be the case that the parents of children who come to the clinic for assessment are unconsciously over-emphasizing some of their children's symptoms. However, there are no studies assessing the accuracy of parental reports of autism symptoms in the Arab world, and this suggestion is therefore purely speculative. Within clinical settings in the Western world, parents can be seen as crucial informants who can provide information on their child's abilities (and disabilities) outside of educational and clinical settings (Stone & Lemark, 1999).

Differences in results between the assessments described in chapter three and those reported in studies carried out in the Western world, might be due to several factors. The first factor that may have influenced the results is sample size. The number of clinical participants in the current study (n = 22) is lower than sample sizes reported in many of the studies conducted in the Western world. Secondly, even though the data analysis failed to reveal significant skewness in the results, it might be that this clinically referred population does indeed exhibit "more severe" autism symptoms. Thirdly, and related to point two, children with autism who live in the Arab world may present with profiles of symptom severity that are different to those of children with autism living in the West. Questions about such potential differences will be best addressed in a large-scale multi-centre study carried out in the Middle East.

Finally, in relation to measures of adaptive functioning, the results from the VABS-II revealed a profile of disabilities that was similar to that reported in Western studies of children with autism. For the children tested in the Lebanon as well as children in the West, the most marked deficits were on the social and communication subset and this was followed by deficits in motor and daily living skills. For the communication subset, the children with autism, tested in the Lebanon, performed similarly to their language matched peers in that their scores in the receptive domain were higher than their scores in the expressive domain. This trend was not apparent in the older age matched typically developing children.

With regard to the relationship between symptom severity and adaptive functioning, results from studies carried out in the Western show showing increased severity in children with lower linguistic outcomes (Paul et al., 2008). In this study correlations differed, with the CARS standardized score revealing significant correlations with weak strengths with the VABS-II, while the GARS standardized score revealed greater size correlations and more significance across the subsets of the VABS-II.

Standardized Measures of Language Assessment

Chapters four and five examined linguistic skills, and specifically tested phonological processing, receptive lexical abilities, syntax abilities and pragmatic abilities. The aims of these chapters were threefold. The first aim was to identify differences between the children with autism and the children in the two control groups on the standardized assessments. The second aim was to investigate potential subgroups on the different language measures and the third, and final aim was to investigate associations between the language measures and measures of symptom severity in the autism group. The results from the assessments were considered in the context of studies of language in autism carried out in the Western world.

Aim One: Examining differences in linguistic abilities between Children with Autism and Controls

The first linguistic skill to be examined for group differences was phonological processing and this was measured using the Comprehensive Test of Phonological Processing (CTOPP). The CTOPP is comprised of two components, which measure phonological memory and phonological awareness. Consistent with previous studies of children with autism living in the Western world (Gabig , 2010; Gabig, 2008), the children with autism obtained lower scores than their age matched and language matched peers on both measures. The second linguistic ability to be measured was receptive lexical skill and this was measured using the Peabody Picture Vocabulary Test PPVT-III. The results from the analysis of the PPVT-III data again revealed significantly poorer standard scores for the children with autism than the children in the language and age matched control groups. These results are also consistent with previous studies using the PPVT to test autistic children living in the Western world (Pickles et al., 2009). The third linguistic ability to be examined was syntax processing and this was measured using the Test for the Reception Of Grammar, TROG-2. The TROG-2 has been used in a number of studies carried out in the West and several of these have failed to report syntactic deficits in these children (Kjelgaard et al., 2001; Riches et al., 2010; Botting & Conti-Ramsden, 2003). For example, in the study carried out by Kelley et al. (2006) unimpaired syntax was observed in the participants with autism, although these children were attending mainstream schools and were likely to have had higher levels of intelligence, social skills and/or language abilities at the point of entry. The children who participated in the current study did not perform as well as their chronological age matched controls on TROG-2 so the results are not wholly consistent with the studies reported above. However, in contrast to their performance on the CTOPP and PPVT-III data, the children with autism performed at similar levels to their language matched peers on the TROG-2. This result highlights the value of including age and language matched control groups in studies of language in autism. Finally, Western studies using the Children's Communication Checklist CCC-2 to test children with autism have shown consistently that children with autism perform lower than controls (Reisinger et al. ,2011; Norbury , 2013; Watson et al., 2013), on measures testing pragmatic skills. In the current study the CCC-2 was used to measure pragmatic skills. The analysis of the CCC-2 data showed that children with autism performed at significantly lower levels than both age matched and language matched controls. The results also revealed a significant difference between the two typically developing groups, with the (older) age matched group performing at a significantly higher level than the (younger) language matched group. There may be a number of reasons why the children from the (younger) language matched group obtained lower scores than the age matched children on the CCC-2. The mean age of the language matched group was 4 years, 6 months and some items may be particularly age sensitive, and may be more likely to be identified as behaviours that not yet been observed by parents of very young children. It is also important to note that none of the children in the language matched group reached the cut-off point for pragmatic abnormalities as reported in the CCC-2 manual, and symptom severity scores were not correlated with the CCC-2 scores for those children.

In sum, the first aim of this thesis was to compare clinically referred children with autism to typically developing comparison children living in Beirut, Lebanon using language assessment methods used in autism research in the Western world. The group comparison revealed deficits in the autism group, relative to chronological age and language level, on tests of phonological awareness, phonological memory, receptive lexical skills, and pragmatics. On the test of syntactic skills, the autism group showed deficits when compared with the chronological age matched group, but not the language matched group. These results are broadly consistent with Western studies of language skills in children with autism and suggest that the standardized tests used are effective in measuring language skills in this English speaking Arab population.

Aim Two: Examining the Existence of Subgroups in relation to linguistic abilities

The second aim of this thesis was to explore heterogeneity and potential language subgroups in the autism sample in the context of similar work carried out in the Western world. Drawing on previous studies using cluster analysis to identify language subgroups in samples of children with autism (Harper-Hill et al. ,2013), this technique was used on the data from the standardized language tests reported in chapters four and five. The cluster analysis carried out on the phonological processing data yielded CTOPP low and CTOPP high clusters. Although the CTOPP low cluster included only children with autism, the CTOPP high cluster included six of the 22 children with autism and all of the children from the language and age matched control groups. Thus there were six children with autism who had normal phonological memory abilities, and were clustered alongside their age and language matched peers. Although the autistic children in the CTOPP high cluster group also performed well on the phonological awareness tasks, phonological memory was most important in differentiating participants in the two clusters. When diagnostic data were inspected for the two CTOPP cluster, these showed a significant difference between clusters, with the CTOPP low cluster showing more severe diagnostic scores. However the presence of typically developing children in the High group would obviously mask any real difference between the children with autism in each group. This will be further discussed in the limitations section.

Cluster analysis conducted on the scores from the receptive lexical test resulted in PPVT high and PPVT low clusters. Four children from the autism group were included in the PPVT high cluster and 18children with autism were included in the PPVT low cluster. This result is consistent with previous work using clustering methods and identifying subgroups of children with autism who have age appropriate receptive communication skills (Kjelgaard & Tager-Flusberg, 2001, McGregor et al., 2012).It was also interesting to note that all of the children with autism who had been clustered in the high CTOPP were also placed in the high PPVT cluster. Inspection of the typical control data showed that all of the children from each of the control groups were included in the PPVT high cluster.

When measures of symptom severity were compared for individuals in the high and low PPVT clusters, those in the high cluster had lower symptom severity scores than those in the low cluster, and this difference was statistically significant. However as mentioned above, the presence of typically developing children in the High group would obviously mask any real difference between the children with autism in each group. This will be further discussed in the limitations section.

Cluster analysis conducted on the data from the test of syntax processing identified TROG high and TROG low clusters. Whilst a proportion of children with autism had been included in both high CTOPP and PPVT clusters, none were included in the TROG high cluster. Of the typically developing controls, 6of the 16children (37.5%) from the language matched group were included in the TROG high cluster and 18of the 22 (81.8%) children from the age matched group were included in the TROG high cluster. Thus, the TROG low cluster was comprised of all of the children with autism, four children from the age matched group and 10 children from the language matched group.

Finally, cluster analysis conducted on pragmatic language skills again identified CCC high and CCC low clusters. Consistent with the results from the TROG cluster analysis, no children with autism were included in the CCC high cluster. Of the typically developing controls 9 of the 16 (56.3%) children from the language matched group and 16 of the 22 (72.7%) children from the age matched group were included in the high cluster. Thus, the CCC low cluster included all of the children with autism, six children from the age matched group and 16 children from the language matched group. These results are broadly consistent with previous Western studies investigating language subgroups in samples of children with autism. For example, a subgroup of the autistic children tested in the current study were clustered in high groups on phonological and lexical skills and low groups on syntax and pragmatic skills, and Kjelgaard and Tager-Flusberg (2001) have reported cases of children with autism who possessed intact phonological and lexical skills but showed deficits in syntactic and pragmatic skills. This provides further support for the utility of standardized language tests during the assessment of English speaking Arab children with autism.

Aim Three: Examining Symptom Severity in Relation to Language Abilities

The third aim of the thesis was to explore the relationship between measures of symptom severity and language skills in the autism group in the context of similar work carried out in the Western world. In order to address this aim, correlational analyses were performed on the standardized linguistic and diagnostic measures. The correlational analyses carried out on the phonological awareness subtest from the CTOPP and the GARS-2 and CARS were not statistically significant. The results also revealed non-significant correlations between performance on the phonological memory subtest from the CTOPP and the GARS and CARS. Furthermore, the memory for digits subtest of the phonological memory test showed no correlation with diagnostic measures although, non-word repetition was significantly correlated with GARS standardized score. No studies were conducted in the Western or Arab world that looked directly at symptom severity with regards to phonological processing. The analysis of the data from the PPVT-III measuring receptive lexical ability, revealed a significant correlation between performance on this test and scores from the GARS. However, receptive lexical ability scores were not significantly correlated with the CARS. Previous studies, carried out in the West, have reported an association between measures of symptom severity and impoverished syntax in children with autism (Norbury & Bishop, 2002; Whitehouse et al., 2008) and bivariate correlations, carried out on the TROGss, CARSss and GARSss data revealed an association between syntax abilities and symptom severity scores in the current sample of children. Finally, scores on the CCC-2 were correlated significantly with standard scores on the GARS-2 and CARS revealing an association between pragmatic skills and symptom severity. This result is also consistent with previous studies reporting an association between symptom severity and pragmatic skills (Norbury & Bishop, 2002; Verte et al., 2006).

Overall, the results from the studies testing aim two were broadly in line with research carried out in the West. Although syntax and pragmatic skills were strongly associated with measures of symptom severity, lexical and phonological processing skills showed weak to moderate associations with symptom severity. It was interesting to note that scores on the PPVT-III correlated with standard scores on the GARS-2 but not with the CARS-2. However, while these tests are highly correlated they are scored and scaled differently and so might have resulted in different correlations with a third dependent variable such as the standard scores on the linguistic measures.

In addition to investigating relationships between symptom severity and language skills using correlation analyses, cluster analysis was carried out on these data. However, the main aim of the cluster analysis was to identify language subgroups, and questions about symptom severity within language subgroup clusters will be discussed in the next section.

Lastly, examination of difference in clusters has allowed further inspection into the specific subsets on the standard scores of both the CARS and GARS-2 that are mostly affected in each of the clusters. So, for example, for the CTOPP clusters the GARS-2 social interaction measures showed the highest difference between the two clusters, followed by communication and stereotyped behaviour. This might indicate that higher severity in these areas might contribute to lower CTOPP scores. In the CARS-2, the highest difference was in the nonverbal communication subtest, followed by verbal communication and social understanding. This might indicate that higher severity in these areas might contribute to lower CTOPP scores. For the PPVT-III clusters, for the GARS-2, social interaction showed the highest difference, followed by stereotyped behaviours and communication. In the CARS-2, the highest difference was shown in the nonverbal communication subtest, followed by verbal communication and social understanding. For the TROG-2 clusters, in the GARS-2, social interaction, followed by communication and stereotyped behaviours, were the most affected. In the CARS-2, the highest difference was shown in the nonverbal communication subtest, followed by listening response and verbal communication. Finally, for the CCC-2, in the GARS-2, social interaction and communication scores had higher differences than stereotyped behaviour scores. As for the CARS-2 the highest difference was in the relating to people subset, followed by social understanding, and nonverbal communication subtests.

Such results reveal that while disturbances in the development of children with autism is related to their linguistic development, disturbances in different domains might affect different linguistic abilities and thus might be related differently to each outcome.

Aim Four: Experimental Measures of Assessment

The final aim of this thesis was to evaluate the use of experimental methods, used in the Western world, to measure the mechanisms implicated in language acquisition in children with typical development and autism.

The first of these studies investigated the noun bias in children with autism and their language matched and age matched controls (experiment one). The group analysis of the experimental data showed that children with autism performed as well as the language matched group, but were poorer than the children in the age matched group. Correlation analyses, carried out on the difference scores and age, were significant for the autism group and language matched group but not for the age matched control group. When the difference scores were correlated with the scores from the PPVT-III, these were significant for the autism group and the younger control group but not for the older control group. Thus for children with autism and young typically developing children, the strength of the noun bias was positively associated with the extent of their receptive vocabulary. One very interesting finding to emerge from the analysis was that measures of symptom severity were not correlated with the difference scores in the autism group. This finding might suggest that deficits in social communication domains and repetitive behaviors are not necessarily associated with a failure to exhibit this important word learning strategy. However, such a finding might also be due to the fact that the sample size was small and couldn't detect the true relationship, specifically since the *r* values were large. This relationship will be further investigated in future studies with larger group sizes.

Results from experiment two, which investigated the subject verb object (SVO) bias failed to show a significant difference between participants with autism and either age or language matched typically developing groups. Whilst all groups showed significantly longer looking times to test than to baseline trials, this effect did not appear to differ across groups. Correlations carried out on the difference scores and age were significant for the children with autism and the language matched group, although an increased SVO bias was not associated with higher receptive grammar scores, measured using the TROG-2, in any of the groups tested. Neither of these correlations reached significance for the older control group. As was the case for the noun bias experiment, measures of symptom severity were not significantly correlated with SVO difference scores for the autism group.

The results from the two experimental studies revealed somewhat mixed results. In both experiments looking times to test trials were significantly higher than looking times to baseline trials and this suggested that the paradigms had revealed both biases tested. However, there were important differences in the results from the two studies. The results from experiment one distinguished the children with autism from age matched controls and most importantly, they revealed an association between the noun bias and scores on the PPVT-III. For the autism group the extent of the noun bias appeared to increase with age, though this effect was not observed for either of the control groups. Taken together these results suggest that acquisition of the noun bias in autism is characterized by developmental delay. Their noun bias was weaker than that of their age matched group but was very similar to that of their language matched group. Importantly, their noun bias increased with age, was positively associated with their level of receptive vocabulary, and was not associated with their level of symptom severity. Studies investigating the noun bias in children with autism living in the Western world have reported inconclusive findings in that some studies suggest an inadequate utilization of word learning mechanisms in these children (Tek et al., 2008), whilst others have reported similar levels of performance to age and/or language matched typical children (Preissler & Carey, 2005; Swensen et al., 2007). Experiment 1 extends these findings by including age and language matched controls groups, and correlating the strength of the bias, measured using a difference score, with measures of receptive vocabulary and symptom severity.

In contrast to experiment one, experiment two, investigating the SVO bias failed to reveal any group difference in performance. As looking times to test trials were longer than looking times to baseline trials it did not appear that this results reflected a failure in replicating the study. Although the age and difference score was significant for the autism and language matched groups, suggesting that looking to test trials increased with age, difference scores did not correlate with scores on the TROG-2 scores. This raised questions about associations between the SVO, as measured in the experiment and syntactic skills. However, one interesting finding to emerge from the studies was that difference scores across the two experiments were significantly correlated for the autism group, and at least one of these biases (noun bias) was positively associated with language skill (receptive vocabulary).Taken together, the results from the two experimental studies suggest that IPL paradigms, if appropriately modified, can be successfully used to test language acquisition biases in clinical settings in the Arab world. They may also be used to test Arabic speaking children, and children for whom translated standardized tests are not available. If these paradigms are used in clinics in the Arab world, potential modifications should include the identification of optimal age groups for testing and appropriate language tests for use in the data analysis.

Limitations

The study described in the thesis was the first to assess language skills in English speaking Arab children living in the Middle East and this resulted in a number of potential methodological limitations. First, the method of participant recruitment may have influenced the results. All English speaking children referred to the Beirut clinic for diagnosis during the period spanning 7th January – 5th May 2011 were given the opportunity to participate. This meant that the children within the sample had variable levels of intellectual ability and symptom severity. As the results from the language assessments were considered in the context of Western studies that sometimes only tested intellectually high functioning children, the comparison across studies may have compromised this comparison. Indeed the extent to which the current results were consistent with findings from studies carried out in the West were surprising given this limitation.

Second, in the study the CARS and the GARS-2 were used to measure symptom severity. These tests have been used extensively in clinics in the West, and also in studies carried out in the Arab world. Whilst the comparison between the results from the current study and Western studies using these tests suggest that they serve a useful function in the Arab clinical setting, changes in diagnostic criteria, and the increased use of ADOS and ADI-R in Western clinics, may merit a reconsideration of the diagnostic tools used.

The ADOS and ADI may provide a more comprehensive view of the symptoms presented, the ADOS is based on a detailed observation of the children and includes different modules that assess specific aspects of behaviour. ADOS and ADI training should be carried out in Arab clinical settings and this will enable researchers to gain increased insights into the heterogeneity of symptoms present in the children assessed at different clinics across the region.

A further potential limitation of the study was that standardized assessment tools, normed in the West, were used to test children with autism living in the Arab world. However, in addition to considering the autistic children’s test scores in the context of the test norms, they were also compared with age and language matched control children living in the Arab world. Whilst the results from the studies using standardized language tests were broadly in line with studies carried out in the West, the possibility that cultural artifacts influenced the results cannot be ruled out. Indeed, the analysis of the data from the TROG-2 suggested the existence of cultural artifacts, although this appeared to influence the performance of the typically developing children rather than that of the children with autism: The typically developing children from the language matched group performed at levels that were not chronological age appropriate. Whilst discussion of this result is beyond the scope of the current study, this finding, and the absence of any relationship between scores on this test and the SVO paradigm, does suggest that this particular test should be used with caution in the Arab clinical setting.

The PPVT-III is widely used in research and in clinical settings, but is limited in that it only measures receptive vocabulary. Other standardized tests, for example the CELF-4 (Semel, Wiig, Secord, 2004), assess both receptive and expressive communication and provide a more detailed profile of lexical abilities. In the Beirut clinical setting, language research was limited by both the number of standardized assessment tools available and their suitability for use with children referred for diagnosis.

An inevitable limitation of this Arab clinic based study is that the sample size was not large. The sample size employed in this study was relatively small (n= 60), although the power analysis revealed that this sample size was sufficient for the comparisons made. However, conclusions based on results from bivariate correlations, conducted on a sample of 22 children with autism, should be taken with caution. The statistical approach taken in the study aimed to extract as much information from the data as was possible. In addition to group comparisons and sub-group analyses, individual data were also shown, and whilst this merely serves to illustrate heterogeneity in the group, they will be useful to psychologists and speech therapists tracking the development of these children. They will also help inform future longitudinal studies carried out in the clinic. Cluster analysis has been used in a number of studies of language in children with autism and in the current study it was used to explore the existence of subgroups in the autism and typically developing groups. One previously mentioned limitation of cluster analysis is that it yields results that can be tautological. It always creates clusters and researchers may make claims about the same constructs that were used to create the clusters in the first place. For example, stating that children who scored badly on phonological memory tasks were also included in the CTOPP low cluster. While such a limitation means that great care should be taken when drawing conclusions about the results of cluster analysis, this technique enabled identification of a subgroup of children with autism, and a language profile similar to that reported in previous studies carried out in the West. In the current study, small sample sizes strongly limited the usefulness of exploring symptom severity in high and low cluster language groups. Whilst some autistic children were included in high clusters for some of the language assessments, other high clusters only included typical children. However, some interesting findings emerged when attention was focused on subsets of the diagnostic tests, and it may be the case that language and symptom severity data, collected from a larger cohort of children with autism, can be analysed usefully using cluster analysis.

Future Directions

Despite the limitations detailed above, the methods used in the study were largely effective in measuring the aims outlined in chapter one. The results from the study suggest that for English speaking Arab children with autism, living in Beirut in The Lebanon, levels of heterogeneity in symptom severity and language skills are broadly in line with those reported in studies carried out in the West.

Whilst clinicians working in the Arab clinical context face many challenges, they also have great opportunities to improve the assessment and delivery of services. Awareness of autism is increasing in the Arab World and it is hoped that this will be met by changing attitudes within these cultures. Although not necessarily the case in the past, within the Western world children with autism are generally enrolled in mainstream schools or special educational institutions, whilst in the Arab world, much autism education and care is undertaken at home. Although private educational facilities for children with autism are available in many regions in the Arab world, they are beyond the financial means of very many of the families who need to access them. In Europe and the USA there are many autistic societies and there is clearly a great need for a similar organization in the Arab world. Such an organization would provide a forum through which parents and autism professionals could educate the public and policy makers on the presentation of autism in the Arab world and the current status of autism care. It would also provide a much needed forum within which clinicians and researchers could share ideas about research programmes and the development of culturally appropriate diagnostic and language assessment methods. Such innovations would help to ensure that Arab children with autism were given a fair chance and a bright start. This thesis has provided the first consideration of crucial questions to get this started.

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