LEXICAL ORGANIZATION IN CHILDREN WITH AUTISM

By

Joanne Gerenser

A dissertation submitted to the Graduate Faculty in Speech and Hearing Sciences in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

2004

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

UMI Number: 3127870

Copyright 2004 by
Gerenser, Joanne

All rights reserved.

INFORMATION TO USERS

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleed-through, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

UMI®

UMI Microform 3127870
Copyright 2004 by ProQuest Information and Learning Company.
All rights reserved. This microform edition is protected against unauthorized copying under Title 17, United States Code.

ProQuest Information and Learning Company
300 North Zeeb Road
P.O. Box 1346
Ann Arbor, MI 48106-1346

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

© 2004

JOANNE E. GERENSER

All Rights Reserved

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

This manuscript has been read and accepted for the Graduate Faculty in Speech and Hearing Sciences in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

April 28, 2004
Date

Chair of Examining Committee

April 28, 2004
Date

Executive Officer

Vicky Sudhalter, Ph.D.

David Swinney, Ph.D.

Supervisory Committee

Gail Gurland, Ph.D.

Outside Reader

THE CITY UNIVERSITY OF NEW YORK

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Abstract

LEXICAL ORGANIZATION IN CHILDREN WITH AUTISM

By

Joanne Gerenser

Advisor: Richard G. Schwartz

The purpose of this study was to examine the nature of lexical organization and representation in children with autism. To date, this issue of whether children with autism are different in their lexical development and organization remains unclear, with conflicting findings in the research. Fifteen typically developing children (aged 6:2 to 11:2) and fifteen high functioning children with autism (6:2 to 12:3) participated in this study. The groups were matched on receptive vocabulary age (PPVT-R). The participants named pictures within four different priming conditions (identity, rhyme, categorical, associative). PRTLAB (Swinney, 1995), a computer program which displays pictures on a monitor and records response time was used to run this experiment. Hierarchical linear modeling procedures were used to test the significance of the results. The results revealed a significant main effect for the identity priming condition with both groups of children naming pictures in this condition significantly faster than the neutral condition. In the associate condition, the typical children demonstrated a significant facilitory effect, while the children with autism did not. Neither of the other conditions resulted in any significant priming effects for either group. An analysis of naming responses and errors revealed a different pattern between the two groups. The typically developing children made more prime related responses. The children with autism made more unrelated and non-informative responses. The results provide evidence for

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

differences in lexical organization in children with autism when compared to typically developing children. These findings have implications with regard to assessment of vocabulary as well as intervention for children with autism.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

DEDICATION

I'd like to dedicate this dissertation to three important men in my life. The first is Dr. James MacDonald. Jim was my mentor and advisor when I was a graduate student in the Master's Program at the Ohio State University. Jim, you challenged me to think and to ask the hard questions. You inspired me to write, despite my fears and doubts. You have influenced me well beyond the two years I spent in Columbus, Ohio.

Dr. Irv Hochberg was the calming presence for me when I first began at the Graduate Center, all those years ago. He was always there with gentle words of encouragement when things seemed so difficult. He will be in my heart forever and especially when I finally receive that long awaited diploma.

Lastly, I'd like to recognize a little boy I met over 25 years ago, Jeremiah. Jeremiah was the first child with autism I ever had the opportunity to work with. I loved working with him so much that it changed the direction of my life. For that, I will be forever grateful.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

ACKNOWLEDGMENTS

I could not have completed this dissertation without the support and patience of my advisor, Dr. Richard Schwartz. I know that it was difficult to keep me focused and on track and there were times when it didn't look like it would happen. You pushed me just enough to get it done, but not enough to push me over the edge. Your support and friendship mean a lot to me.

I am so grateful for the efforts of my two other committee members Dr. Vicky Sudhalter and Dr. David Swinney. I know that it seemed like a lifetime ago when I first asked you to be on my committee. I am glad you stuck with me and appreciate your patience with me.

I need to thank my outside reader, Dr. Gail Gurland, for her support and for taking the time to read my paper. I value your thoughts and your friendship.

I must recognize the participants and families at the Eden II and Genesis Programs. You have always been my inspiration and reason for doing what I do. You bring so much energy and excitement into my life. I am truly blessed for having the opportunity to be a part of your lives. I also need to thank the Nassau Suffolk Autism Society for helping me in subject recruitment. I owe such a debt of appreciation to all of the children who participated in this project.

I need to thank my colleagues at work for putting up with me these last couple of months. I know I was not the easiest person to be around and your patience and support really helped. I especially want to thank Mary McDonald, Eileen Hopkins, Daphne El-Roy and Adrianne Horowitz who inspired me to see the end of the road.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

I want to thank the Board of Directors at Eden II. They allowed me to take the time to get this done and never questioned it. They are a truly amazing group of people who make it possible for me to love my job so much.

I was lucky to have had the fortune of going through the doctoral program with so many great fellow students. Some of you will remain my friends and colleagues for life and for that I'm grateful. I especially want to recognize my friends Kakia Petinou, Linda Jarmulowicz, and Faye Erickson Parton for their support and for leading the way.

I'd like to thank Gary Chant for all his efforts with my equipment. I know it seems like ages ago when we put this together but your skills and expertise were so critical, especially when things broke down and I needed a quick fix.

I need to recognize the help and guidance from David Livert. David's help in getting my data analysis done (and done well) was invaluable. David, you are a genius!

I'd like to thank Margaret Zampardi from Eden II. Margaret rescued me on more than one occasion with typing, formatting and just generally getting this dissertation finished.

I have to thank Loretta Walker for all her help and support over the years I was at the Graduate Center. There were numerous times she bailed me out of jams with things and she constantly provided me with words of encouragement and support.

Finally, I need to recognize the patience, support, kindness, and love of my partner in life, Randy Horowitz. Randy, you made getting through this possible and I know I tortured you with all my piles of papers, notes, articles and books. Thank you for being a part of my life.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Table of Contents

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

List of Tables

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

List of Figures

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Literature Review

Autism Spectrum Disorders

Autism is a developmental disability characterized by deficits in social functioning, in language, in communication, and in sensory perception (Dawson et al., 2002; Lord & Paul, 1997; Kjelgaard & Tager-Flusberg, 2000). Autism is categorized as one of the pervasive developmental disabilities within the DSM-IV (American Psychiatric Association, 1994). There is considerable overlap among several of the pervasive developmental disorders described within the DSM-IV, particularly for the diagnostic categories of autism, Asperger's syndrome, and pervasive developmental disorder-not otherwise specified (PDD-NOS). Many researchers and diagnosticians describe these disorders as a spectrum; they are collectively termed the "autism spectrum disorders" (Gillberg, 1990; Tager-Flusberg, Joseph, & Folstein, 2001).

Although the behavioral characteristics of autism and related disorders vary considerably, one consistent problem area is in the acquisition and use of language (Lord & Paul, 1997; Rutter & Schopler, 1987). Many individuals with autism perform within normal limits on non-verbal intelligence tests yet demonstrate severely impaired or restricted use of language (Gluer & Pagan, 2003; Wetherby, Prizant, & Schuler, 2000). The unique speech and language problems present in children with autism have attracted significant attention from linguists and psychologists. However, the precise nature of these deficits has not yet been delineated.

There is great heterogeneity across cognitive, linguistic, and behavioral functioning within and across individuals with autism. Approximately one half of the children with autism never develop functional speech (Tager-Flusberg, 1994). Anywhere

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

from fifty to seventy five percent of individuals diagnosed with autism have I.Q. scores consistent with a diagnosis of mental retardation (Frith, 1989; Zelazo, 2001). The best approach for determining cognitive and linguistic deficits specific to autism is to focus on the higher functioning sub-group of individuals with autism spectrum disorders (Lord & Paul, 1997; Rutter, 1983; Tager-Flusberg, 1985a). This sub-group of individuals provides researchers an opportunity to identify those characteristic deficits that are unique to autism and are not the result of more general cognitive impairments. Although these findings may not be generalized to the entire population of individuals diagnosed with autism and related disorders, this may be a starting point for research with the other more severely impaired sub-groups.

Speech and Language Characteristics

Speech development

Delayed onset of speech is typical in children with autism. Despite this delay, it is believed that verbal children with autism demonstrate normal speech acquisition patterns and typical phonological errors (Bartak, Rutter, & Cox, 1975; Kjelgaard & Tager-Flusberg, 1997; Gluer & Pagan, 2003). That is, the phonological development for children with autism is appropriate for their developmental levels. These findings, however, have been questioned with more recent research. Flipsen (1999) found that when looking at high functioning adolescents and adults with autism and Asperger syndrome, 33% of these individuals demonstrated distortion errors. This is compared to estimates of 1-2% on the typical adult population. One of the problems with the earlier findings was that researchers focused exclusively on preschool and early elementary aged children (Flipsen, 1999; Shriberg, et al., 2001). In addition to the differences in

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

articulation, significant differences in phrasing, stress, and nasal resonance have been identified when compared to the typical population (Shriberg, et al., 2001; McCann & Peppe, 2003).

Syntactic development

There are conflicting findings in the area of syntactic development as well. Some researchers have concluded that children with autism have no specific deficits in the comprehension and use of syntax (Waterhouse & Fein, 1982; Tager-Flusberg, et al., 1994; Gluer & Pagan, 2003). They found that the length and complexity of utterances seemed comparable to individuals with similar cognitive developmental levels.

Tager-Flusberg, et al. (1990) conducted a longitudinal study comparing six 3-6 year old high functioning children with autism to six children with Down syndrome. She followed the children for two years and found similar syntactic development across both groups. Further, the development across the two groups did not differ from typical development.

Others, however, propose that there may be specific deficits in syntactic processing and development in children with autism (Boucher, 2003; Kjelgaard & Tager-Flusberg, 2001). Kjelgaard & Tager-Flusberg (2001) administered a series of speech-language tests to a large number of children with autism. They found that many of the children demonstrated specific deficits in syntax, despite having vocabulary scores and I.Q. scores within normal limits. Ramando and Milech (1984) found that typically developing children were significantly better at recalling syntactically well formed utterances, regardless of degree of semantic relatedness, than children with autism. In addition, children with autism use fewer grammatical morphemes than typically

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

developing children (Bartolucci, Pierce, and Steiner, 1980). These researchers proposed that these differences in comprehension and use of syntax cannot be accounted for by semantic or cognitive delays.

Semantic development

Findings in semantic development are even more diverse and conflicting. Very early studies reported that children with autism did demonstrate semantic deficits (Fay & Schuler, 1980; Menyuk, 1978). Hermelin and O'Conner (1967; 1970) were the first to present empirical evidence for these deficits. In a series of studies, these investigators compared children with autism and mental age matched controls in their ability to recall lists of words. Children with autism did not rely on semantic cues to facilitate recall. Unlike the controls, the children with autism did not differentially recall groups of unrelated words and words grouped according to categories. These original studies have been criticized for methodological reasons such as small sample size, inadequately defined controls and poor subject descriptions (Schwartz, 1981). Hermelin and O'Conner's findings, however, have been replicated in subsequent studies with more appropriate control groups and with larger subject samples (Fay & Schuler, 1980; Fyffe & Prior, 1978; Tager-Flusberg, 1991).

Children with autism are concrete and literal in their interpretation and use of language (Tager-Flusberg, 1999; Happe, 1993; Andrews, 2002). They fixate on initial learning situations and seem unable to relate novel sensations or experiences to past experiences (Fay & Schuler, 1980; Plaisted, 2001). This is consistent with the way Temple Grandin, a high functioning person with autism, has described her language (Grandin, 1996). For example, Grandin described how hearing the word cat did not lead

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

her to think of an abstract category of cats or animals but rather only to the image of a specific cat in a specific situation.

Early language acquisition

Semantic problems have been noted in children with autism at the earliest stages of language acquisition. The first words acquired by children with autism are generally names for concrete objects such as cookie or car. Noticeably absent from the early vocabularies of children with autism are words such as up, more, or all gone. Bloom (1973) described these words as function or relational forms. Typically developing children demonstrate use of these word forms as early as 15-16 months of age (Bloom, 1973). Although the majority of words in a child's early vocabulary tend to be nouns, only about one half are names for basic level objects. Furthermore, over one third of these early nouns are words referring to locations, to actions, or to events (Nelson, Hampson, & Shaw, 1993). This is in sharp contrast with the types of concrete object labels that dominate the vocabulary of young children with autism (Menyuk & Quill, 1985).

Analysis of language samples and early vocabulary development of children with autism revealed that overgeneralizations rarely occurred (Menyuk & Quill, 1985). These children demonstrate a restricted range of word use, often not moving beyond a single referent. For example, a child with autism may only label a specific chair as a chair and fail to generalize this label to other chairs (Lovaas, Koegel, & Schreibman, 1979).

Semantic categories

Impairment in the ability to form semantic categories has been suggested as an underlying problem in autism (Klinger & Dawson, 1995). Klinger and Dawson described

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

categorization as a mental process that allows individuals to integrate new information with previous experiences. This skill of relating new experiences to previously acquired information has been found to be particularly deficient in individuals with autism (Grandin, 1996; Menyuk & Quill, 1985). Deficits in forming categories could result in some of the behavioral characteristics present in individuals with autism. Difficulty understanding novel situations would be expected if all novel situations were unpredictable or confusing. The repetitive or stereotypic behaviors demonstrated by individuals with autism may be adaptive coping mechanisms due to the difficulty in categorizing new information (Klinger & Dawson, 1995).

Klinger and Dawson (1995) investigated the ability of children with autism to learn categories. They evaluated children with autism, children with Down syndrome, and typically developing children to determine their abilities to categorize pictures under different conditions. The subjects were presented with schematic drawings of animals that varied on specific feature dimensions (e.g., width of tail). In the rule-based condition, each animal possessed a specific feature that determined category membership. In contrast, animals in the prototype condition had no unique feature or features, but rather had a combination of the necessary features required for membership to that category. During the test trials of the rule-based conditions, subjects were presented with two novel animal drawings that differed only on one feature and were asked to touch the animal that belonged with those seen in the familiarization trials. During the test trials of the prototype-based condition, children were shown two novel animals, one average prototypical animal (i.e., an animal composed of the average of each of the features presented during the familiarization trials) and one animal composed of features seen

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

during the familiarization trials but in novel combinations with insufficient features required for membership to the category. The children with autism were able to categorize when they were given concrete rules for category membership. They were unable to do so in the prototype categorization condition. In contrast, the typically developing children demonstrated categorization skills across all conditions. It is not possible to infer that these categorization deficits are specific to autism, however, as the participants with Down syndrome demonstrated similar patterns of categorization deficits.

Despite the clinical observations that children with autism demonstrate difficulty in forming categories, the research in this area has been limited. Tager-Flusberg (1985a; 1985b) examined the categorization abilities of children with autism, children with mental retardation, and normally developing children matched on receptive language age. She used a matching task and a sorting task to evaluate categorization of pictures at the basic and super ordinate levels. In one study, the subjects were required to match target pictures to similar pictures, based on basic categories (e.g., pictures of animals and foods to other animal and food pictures). In a subsequent study, the subjects had to indicate whether a pictured object was an instance of a particular word (e.g., animal) as well as select several pictures from an array of pictures when given a category name. Tager-Flusberg found no significant differences in categorization abilities across any of the groups of subjects. Ungerer and Sigman (1987) replicated these findings in a subsequent study. The investigators concluded that lexical organization and categorization skills of children with autism were similar to that of typically developing children.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

The sorting and matching tasks employed in the previous research used simple and common pictures and categories (e.g., foods, animals). In addition, the range of meanings examined was limited. All of the words were limited to names for concrete objects. The skills evaluated were those typically well established in children as young as three or four years of age (Gelman & Coley, 1990; Gelman & Markman, 1987). Tager-Flusberg's subjects all had mental ages of five years or greater. Failure to detect a difference in group performance could easily have been due to a ceiling effect. There is little reason to assume that children with autism with receptive vocabulary scores over the age of five would perform differently than the control group matched on vocabulary scores. It is quite possible the tasks employed were too simple and basic to detect real differences in lexical organization between the two groups of children.

Picture naming abilities

In a subsequent study with the same children, Tager-Flusberg (1986) analyzed their naming abilities of basic level and super ordinate level pictures. The subjects named pictures that had been divided into central and peripheral members of categories across basic and super ordinate categories. The results revealed no significant differences in the naming abilities across groups. Tager-Flusberg concluded that because all of the subjects performed in a similar manner, semantic development was similar across groups. She further proposed that the similar pattern of errors demonstrated across all three groups provided evidence of meaningful organization of the lexicon. She concluded that because the errors all tended to be semantic in nature, lexical organization must be semantic as well. This is consistent with the assumption that the mental lexicon is

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

semantically organized (Tyler & Moss, 1997; Plaut & Booth, 2000; Collins & Loftus, 1975).

Although Tager-Flusberg drew conclusions about intermediate representations (e.g., lexical organization), she only measured final representations, untimed naming of pictures. The process of translating input (such as pictures or words) into a meaningful representation is obligatory. For example, when a listener hears a word, he or she cannot choose to hear it as anything but a meaningful utterance (Tyler, 1992). This stage of processing can be referred to as the intermediate representation. The final representation (e.g., the naming of the picture) is subjected to a process that may include the comparison of information to a number of cues. Cognitive, non-linguistic variables such as general word knowledge or memory influence the final representation.

Controlled procedures measuring the timing of responses are necessary to draw conclusions about semantic processing and representation. These procedures evaluate the earliest stages of processing, those that are obligatory and not available to conscious awareness. It is this information that is needed in order to make inferences about lexical representation. The tasks employed must not require any explicit decisions about the properties of the representation (Tyler, 1992). "On-line" procedures such as lexical decision or priming tasks, if carefully conducted, allow for the evaluation of intermediate representations. Tager-Flusberg only analyzed correct and incorrect responses in an untimed naming task. This type of "off-line" task requires the subjects to reflect upon the properties of the representations and is greatly affected by the non-linguistic variables such as memory or attention. Tyler et al., (1997) found conflicting results with the same subjects with Williams syndrome when comparing on-line measures (priming) vs. off line

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

measures (e.g., sorting, untimed naming) to evaluate lexical organization. These researchers concluded that on-line measures were essential when evaluating lexical organization, especially when studying special populations.

Finally, Tager-Flusberg matched her subjects on vocabulary scores. Naming pictures should have been similar across groups given their similar vocabulary levels. That is, accuracy of picture naming would be expected, given similar picture naming abilities across subjects. Rate of picture naming or naming latency, however, could have been very different between the groups, despite similar scores on vocabulary tests.

A closer analysis of the error patterns of the three groups revealed a category of errors that was not discussed by Tager-Flusberg. In the results, there was a section under errors referred to as "no response". The children with autism demonstrated 127 "no response" scores across all items as compared to 28 by the mentally retarded group and only 14 by the typically developing subjects. The conclusion about the subjects' lexical organization was based on their pattern of errors without considering the "no response" category which varied substantially across groups. The smaller number of subjects combined with the selective data analysis greatly reduces the probability of statistically significant differences across groups.

It is very difficult at this time to draw conclusions about the semantic abilities of individuals with autism (Toichi & Kamio, 2001). Tager-Flusberg (1993) proposed that the earlier research supporting specific semantic deficits to autism failed to evaluate whether subjects performed poorly because they lacked underlying semantic categories or because they could not use what they had acquired. She suggested that the semantic deficits present in autism reflect performance limitations (e.g., being unable to perform

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

the task) rather than representation limitations. However clinical observations (e.g., rote language, difficulty understanding abstract concepts) along with conflicting findings regarding semantic deficits in children with autism compel us to reconsider this question.

Lexical organization

There are a number of reasons to believe that children with autism are different in the way their lexicons are organized and in the way they learn new lexical items. Children with autism are delayed in lexical development (Charman, Drew, Baird, & Baird, 2003; Hobson, 1993; Lord & Paul, 1997). There is evidence that these children have difficulty with multiple meanings (e.g., hair, hare; river bank, savings bank) as well as referring to a known object with multiple names (Dennis, Lazenby, & Lockyer, 2001; Hobson, 1993, Jollife & Baron-Cohen, 1999). Idioms and slang terminology have been shown to be difficult for children with autism to understand or use (Dennis, Lazenby, & Lockyer, 2001).

Word learning

The way children with autism perceive the environment and learn novel information must be considered when examining lexical development and organization. Children with autism demonstrate "stimulus overselectivity" when learning novel information (Frith, 1989; Lovaas, Koegel, & Schreibman, 1979). They focus on one feature or cue and ignore or miss more relevant, salient features (Happe & Frith, 1996; Shah & Frith, 1993). For example, when a child with autism was taught to sort pictures by specific categories (e.g., foods, clothes, etc.), the child inadvertently learned to sort pictures by background color, as that was the feature he had found most relevant. The

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

child failed to attend to the more appropriate features that distinguished the categories of foods and clothes.

In addition to stimulus overselectivity, children with autism tend to focus on parts of objects rather than wholes (Shah & Frith, 1993; Frith, 1989). This preference is reflected in their play (e.g., playing with only the right rear tire of a toy car), their art (e.g., drawing the upper right quadrant of a face when asked to draw a person), and their language (e.g., stating "alligator" when asked to label an "Izod shirt"). Typically developing children do the exact opposite in word learning. They view objects as wholes in order to constrain their word learning task (Markman, 1989). Children with autism may be learning words differently if they attend to parts rather than the whole object.

It is estimated that children have acquired over 5000 words by age six and more than 40,000 words by age ten (Anglin, 1993; Beck & McKewan, 1990). "Fast mapping" is one process that has been used to explain the rapid word learning of young children (Carey, 1978; Carey & Bartlett, 1978). Fast mapping refers to the young word learner's ability to form a quick partial understanding of the word's meaning after very limited exposure (Rice, 1989). More importantly, this early mapping occurs without any explicit training or feedback. Many children with delayed vocabulary development demonstrate problems with the process of fast mapping (Mervis & Bertrand 1995; Romski et al., 1995; Rice, Buhr, & Nemeth, 1990).

Findings regarding fast mapping have been mixed in children with autism. In a pilot study, Bailey (2003) found impaired fast mapping abilities in all five of her subjects. These five subjects were specifically selected, however, because they had severe delays in vocabulary development. Further evaluation of more capable children with autism

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

resulted in less consistent findings. Some of these children exhibited fast mapping abilities and some did not (Bailey, 2003).

"Slow mapping" has been described as the process of enriching the representations of an old word via multiple exposures (McGregor, et al., 2002). The process of slow mapping involves the child as an active word learner relying on perceptual, social, linguistic, and metalinguistic information. Although some children with autism may be able to associate the name of the referent to the referent, especially with explicit instruction, it is very likely that they will have more significant problems with the parts of the process of word learning that involves active social interaction and inferencing. It has been hypothesized that problems in the process of slow mapping can result in deficits in the quality of stored lexical knowledge (McGregor, et al., 2002).

Recent research in joint attention and autism has direct implications for language acquisition and more specifically, for vocabulary development. Joint attention routines form the foundation for early language acquisition and word learning (Baldwin, 1991; Baldwin, 1993; Baldwin, et al., 1996). Typical infants and toddlers preferentially attend to a parent or caregiver's gaze or point to map labels on to a referent (Baldwin, 1993). Baron-Cohen, Baldwin, & Crowson (1997) found that children with autism were unable to use adults' referencing gaze or point to facilitate word learning. The typical children, on the other hand, reliably mapped the labels on the referents pointed to or looked at by the adults, even when holding or playing with an equally unfamiliar object.

Despite all of the challenges and obstacles to word learning, many higher functioning children with autism develop extensive and often age-appropriate

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

vocabularies. It remains unclear, however, if these vocabulary skills are as developed or organized in the same way as typical peers.

Methodological Issues

Much of the research to date examining semantic organization or lexical development in children with autism has failed to find any significant differences across groups. Researchers have concluded that there were no differences in the lexical development and underlying representational abilities of children with autism when compared to typically developing children (Tager-Flusberg, Joseph, & Folstein, 2001; Tager-Flusberg, 1989; Ungerer & Sigman, 1987). Failure to detect differences, however, can be attributed to a number of possible factors, ranging from issues of limited power to problems with methodological design.

All of the experiments reviewed here have relied on "off-line" procedures such as sorting pictures, generating categories or answering questions to examine lexical representation. These tasks typically tell more about general knowledge of the world than about lexical semantic representation (Tyler & Marslen-Wilson, 1977; Tyler et al., 1997). For example, two individuals with completely different underlying lexical organization could easily name a set of given pictures accurately in an untimed naming task because the task only evaluates whether the individual knows the name as opposed to how it is represented. "Off-line" tasks allow the individual to call on other metalinguistic or general cognitive processes such as vocabulary size or general world knowledge and may distort the nature of the linguistic deficits present. The subject could mask the deficit present by compensating with other non-linguistic skills such as memory or strong visual processing. In some cases, more significant deficits could be obtained

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

than are actually present, due to the need to rely on additional cognitive non-linguistic processes that may be challenged in special populations (Tyler et al., 1997). For example, a child with attention or memory deficits may perform poorly on a confrontation naming task, yet this performance may not reflect an actual linguistic problem but rather a problem of resources. More controlled tasks described as "on-line" procedures would be necessary to examine semantic or lexical representation. These procedures are designed to tap into the early stages of lexical processing, thereby reducing the likelihood on non-linguistic variables influencing the results in either direction.

On-line methods

Psycholinguists and psychologists have relied on a number of on-line procedures to investigate the lexicon and semantic representation (Tyler, 1992). On-line tasks require the subject to make a response closely tied in time to the relevant input (Tyler & Marslen-Wilson, 1977). The timing variable is one critical component in that the more time that is allowed to elapse between stimulus and response; the more likely it is that the response will be affected by other non-lexical processes (e.g., context, processing demands).

On-line methods have been developed in extensive research with adult subjects (e.g., Moss et al., 1995; Tyler et al., 2000; Tyler & Marslen-Wilson, 1977). The lexical decision task and the naming task have been two of the most widely used on-line procedures. A standard lexical decision task requires a subject to indicate whether a string of letters is a real word or not by pressing one of two buttons. For example, when presented with the letters <u>nog</u>, the subject would press the no button to indicate that this

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

was not a real word. In the naming task, the subject is simply required to pronounce the word.

Stimuli other than print (e.g., pictures) have been used in both paradigms, especially with children (Pratarelli, Perry, & Galloway, 1994; Share, Jason, Matthews, & Maclean, 1988; Swinney & Prather, 1989). For example, Swinney & Prather (1989) modified the traditional lexical decision task to allow for use with pre-literate children. They presented pictures rather than strings of letters. The subjects were required to indicate whether or not the picture represented a food by pressing one of two buttons. The children were instructed to press the "yes" button if the picture represented something edible and the "no" button if the representation was something non-edible. The underlying assumption was that, for the subjects to determine whether the picture represented an edible object, the meaning would first have to be accessed. The subject would first have to identify the item in order to be able to make a decision about it. Swinney and Prather found this procedure to be an effective way to investigate the mental lexicon of pre-literate subjects.

The research to date has resulted in limited evidence of specific impairments in lexical organization or semantic representation in children with autism (Tager-Flusberg, 1996; Minshew & Goldstein, 1993). It is quite possible, however, that the use of more controlled "on-line" procedures may be necessary to detect differences in lexical organization. Priming techniques have been the most widely used within the psycholinguistic research to explore differences in semantic organization (Crump-Wiegel, & Dennis, 1986).

Priming

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

The semantic priming paradigm (Moss et al., 1995; Neely, 1991; Meyer & Schaneveltd, 1971) is one of the most widely used procedures in the study of the lexicon. In a standard priming task, two stimuli are presented in succession. The first stimulus, the prime, may or may not require an active response from the participant. The prime is then followed by the target stimulus to which a response is required. This paradigm allows researchers to investigate the nature of the semantic information accessed when a word or picture is recognized by charting the prime-target relationships through reaction times. A person will name a picture or word more rapidly if it has been preceded by a related picture or word (Forster, 1981). For example, a subject will name nurse faster if he or she just named the word doctor as opposed to an unrelated word such as tree. These findings support the assumption that the lexicon is semantically organized.

The initial research in priming relied on the lexical decision task and evaluated primarily the effects of semantic relationships and of context. Meyer and colleagues (1975) were the first to report priming effects using something other than the lexical decision task. These researchers used the naming task and found results consistent with earlier work in semantic priming.

Priming conditions

Closer analysis of priming effects have resulted in mixed findings with regard to the effects of the prime on the access and production of words. The nature of the prime-target relationship is one important variable influencing the direction and magnitude of the priming effect. There have been a number of different types of prime-target relationships examined within the literature. The most frequently discussed conditions

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

include identity or repetition priming, associate priming, categorical or semantic priming, and phonological priming.

Identity priming

There is considerable evidence in the literature supporting strong identity priming effects, intra and cross-modally (also referred to as repetition priming effects) (Scarborough, Cortese, & Scarborough, 1977; Feustel, Shiffron, & Salasoo, 1983; Wheeldon & Monsell, 1992; Bruce et al., 2000). Identity priming involves the reduction of naming latency of a target when preceded by a prime related by identity. For example, a target picture is named faster when preceded by the same word in print or the definition of that word. Identical pictures also facilitate naming, whether the subject names the prime picture or not (Lachman & Lachman, 1980; Caroll, Byrne, & Kiegner 1985).

There are a number of explanations proposed to account for identity priming. Task-specific learning is one mechanism discussed in relation to identity priming (Wheeldon & Monsell, 1992). A task-specific response is a learned association to a stimulus that facilitates this same response when the same task (e.g., picture identification with same picture) occurs again within a given period of time. Task specific learning would occur primarily when the prime and target are identical.

A second explanation for identity priming involves the presence of an episodic memory trace (Feustal, Shiffrin, & Salasoo, 1983; Bruce et al., 2000). The repetition effects are due to the retrieval of context specific information without any necessary access to the lexical knowledge of that specific word. The priming effect is primarily due to perceptual encoding of structural information. Some argue, however, that this explanation is insufficient because the actual appearance of the prime does not appear to

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

affect the magnitude priming effect (Scarborough, Cortese, & Scarborough, 1977; Feldman & Maskovljevic, 1987). That is, even when the prime is a printed word and the target is a picture; there are strong repetition effects.

A third explanation for identity or repetition priming involves changes in the accessibility of lexical information (Morton, 1970; McClelland & Rumelheart, 1981; Monsell, 1991). When a word or picture is identified, the semantic properties of that word are accessed, in turn lowering the access threshold for the second encounter.

Naming a picture involves three stages (Levelt, 1992). The individual must first perceptually encode the picture, then access the semantic properties, and finally, access the phonological properties to allow for actual naming. A final explanation proposed to account for identity priming is that it is due to the lowered threshold for activation of the phonological information. When naming the prime (either in response to a picture, word, or definition), the phonological properties are activated. Monsell (1991) was able to demonstrate, however, that the identity priming effect was not due to the phonological activation. He used definitions of homophones (of the target picture) to serve as the primes. For example, a person was given the definition "you use it to hit a baseball" and provided the response "bat". The target picture of the animal bat then followed. Monsell found that simply producing the word form without access to the meaning was insufficient to produce priming.

Associate priming

It is well agreed that strongly associated words are linked within the semantic lexicon (Chiarello, Burgess, Richards, & Pollock, 1990; Fodor, 1983). Association strength has been defined as frequency counts of responses to a stimulus word (Postman

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

& Keppel, 1970). These associated connections are built up within the lexicon through repeated co-occurrence of two word forms. The link represents the high probability of a specific word form occurring shortly after a highly associated word form (Fodor, 1983; Lupker, 1984). These highly associated words linked through frequent co-occurrence do not necessarily share semantic features (Levelt, 1989). Results from associate priming tasks have revealed consistent and robust priming effects for strong associates (LaHeij, 1990; Humphreys, Riddoch, & Quinlan, 1989; Alario, Segui, & Ferrand, 2000).

Category priming

Priming research has largely treated category membership as the most typical semantic relationship that is mentally represented (Becker, 1975; Ross, 1999; Chiarello & Richards, 1992). Previous priming studies revealed significant priming effects for words that belonged to the same semantic category (Carr, McCauley, Sperber, & Parmelee, 1982; Sperber, McCauley, Ragain, & Weill, 1979; Lupker, 1984). These facilitory effects were explained in terms of spreading activation to connected representation (Collins & Loftus, 1975).

Lupker (1985) and others (Alario, Segui, & Ferrand, 2000; LaHeij, Dirks, & Kramer, 1990) have re-examined the category priming. They found two important variables that greatly affected the magnitude and nature of the priming effect. The first involves controlling the stimuli within the category priming condition for strength of association (Lupker, 1985; Alario, Segui, & Ferrand, 2000). In many cases, words that are categorically related (e.g., <u>cat</u>-<u>mouse</u>) are also strong associates. When categorical primes were controlled for associative relationship, the priming effect disappeared and in most cases, interference effects were found (Alario, Segui, & Ferrand, 2000; LaHeij,

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Dirks, & Kramer, 1990; Lupker, 1988). Because categorically related items within the lexicon share many features, when one is used to prime the other, many of the same features are activated. This then results in competitive interaction in the mapping between the semantic representation and phonological form (Humphreys, et al., 1995; Dean, Bub, & Masson, 2001). This has been described as the "lexical competition hypothesis".

A second variable that must be considered when evaluating results from category priming studies is the nature of the categories used (Atran, 1989). Atran suggests that artifact or rule based categories (e.g., tools, countries) are less stable than natural kind categories with the concepts being organized around functional properties rather than category membership. In turn, different priming effects have been found for these types of category relations, with much stronger and more stable effects for natural kind categories (Moss, Ostrin, Tyler, & Marslen-Wilson, 1995).

Phonological priming

Phonological priming effects have been studied less frequently than semantic priming effects. The research that has been done to date in phonological priming has yielded extremely variable results.

A phonological prime is a speech fragment that is phonologically related to the target word. The most extensively studied phonological prime has been the rhyme prime (Sereno & Quene, 2002). Rhyme primes are defined as a preponderance of overlap of phonological information between the prime and the target, primarily at the end of the word (Sereno & Quene, 2002). Research in rhyme priming has resulted largely in speeded naming of target words preceded by rhymes (Hillinger, 1980; Burton, Jongman,

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

& Sereno, 1996; Gordon & Baum, 1994). Others, however, have failed to replicate these findings using rhyme primes (Martin & Jensen, 1988; Brooks & MacWhinney, 2000; Sullivan & Rieffel, 1999).

Sereno & Quene (2002) proposed that phonological priming results are affected to a large degree by variables within the research design, including relatedness properties, timing of the stimuli, and other task demands. Radeau, et al. (1995) found greatly reduced rhyme priming effects when they increased the interstimulus intervals (from 20 ms to 400 ms). Furthermore, the presentation mode of the prime affected the degree of priming. They found significant priming only when both prime and target were presented auditorily and failed to find any priming when the task was a bi-modal task (with the prime presented visually).

Brooks & MacWhinney (2000) found that age of participant, nature of the phonological prime as well as the timing of the presentation affected the results. Four groups of individuals varying in age (5, 7, 9 years old, adults) participated in a picture naming task. Primes were presented very shortly before the picture appeared, simultaneously with the picture and very shortly after the picture appeared. The primes included identity primes, onset overlap primes, rhyme primes and unrelated primes. Onset primes presented just prior to the pictures facilitated naming for the older children but not so for the younger ones. They found that the rhyme primes facilitated naming in the younger children but not so in the older children. These findings, however, must be interpreted with some caution. A closer examination of all of the conditions revealed extremely variable results and findings that were somewhat inconsistent with the prior research. For example, they found no facilitation for identity primes, which is unusual

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

given the maximal overlap between the prime and the target. Further, they did not actually find priming for the rhyme prime for the younger group, but rather an absence of interference.

Although it is difficult to interpret these findings with regard to their linguistic implications, the fact that the naming speed appeared to be affected by variables such as the timing and the nature of the prime is important to note when developing phonological priming tasks. Further, the potential effects of age on outcomes must also be considered.

Factors influencing reaction time

Work frequency and age of acquisition

There are several other factors that have been shown to affect reaction times with lexical access. For example, most theoretical accounts of word retrieval have proposed that word frequency will influence naming speed as well as accuracy (Oldfield & Wingfield, 1965; Jescheniak & Levelt, 1994). The implication is that words that are used more frequently will become more rapidly accessible due to repeated activation. More recently, however, some have come to question the word frequency effect and propose that this effect is confounded by age of acquisition of words (Morrison, Ellis, & Quinlan, 1992; Barry, Morrison, & Ellis, 1997). Morrison, Ellis and Quinlan re-evaluated the data from the original Oldfield & Wingfield study using several additional variables. They found that age of acquisition (AoA) as well as the length of the word were highly correlated with Oldfield and Wingfield's naming times. They suggested that when investigators control for age of acquisition, there will be little or no word frequency effect. They further proposed that the higher activation thresholds are due to age of acquisition and not word frequency. One of the issues with use of age of acquisition has

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

been that investigators have had to rely on adult ratings of acquisition as opposed to actual word learning data. More recently, Barry, Morrison, & Ellis (1997) conducted a study to develop actual word learning age of acquisition data. Interestingly, they later found that adult rated age of acquisition scores were actually good estimates of actual word learning age.

Image agreement and name agreement

Image agreement and name agreement are still other factors that have been shown to impact upon the course of naming speed (Snodgrass & Vanderwart, 1980; Barry, Morrison, & Ellis, 1997). Image agreement is a measure of how well a picture or object actually represents its intended name. Name agreement indicates how well participants agree to the name for a given object. Barry, Morrison, & Ellis (1997) found that pictures with poor name agreement (e.g., donkey → horse, pony) were named incorrectly more frequently and were classified slower by participants. In addition, they found that objects with higher ratings of image agreement (i.e. the extent to which the picture resembles the raters mental image of the object) were named faster than those with lower ratings.

Timing and quality of the prime

The time and quality of the prime itself can affect the priming effect. It has been demonstrated that when the stimulus onset asynchrony (SOA) is very short, the priming effects are strongest (Vitkovitch, Rutter, & Read, 2001). The direction of the priming effect can also be altered with different SOA's. In word naming studies, it has been demonstrated that short SOA's can result in facilitation with category priming but long SOA's result in inhibition (Plaut & Booth, 2000). This effect has been explained by the presence of automatic versus strategic effects (Neely, 1991; Neely, 1977). The short

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

SOA's result in automatic effects, in turn, speeding up the naming process whereas the longer SOA's allow the participant to begin to rely on strategic planning, slowing down the naming process.

Priming with other populations

Priming with children

Although the majority of priming research has been with adults, there is evidence of priming effects in children (Pratarelli, Perry, & Galloway, 1994; Radeau, 1983; Share, Jason, Matthews, & Maclean, 1988). Tyler and Marslen-Wilson (1981) used a word monitoring task. Subjects listened to sentences and pressed a button when target words were heard. Studies using priming tasks with children indicate effects similar to those found with adults when non-lexical factors such a motor skills and attending were adequately controlled (Schwantes, 1981; Simpson & Lorsbach, 1983; Swinney & Prather, 1989).

Priming with special populations

The semantic priming paradigm has also been used in studies with individuals with mental illness as well as developmental disabilities (Blum & Freides, 1995; Ober, Vinogradov, & Shenaut, 1997; Toichi & Kamio, 2001). The findings in studies with individuals with schizophrenia and other forms of mental illness have been quite mixed. Several studies found heightened semantic priming in the schizophrenic subjects when compared to typical controls (Kwapil, et al., 1990; Manschreck, et al., 1988). Other studies, however, were unable to replicate these findings and rather found similar priming effects across all groups (Blum & Friedes, 1995). A careful examination of these studies revealed procedural differences that could have accounted for these mixed findings.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

These differences included the nature of the related prime-target pairs, the type of priming task, as well as the SOA duration. These have all been demonstrated in previous research to be factors that greatly influence the priming in typical individuals.

Priming in autism

Toichi & Kamio (2001) utilized a novel method to investigate the semantic memory in children with autism. They used a word competition task. Words were presented with several letters omitted and the subjects were required to label the word. The words were difficult to complete without semantic cues. The investigators compared the effects of word pairs that were semantically related (e.g., bus, train) to word pairs that were unrelated (e.g., necktie, television). An unusually long prime presentation was employed to insure processing. The SOA was quite long as well (2 seconds) with a very short inter-trial interval (0 seconds). The investigators found a main effect for relatedness but no group or interaction effects, indicating similar semantic priming effects in both groups. The investigators used percentage correct as the dependant measure rather than reaction time. This, paired with the unusually long prime presentation and SOA, make these results less clear to interpret. The investigators examined their findings to determine if there were any significant correlations between the results of the task and age, performance I.Q., and scores on the Raven's *Standard Progressive Matrices* (*RSPM*, Raven, 1969). They did not find any significant correlations for the control group. They did, however, find significant correlations between the performance on the task and the Performance IQ scores as well as between the performance and the scores on the *Raven's Standard Progressive Matrices.* The investigators concluded that although the groups showed similar performance scores on the experimental task, they might have employed

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

different strategies. The individuals with autism may have relied upon non-verbal strategies such as visual imagery when performing the task. It is quite probable, given these suggestions, that the use of reaction time as the dependent measure as opposed to percent correct could have revealed group performance differences.

One important limitation with the procedures used by Toichi & Kamio is that it required the subjects to rely on reading skills. The problem with using a reading task with individuals with autism is the potential confound of hyperlexia. Hyperlexia is defined as a precocious self-taught ability to read with an apparent lack of comprehension (Mirenda & Erickson, 2000). There appears to be a discrepancy between the individual's word decoding skills and reading comprehension (Cobrinik, 1974). Although hyperlexia can occur in a wide range of disabilities, there appears to be a higher incidence in children with autism (Elliot & Needleman, 1976; Goldberg & Rothermal, 1984). Reading of printed words can occur without full lexical access. The investigators did not provide any information about the subjects' reading skills making it impossible to evaluate the potential effects of advanced decoding skills or hyperlexia.

Overall response speed in special populations

The overall response time for special populations in reaction time studies appears slower when compared to control groups (Kail, 1994; Miller, et al., 2001; Inui, Yamanshi, & Tada, 1995). Kail (1994) described a "generalized slowing hypothesis" to explain the slower reaction times in children with specific language impairment (SLI). He proposed that children with SLI demonstrated overall slowed responses on all aspects of processing, linguistic and non-linguistic. Slower response time in reaction time studies have been found in other population, including schizophrenia (Ober, Vinogradov, &

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Shenaut, 1997), Down syndrome, and mental retardation (Inui, Yamanishi, & Tada, 1995). Problems with perceptual, motor and cognitive skills contribute to this "generalized slowing" in special populations (Schul, et al., 2004).

Children with autism may not be as affected by this "generalized slowing". Inui, Yamanashi, & Tada (1995) compared reaction time of children with autism, children with Down syndrome and children with mental retardation on a simple reaction time task involving touching a screen upon presentation of a light flash. The three groups of children with disabilities demonstrated slower and more variable reaction times when compared to the typically developing children. The children with autism, however, demonstrated much faster reaction times than the children with Down syndrome or mental retardation.

Brian et al. (2003) also failed to find any slowed reaction times for the participants with autism in their negative priming task. They did, however, find an age effect across both groups, with faster reaction time scores for older participants. This finding is consistent with research by Kail (1991; 1994). Kail found large and consistent age effects on reaction time tasks.

There is a significant body of research examining the semantic development and lexical organization of children with autism. Findings, however, have been inconsistent and conflicting. Most of this research has relied on off-line tasks such as sorting or naming pictures. The few studies using on-line procedures did not rely on reaction times or control for the nature of the prime-target relationship. The purpose of this investigation was to re-examine the lexical processing and organization of children with autism using a priming paradigm. More specifically, a naming paradigm with pictures

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

was used to examine the effects of four different priming conditions on the response latencies of children with autism and typically developing children. In order to address many of the complex issues within both the priming methodology as well as the individuals with autism, pictures were used as the targets and the primes. Printed words were not used because of the potential confound of hyperlexia. Spoken words were avoided due to the problems frequently present in autism with attention to auditory stimuli (Courchesne, 1987; Rapin & Dunn, 2003; Tecchio, et al., 2003).

Picture Naming

Pictures are symbols of their objects or object classes due to their physical similarity. Naming pictures involves the same cognitive processes as naming the objects themselves (Potter, 1979). At least three kinds of information must be accessed and retrieved within the process of naming an object: visual, semantic, and phonological (Levelt, 1989; Glaser, 1992; Humphreys, Riddoch, & Quinlan, 1988). There is considerable evidence that pictures and words access a common semantic representation (Riddoch, Humphreys, Coltheart, & Funnell, 1988; Humphreys, Lloyed-Jones, & Fias, 1995). This is in contrast to the Dual Coding model, which proposes two separate but interconnected knowledge systems (Paivio, 1971; 1983). Results from a large number of priming tasks using pictures as targets, primes, or both have resulted in similar effects when words (either printed or spoken) have been used. Frequency, age of acquisition, and SOA has all been found to affect reaction time to pictures in a similar pattern as words (Barry, Morrison, & Ellis, 1997; Vriezen, Moscovitch & Bellos, 1995). In addition, the strong associate priming effect along with the conflicting semantic relatedness results have been obtained with pictures. These consistent findings, along

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

with research that has examined different aspects of the picture naming process, provide ample evidence for a single system (Riddoch, Humphreys, Coltheart, & Funnell, 1988; Humphreys, Lloyed-Jones, & Fias, 1995).

Research questions and predictions

In this study, stimuli were employed in four conditions to address issues in prior picture naming priming tasks. The identity condition was designed to serve as the baseline condition. It was hypothesized that this condition should yield strong priming effects across both groups, as it does not necessarily involve access of lexical information. If children with autism demonstrate priming in this condition, then it could be concluded that they were capable of performing the task and the remaining results could be interpreted as effects from the priming conditions as opposed to task complexity. If the children with autism demonstrate similar naming performance across the different conditions as the typically developing children, then it would support previous research indicating a lack of any unique semantic deficits when controlling for cognitive development. More specifically, both groups should demonstrate positive priming effects within the associate condition. It is likely they would demonstrate slowed reaction times in the categorical condition due to the interference effects found in previous research. Given the underlying model for naming pictures (Figure 1), it is believed that the participant should be facilitated in naming the rhyme primes. Figure 1 presents the hypothesized effects for the different priming conditions. The lexical competition effect should result in slower naming of pictures that are categorically related to primes. The strength of associations should facilitate the naming of subsequent pictures and the rhyme relationship should reduce the naming time for targets.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

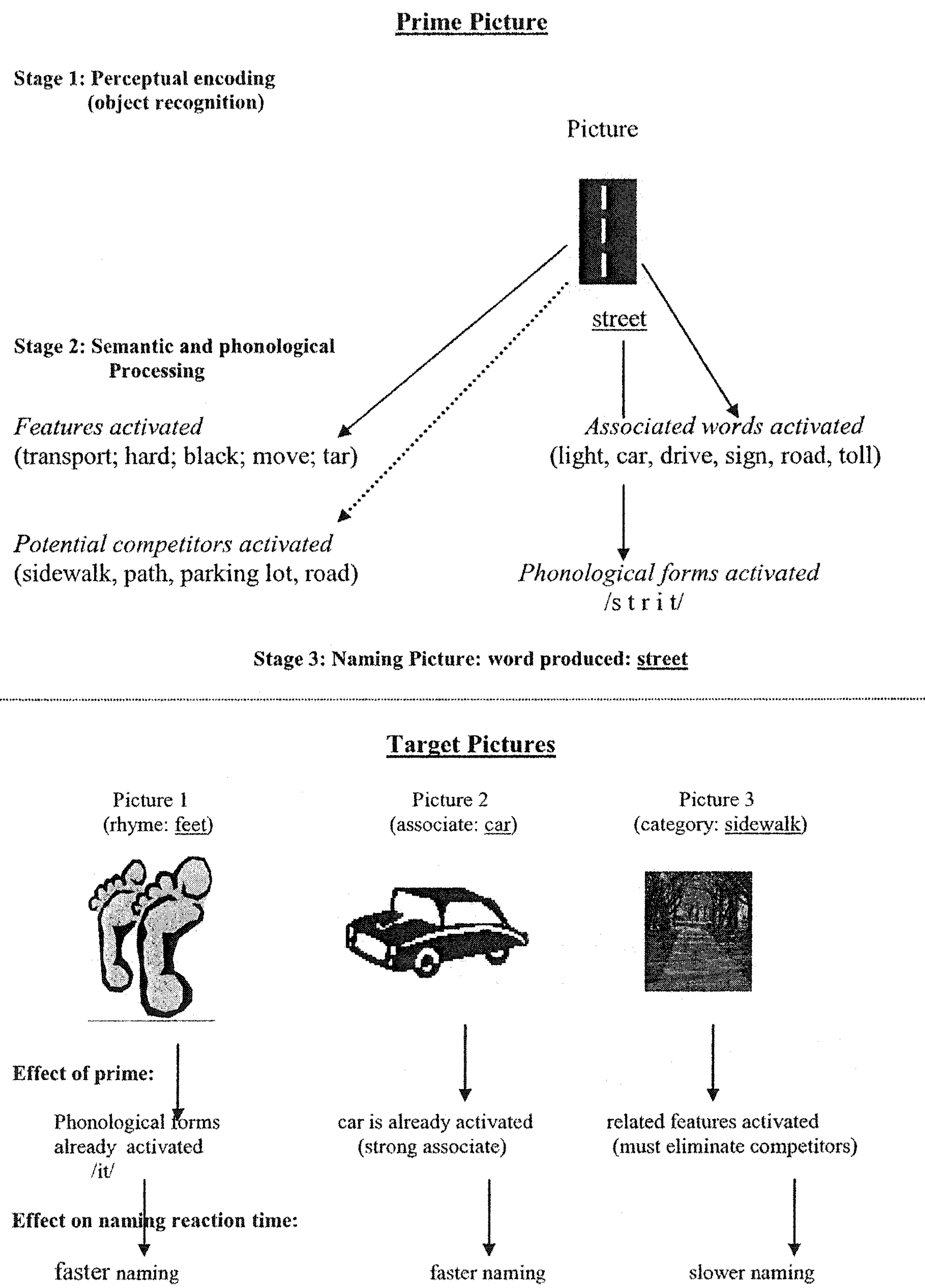

Figure 1. *Naming model: Proposed effects of priming conditions on naming reaction time*

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

This study addressed the following questions:

1. Do children with autism demonstrate identity priming effects?
2. Do children with autism demonstrate similar priming effects when compared to typical children matched on receptive vocabulary age?
3. Do children with autism demonstrate response time profiles similar to typical peers in relation to word frequency and age of acquisition?

If the groups do not differ in their performance across priming tasks, it will suggest comparable lexical processing and organization. If children with autism differ in their lexical processing or organization, performance differences across the priming tasks should be present.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Chapter II

Method

Participants

Fifteen typically developing children and fifteen children with Autism Spectrum Disorders participated in this study. The children with autism were recruited through local autism associations and schools via mailings and Internet posts. Only children with an independent diagnosis of autism or PDD-NOS as well as non-verbal IQ scores within normal limits were considered for this study. 24 children with autism responded for participation during the first attempt of recruiting. Two five year old children were unable to follow the instructions provided during the experimental phase and were eliminated from the study. Six other children were excluded due to scores that were too low on the *Peabody Picture Vocabulary Test-Revised* (*PPVT-R*, Dunn & Dunn, 1997) or the *Test of Non-Verbal Intelligence 2 (TONI 2,* Brown, Sherbenor, & Johnson, 1990). One subject failed to return for the second experimental session. In addition, one other subject was excluded due to a change in medication status that affected her reaction time. A second phase of recruiting was conducted to locate the 15th subject with autism. The first participant that responded met the necessary criteria and was selected for participation.

Fifteen high functioning children with autism took part in this study. The children had all received a diagnosis of autism by experienced clinicians using the guidelines of standard criteria in the DSM IV. In addition, all had received scores of 27 or higher on the *Childhood Autism Rating Scale* (Schopler, Reichler, & Renner, 1986). All had I.Q. scores within normal limits as measured by the *Test of Non-Verbal Intelligence 2* (Brown,

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Sherbenor, & Johnson, 1990). They ranged in age from 6;2 to 12;3 (M=9;3, SD=1;9). They all demonstrated clear intelligible speech and generally spoke in complete sentences. All attended local private or public schools specializing in autism.

A group of 15 typically developing children matched on receptive vocabulary scores participated in this study. They ranged in chronological age from 6;2 to 11;2 (M=8;2; SD=1;4.5). All of these children attended regular education classes and received no special supports or services. Parents reported satisfactory progress in all areas for all children. There was no familial history of autism within any of the children in this group. These participants were recruited from neighborhood groups such as little league teams and a dance class. Only one participant was excluded due to a score too low on the *Peabody Picture Vocabulary Test.*

The two groups were matched according to vocabulary development as measured by the *Peabody Picture Vocabulary Test-Revised* (*PPVT-R*, Dunn & Dunn, 1997). There were no significant group performance differences on the *PPVT-R* as reflected by an independent samples t-test (1 (28) = -818, p = .421). Subject information is summarized in Table 1.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Table 1: Subject Information

	Autistic	Typical
Sex		
Males	7	8
Females	8	7
Age		
M (years;months)	9;3	8;2
(SD (months)	(22.9)	(16.5)
PPVT-R Standard Score		
M	88.87	98.93
(SD)	(7.98)	(3.45)
TONI-2		
M	95.73	
(SD)	(14.9)	
CARS		
M	30.8	
(SD)	(1.8)	

Materials

A set of words and corresponding black and white line drawings of common objects were used. The items selected were those ranked high in terms of name agreement of the most common name. Name agreement was established prior to this study. Ten adults were asked to name a set of 200 pictures. Pictures receiving less than 90 % name agreement were not included in this study.

Four sets of prime-target relationships were selected from these words. One group, the identical prime-target set consisted of identical word pairs. The second set, the rhyme-prime condition consisted of single syllable labels that rhymed (e.g., cat, hat). The third set, the associate prime-target condition, consisted of words that had been rated as primary or secondary associates of their targets (Postman & Keppel, 1970; Palermo &

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Jenkins, 1964; Nelson, McEvoy & Schreiber, 1994), but not members of the same semantic category. The fourth set, the categorical prime-target condition, included words that were members of the same semantic category as their targets (Battig & Montague, 1969). The remaining words served as fillers and did not occur in any related conditions.

The words were controlled for frequency of label in print (Francis & Kucera, 1982), age of acquisition (Morrison, Chappel, & Ellis, 1997) as well as degree of naming agreement for pictures. These variables have all been demonstrated to affect picture naming latencies (Ulrich & Miller, 1994; Barry, Morrison, & Ellis, 1997).

Ten words were included in the identity prime condition. The remaining three conditions (associate, rhyme, & category) included twenty pairs for each condition, resulting in a total of 70 experimental word pairs across four conditions (See Appendix A for a complete list of stimuli). For ten of the targets, the same target words were used across all four prime conditions. One target (e.g., bed) occurred in all four conditions with the necessary respective prime (e.g., pillow-bed, couch-bed, head-bed, bed-bed). Only ten target words were able to be placed into all four conditions with different respective primes due to restrictions of frequency, name agreement and imageability. The use of pictures as opposed to spoken words or printed words limits the pool of potential targets and primes to things that can be clearly depicted visually. In order to develop a sufficient number of word pairs, ten word pairs were developed specifically for each of the experimental conditions, resulting in an additional thirty word pairs.

PRTLAB (Swinney, 1995) a computer program that displays pictures on a monitor and records response time, was used to run this experiment. Reaction time (RT) was measured from the target onset using a voice activated microphone and recorded in a

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

computer file. The experimenter observed all sessions and manually recorded responses. The experimenter recorded responses as correct, incorrect, or technical failure (e.g., computer failure or sounds other than the subjects response activated the switch). An intertrial interval (ITI) of 300 ms was employed. Each picture was presented for 3000 ms or until the subject named it. See figure 2 for an overview of the timing variables.

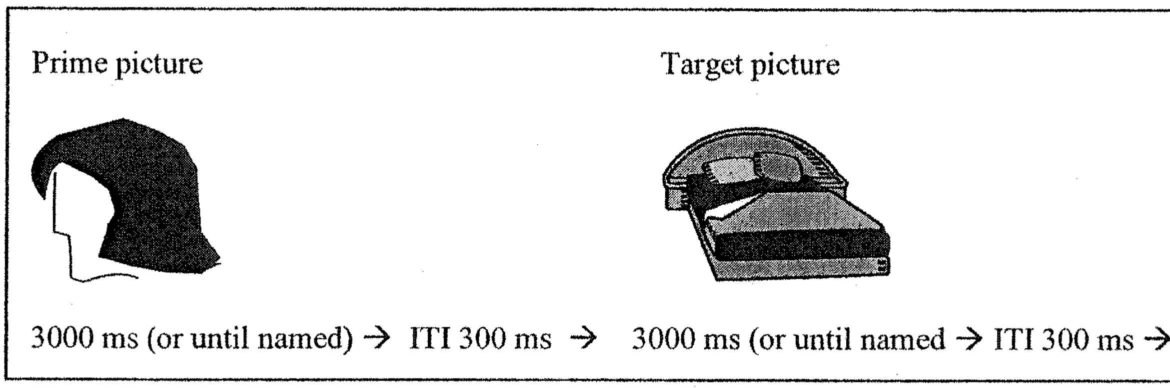

Figure 2. *Sample timing of stimuli presentation*

The reaction time consisted of picture onset to naming (voice activated microphone began timing with picture onset and terminated recording with naming onset). Prime-target pairs were distributed throughout a set of thirty pictures with fillers (unrelated pictures) interspersed between experimental pairs (see appendix F for complete stimuli sets).

Procedure

All subjects were pre-tested on their receptive identification of all pictures used as prime or target stimuli. Only subjects who were able to identify 90 % or more of the pictures participated in this study. All of the subjects were given a detailed explanation of the project and provided with an informed consent form. Only subjects for whom

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

informed consent was obtained participated in this study. When possible, verbal assent was obtained from the child with autism as well.

Prior to experimental sessions, subjects were evaluated with the *PPVT-R* (Dunn, 1997). In addition to the *PPVT-R,* the children with autism were also evaluated with the *TONI-2* (Brown, Sherbernor, & Johnson, 1990) and the *Childhood Autism Rating Scale* (Schopler, Reichler, & Renner, 1986). The subjects participated in two subsequent experimental sessions. Each session was separated by at least two weeks. Each session began with a set of 20 practice trials. The child was seated in a chair in front of a computer monitor. The instructions given were to name each picture immediately as it appeared on the screen and to remain quiet at all other times. The pictures used during the practice trials were neither targets nor primes within the actual experimental trials. The subjects were told that they should try to name the pictures as fast as they could. Visual token systems were employed for the children with autism to promote attending and reduce the potential for frustration. The children were provided with a token for each set completed and were allowed to select from preferred items or activities once all the sets were completed and the necessary tokens were obtained. Verbal prompts were provided to both groups to "go fast". Both groups demonstrated adequate attending to effectively complete the task. Only one participant with autism required additional training beyond the twenty original practice trials. This subject was given a second set of practice trials to insure adequate understanding of the task had been secured.

The practice trials were followed by a set of baseline trials. These trials included targets, primes, and fillers. None of the targets occurred in any primed condition during the baseline trials. Each experimental group contained 30 pictures with prime-target sets

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

interspersed with filler pictures. The identity prime condition was presented first for one half of the targets and last for the other half of the targets. This order was counterbalanced across subjects. The remaining conditions were randomly distributed across the two experimental sessions. Filler pictures were distributed between all of the experimental word pairs. These pictures were selected from categories not included in the experimental conditions. The filler pictures were necessary in order to reduce the likelihood that participants would detect a pattern and attempt to use this pattern to facilitate naming. In addition, pictures completely unrelated to any of the primes and targets were needed to fill in between the experimental word pairs to reduce the possibility of inadvertent priming effects from pictures other then intended primes.

Each word that served as a target within the prime-target condition was also presented in a neutral condition preceded by a word that was neither semantically nor phonologically related. The inclusion of the neutral condition and the baseline condition was necessary to establish a reliable baseline reaction time for the targets.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

CHAPTER III

Results

Mean reaction times were calculated for each child for each condition. Reaction time scores were excluded for any trials on which either the prime or the target was misnamed, if there was a hesitation or inadvertent noise, or for failure of the timing mechanism. In addition, items for which there was greater than 60 % naming errors across all subjects were excluded from analysis. This resulted in the elimination of three items from the rhyme condition (coat, clock, bed). The errors were primarily due to incorrect naming of the prime (e.g., blocks as opposed to block) and thereby resulted in a name that was no longer a rhyme for the intended target. Reaction times less than 250 ms and greater than 2500 ms were also excluded from the analysis, providing they were greater than 2 standard deviations from the individual participant's mean reaction time. Approximately 17 % of the trials for the typically developing children and 19 % of the trials for the children with autism were excluded. The raw scores for reaction times across groups and conditions are presented in Table 2.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Table 2. Unadjusted mean reaction times for correct responses in ms across groups and conditions

	TD (N=15) Mean (SD)	Difference Score*	Autistic (N=15) Mean (SD)	Difference Score*
Neutral	872.07 (60.97)		838.07 (73.38)	
Identity	782.39 (47.92)	-89.68	732.58 (61.11)	-105.49
Rhyme	854.73 (72.46)	-17.34	821.80 (78.29)	-16.27
Associate	862.62 (70.98)	-9.45	872.87 (80.95)	34.80
Category	880.45 (60.88)	8.38	848.27 (108.59)	10.20

* Difference Score= condition mean – neutral mean

The data indicate that children with autism were slightly faster in naming pictures in the neutral condition when compared to typical children. In addition, both groups were faster at naming pictures when preceded by the identical picture. The remaining effects were smaller and varied in direction of effect across groups. Hierarchical linear modeling procedures were employed to test the significance of these results.

Analyses using Hierarchical Linear Modeling

Statistical analyses using Hierarchical Linear Modeling (HLM) were employed because of the nested nature of the variables. Traditional methods of analysis (e.g., ANOVA) often overestimate the significant group effects in nested data sets when the samples are small. HLM allows for an analysis at three levels while simultaneously measuring the predictive factors related to the subject level data (Bryk & Raudenbush, 1992).

Reaction time scores for each condition were nested within words, which in turn were nested within individual child (with and without autism). The data were analyzed at

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

three levels. Level one consisted of reaction times for each item within condition. Level two represented the individual word level and level three represented the individual characteristic such as group membership (typically developing/ autistic) and age.

At the first level of analysis, we employed a regression model in which the reaction time (dependant variable) was a function of the reaction time for that word in a neutral condition (π_{0jk}), dummy variable terms represented the other four conditions (π_{1jk}, π_{2jk}, π_{3jk}, π_{4jk}) and an error term (e_{jk}) condition level. In this case, the model for reaction time scores was as expressed as follows:

$$Y_{ijk} = \pi_{0jk} + \pi_{1jk(identity)} + \pi_{2jk(rhyme)} + \pi_{3jk(associate)} + \pi_{4jk(category)} + e_{ijk}$$

In the second level of analysis we modeled effects for individual words. The reaction times for an individual word was a function of the overall reaction for all words for that child (β_{00k}) plus a word-level error term (r_{0jk}). This condition was expressed as follows: $\pi_{0jk} = \beta_{00k} + \gamma_{0jk} + r_{0jk}$

The third level of analysis addressed the effects of group and was expressed as a function of the average of reaction time for all typically developing children (γ_{000}), the effect of autism (γ_{001}) and a child-level error term (μ_{00k}). Level III was expressed as:

$$\beta_{00k} = \gamma_{000} + \gamma_{001group} + \mu_{ook}$$

Reaction Time Analysis

Table 3 displays the results from the model testing differences between the two groups of subjects by condition.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Table 3. Differences between groups by condition

Model Testing Differences between TD and Autistic by Condition

	Est.	S.E.	
Constant	873.22	23.84	

Effect for condition compared with neutral

	Est.	S.E.	Predicted RT
Identity	-96.04**	13.87	778.18
Rhyme	-19.54	12.29	853.68
Associate	-15.88	11.51	857.34
Category	11.6	11.54	884.82

Effect for autistic by condition

	Est.	S.E.	Predicted RT
		33.75	840.58
Identity	-11	20.65	734.54
Rhyme	9.91	17.23	830.10
Associate	42.12**	16.52	867.06
Category	7.71	16.56	859.88

* $p<.05$ ** $p<.01$

The analysis of the four priming conditions revealed a significant main effect for the identity condition (b=-.95.04, SE=13.87, p<.01). Both groups of children demonstrated faster reaction times for object labels preceded by the identical object label.

Both groups of children demonstrated slightly faster reaction times within the rhyme condition, although neither group reached significance. In addition, both groups were slower in naming pictures within the category condition, although again not reaching statistical significance. The analysis did reveal a significant interaction effect within the associate condition (b-42.12, SE=16.52, p<.01). The typical children named targets more quickly in this condition when compared to the neutral condition where as the children with autism named them more slowly when primed by an associate. Figure 3 reflects the difference scores between groups across conditions in a bar graph.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

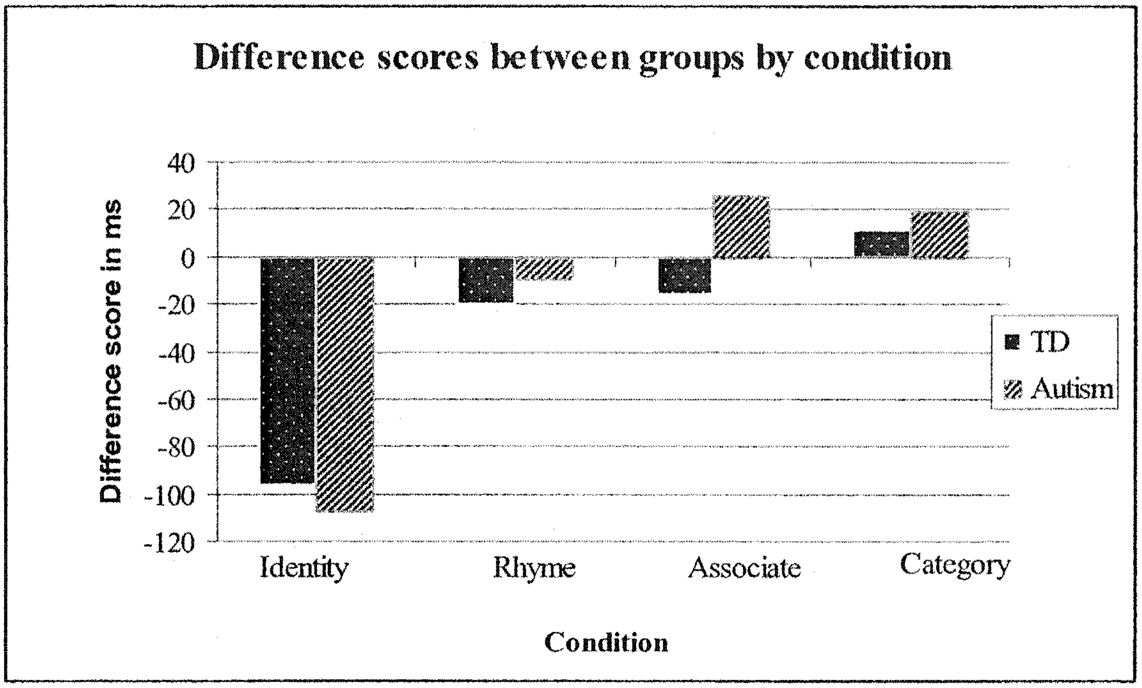

Figure 3. Difference scores by group and condition

This interaction effect was difficult to interpret because there was no main effect for associate priming. That is, neither group demonstrated any significant associate priming.

Prior research has indicated that the amount of priming effect can be greatly influenced by the strength of association of the prime and the target (Hino, Lupker, & Sears, 1997). Unfortunately, because of the need to use pictures as well as other restrictions imposed by the research design, it was difficult to find twenty optimal associate pairs. Compromises in associate strength were made to accommodate issues such as familiarity, imageability, and frequency of the words in order to obtain the necessary number of pairs.

To determine if there was less priming overall due to the effects of word pairs with weak association ratings, a second analysis was conducted. Four different

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

association ratings were used to evaluate association strength for each of the twenty word pairs. A prime that was ranked as one of the top ten associates for the specific target (based on the average of four association ratings) was determined to be a "strong associate". A prime that was not identified as at least one of the top ten associates named for a given target was determined to be a "weak associate" (See Appendix B for a summary of association ratings).

The analysis was re-done, using only those word pairs ranked as "strong associates". This analysis excluded data from seven word pairs (that had not been ranked as "strong associates". The results of this new analysis are summarized in Table 4. This second analysis revealed a significant priming effect for they typically developing children. The typical children were significantly faster in naming items when preceded by a strong associate (b=-32.36, SE=13.66, p<.01).

Table 4. Difference between groups by condition (after removal of weak associates)

Model testing difference between TD and Autistic Conditions

	Estimated	S.E.	
Constant	873.16	23.63	

Effect for condition compared with neutral

	Estimated	S.E.	Predicted RT
Identity	-95.51**	13.85	777.65
Rhyme	-19.82	12.27	853.34
Associate	-32.36**	13.66	840.80
Category	11.56	11.51	884.72

Effect for autistic by condition

	Estimated	S.E.	Predicted RT
Neutral	-32.60	33.47	840.57
Identity	-10.84	20.61	734.25
Rhyme	10.15	17.32	830.89
Associate	57.07**	19.55	865.28
Category	7.53	16.52	859.66

* p<.05 ** p<.01

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

The difference scores for the re-analysis are presented in bar graph format in Figure 4.

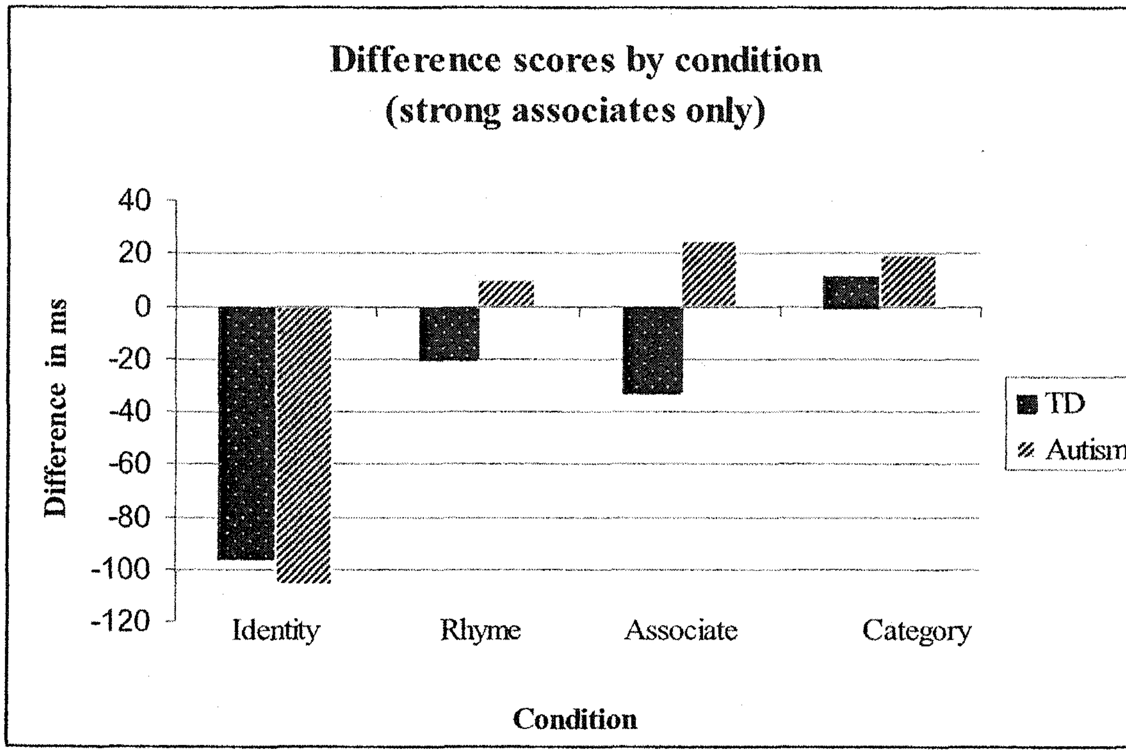

Figure 4. Difference scores by group and condition (strong associates only)

Age of acquisition and frequency

The reaction time data were also analyzed to determine the potential effects of age of acquisition ratings as well as word frequency on naming speed. Objective measures of age of acquisition (AoA) established by Morrison, Chappell, & Ellis (1997) were used to identify the AOA scores for the targets analyzed. 11 out of the 38 targets (29 %) were excluded from analysis as objective age of acquisition scores were not available. The target words were then arbitrarily divided into two groups: early acquired words and later acquired words by using a median split. Early acquired words included those words learned between the ages of 21 months and 24 months. Later acquired words included

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

words learned after 25 months through 68 months. The actual age of acquisition scores were summarized in Appendix C. There were no significant effects of the age of word acquisition on the naming speed within either group (b=.016, SE-.327, ns).

The mean word frequencies (Francis & Kucera, 1982) were identified for each target item. Although the Francis and Kucera word frequency norms reflect frequency counts of words in print, these norms, as well as similarly established norms (e.g. Celex Lexical Database, Baayen, Piepenbrocket & Gulikers, 1995) have been used frequently to evaluate frequency effects in picture and object naming tasks as well as spoken word tasks (Hino, Lupker, & Sears, 1997; Meschyan & Hernandez, 2002; Jescheniak & Levelt, 1994). Snodgrass and Vanderwart (1980) studied the effects of word frequency counts from print with picture naming tasks and found them to be highly correlated with familiarity ratings in pictures. They defined familiarity as the degree to which you come in contact with the item.

The items were divided into two groups: high frequency words and low frequency words using a median split. Low frequency words were those identified as those with a word frequency of 57 or less. High frequency words had scores of 70 and higher, with an upper cut off of 425. The actual word frequency scores are summarized in Appendix D. The analysis revealed significant word frequency effects across both groups (b=-0.085, SE=0.024, p<.01). All of the participants named high frequency words significantly faster than low frequency words.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Error Analysis

Overall errors

Error proportions were calculated using the number of errors made by a subject and the number of opportunities for errors. The number of opportunities for errors differed for each subject due to the computer errors caused by environmental noise, inadvertent vocalizations, or hardware errors. There was no significant difference between the two groups of children with regard to the total number of errors. The distribution of these errors, however, differed between the groups. An independent samples t-test revealed that the typical children made significantly fewer errors on target words when these words occurred within the identity condition ($t(28)=3.16$, $p<.01$). The children with autism did not demonstrate this reduction of error rates within the identity condition. Rather, they made the same percentage of errors across all four priming conditions. These data are summarized in Table 5.

Table 5. Percentage of naming errors of total responses within condition across conditions

	neutral	identity	Rhyme	associate	Category
TD	14%	3%**	11%	13%	15%
Autistic	17%	14%	17%	16%	13%

*p<.05 **p<.01

Prime-related errors

The errors made within the four priming conditions were analyzed to determine if these errors reflected prime-related or non prime-related errors. Prime-related errors had a clear semantic, associate, or phonological relationship with the prime and were unrelated to the target. Responses that were strongly related to both the prime and the target were not counted as prime-related errors. All of the related errors were coded as prime or target-related errors by two research assistants who had been trained on the

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

definitions of prime-related and non prime-related. The two raters had achieved 94 % inter-rater reliability on practice ratings. In the actual experimental data, the items not agreed upon were excluded from the analysis. The results indicated that the typical children made significantly more prime-related errors when compared with the children with autism ($t(28)=4.17$, $p<.01$). These data are summarized in Table 6 as percentages of errors made that were prime-related as opposed to non prime-related.

Table 6. Percentage of target related/prime related errors

	Total related	Non prime-related	Prime-related
TD	12 %	7 %	5%
Autistic	16 %	12 %	4%

Error type

The errors were further analyzed to examine the type of errors made by the participants. Errors that were repeated by a subject for an item were only counted one time within this analysis. For example, if a child repeatedly labeled the picture of egg as oval, this would have been counted as only one error. If the child labeled the egg as an oval in one instance and as a chicken in another, this would have been reflected as two errors. Errors were recorded for all primes as well as for all targets. Responses were coded as errors if they did not correspond to the name established for each picture at baseline. In some cases, therefore, responses were coded as errors for the purposes of this study that would not be considered errors in general naming tasks. For example, road was coded as a synonym error when given for the picture of street even though technically, it was a correct response given the picture. In addition, responses that were either too specific (e.g., Donald Duck → Duck) or too general (e.g., money→ dollar)

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

were also coded as errors because they did not correspond with the names the stimuli would typically elicit or was established at baseline.

Thirteen categories of error types were established. These categories were adapted from a study on naming errors in children with specific language impairment by Lahey and Edwards (1999). The list of all errors (along with the intended target) was provided to two research assistants for rating. In addition, the primary investigator classified all errors. All raters were blind as to the subjects' group or identities.

Each rater received written definitions for each of the thirteen categories (see Appendix E for complete definitions of each error category). Inter-rater reliability (94 %) was established on a sample of errors prior to rating the actual experimental errors. Errors that were not classified as the same by at least two of the raters were excluded from the final analysis. This resulted in the exclusion of 4 % of the errors. The data are summarized in Table 7. These data reflect the number of errors made for each group.

Table 7. Number of errors by type of error

	Semantic-General	Semantic-specific	Semantic-Part	Semantic-category	Semantic-associate	Semantic-Perceptual
TD	11	37	7	26	26	49
Autistic	20	28	7	24	40	35
Difference	9	7	0	2	14	14

	Perceptual	Phonological	No relationship	Circum-locution	Synonym	Non-informative	Persev-erative
TD	26	7	15	3	13	15	25
Autistic	26	6	13	5	6	33	21
Difference	0	1	2	2	7*	18*	4

* p<.05 ** p<.01

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Typical children made significantly more synonym errors when compared to the children with autism ($t(28)=-2.34$, $p<.05$). The children with autism, on the other hand, made significantly more errors that were rated as "non-informative" ($t(28)=2.61$, $p<.05$).

An analysis was conducted to determine if the participants naming speed affected their rate of errors. Previous research has indicated that when participants named pictures under speeded naming conditions, they typically made significantly more errors than un-timed naming (Vitkovitch & Humphreys, 1991). The results revealed no relationship between naming speed and number of errors, across either group.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

CHAPTER IV

Discussion

Despite considerable research into the semantic abilities of children with autism, the precise nature of these abilities and deficits has not been clearly delineated. Some researchers proposed that the lexical processing and representation of children with autism is not specifically impaired and any deficits could be accounted for by general developmental delay (Tager-Flusberg, 1985a; 1985b; 1989; Boucher, 1988). More specifically, children with autism were similar to cognitively matched peers in their abilities to sort and name categories as well as recall semantic information. In addition, naming errors were similar to the error patterns for cognitively matched peers. Researchers concluded that the similar error patterns were evidence of similar lexical organization across all groups. (Tager-Flusberg, 1985b)

Other researchers, however, have provided evidence for the presence of semantic deficits specific to autism. Klinger and Dawson (1985) found that children with autism failed to form semantic categories for novel pictures when compared to control groups. Children with autism have been described as being less efficient in their ability to organize information, especially verbal information (Minshew & Goldstein, 1993; Ameli et al., 1988). They fail to use semantic information to facilitate recall (Hermelin & O'Connor, 1970; Fyffe & Prior, 1978). Children with autism are concrete and literal in their use of language and often demonstrate peculiar use of words as well as words with idiosyncratic meanings (Lord & Paul, 1997; Volden & Lord, 1991).

The purpose of this study was to investigate the lexical processing and organization of children with autism through the use of on-line priming tasks. On-line

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

tasks are more sensitive to the potential differences in lexical processing than many of the tasks used in previous research. The majority of research investigating the lexical and semantic abilities of individuals with autism has relied on off-line tasks such as sorting pictures or untimed naming tasks (Tager-Flusberg, 1981; 1985a; 1989; Boucher, 1988). These tasks can easily be confounded by non-lexical factors such as attending or general processing ability, making the results less clear. The limited research available using on-line methods did not rely on reaction time but rather percent correct and number of errors (Toichi & Kamio, 2001). Although these are important results and warrant consideration, reaction time has been demonstrated to be a more sensitive measure of actual lexical processing (Tyler et al., 1997).

This present study examined the picture naming abilities of children with autism compared to a group of typically developing children matched on receptive vocabulary age. More specifically, naming reaction times within different priming conditions were examined.

Overall response speed

The children with autism demonstrated similar overall reaction time scores as the typically developing children within the neutral condition. This is consistent with previous research with children with autism and reaction time data (Brian, et al., 2003; Inui, Yamanishi, & Tada, 1995).

There was no evidence for the "generalized slowing effect" that has been described by Kail (1994) for children with specific language impairment (SLI). Slower response times within reaction time studies have also been found for other special populations, including mental retardation, Down syndrome, and schizophrenia (Inui,

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Yamanishi, & Tada, 1995; Ober, Vinogradov, & Shenaut, 1997). Individuals with autism do not seem to be as affected by the non-linguistic variables that influence reaction times in other special populations. That is, attention span, processing speed, motor coordination, and other potential variables found to affect reaction times in special populations did not seem to be factors for these participants with autism. It is possible that this finding is unique to high functioning children with autism.

The absence of this "generalized slowing effect" suggests that high functioning children with autism are not as affected by non-lexical factors such as motor execution, perceptual processing, or attention when performing reaction time tasks as other clinical populations. The participants with autism were able to stay focused for each set of thirty pictures and name each picture as it appeared with minimal problems. Picture naming is a well established skill, often practiced daily for many of the children with autism. In addition, the use of token systems for responding may have reduced the likelihood of off task behavior. If they were affected by non-lexical factors, there would have been overall slowed responses across all conditions, including the neutral condition, when compared to the typically developing children. The neutral condition involved naming the pictures that were not preceded or followed by any related pictures (or primes). Any reaction time differences in the primed conditions, therefore, can reliably be interpreted as linguistic effects because of the absence of these non-linguistic effects in the neutral condition.

Priming conditions

Identity condition

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

All of the participants demonstrated significant priming within the identity condition. Strong identity priming has been consistently reported in the literature (Bruce et al., 2000; Wheeldon & Monsell, 1992; Feustal, Shiffrin, & Salasoo, 1983).

The identity condition involved naming identical pictures in succession. All of the subjects, across both groups, named the second instance of the picture significantly faster than the first. When naming a picture, there is access to and retrieval of three kinds of information-perceptual, semantic, and phonological. All three stages of access have been suggested as playing a role in identity or repetition priming. The perceptual stage of access plays a critical role in the proposal that identity priming is the result of an episodic memory trace (Feustal, Shiffrin, & Salasoo, 1983; Bruce et al., 2000). That is, there is retrieval of context specific information due to perceptual encoding of structural information that can occur without any necessary access to semantic information.

A second explanation for identity or repetition priming that also involves the perceptual stage of access is the task specific learning model. Task specific learning involves the association of a response to a specific task (in this case, to a specific picture) which then facilitates this response with the same task (or picture) (Wheeldon & Monsell, 1992).

Both explanations are very plausible within this research design. Both task specific learning and episodic memory trace can occur primarily when the prime and the target are identical in appearance, as was the case within this study. Furthermore, the target immediately followed the prime in rapid succession, which facilitates task specific learning.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Although both explanations are plausible for identity priming, the results of the error analysis imply that the children did actually access semantic information as well. There were several occasions where the child with autism made errors within the identity condition that were actually semantically related to the target. In fact, the children with autism made as many errors proportionately in the identity condition as all the others (unlike the typical children), which would be inconsistent with the concept of a pure memory trace or task specific learning.

The fact that the children with autism performed as well as the typical children within this condition makes the remaining findings more meaningful. If the participants failed to demonstrate identity priming (which was expected because of the perceptual nature of the task), then it would not be clear that the results in the other conditions were actually due to facilitory or interference effects from the primes as opposed to an inability to perform the tasks.

Associate condition

The two groups of children performed quite differently in this condition. The analysis revealed an interaction effect for the associate condition. Despite this interaction, neither group actually demonstrated any significant priming. In other words, the faster responses for the typically developing children (compared to the neutral condition) were not significant on its own, nor were the slowed responses for the children with autism. The only thing that was significant was the difference between the two groups in their overall reaction times within this condition. A second analysis was conducted to evaluate the effects of association strength on the reaction times. This second analysis, with the removal of "weak associates", revealed the same interaction

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

effect as the first analysis. In addition, however, the second analysis also resulted in significant priming for the typically developing children, but not so for the children with autism.

This finding suggests that the children with autism differ in lexical processing and organization compared to cognitively and vocabulary matched peers. According to the association hypothesis, the connections between semantic units are strengthened by the frequency of co-occurrence (Oldfield & Wingfield, 1965; Humphreys, Riddoch, & Quinlan, 1988). Faster reaction times should therefore be expected for words preceded by strong associates due to these strengthened connections. Consequently, the typically developing children named the pictures that followed strong associates much faster than they named the same pictures when they appeared in the neutral condition. The lack of an association effect for words in the lexicon of children with autism reflects their lexical acquisition and representation. Selective attention is a critical aspect of all processing and plays an important role in the representation and categorization of referential information that underlies the mental lexicon (Fox, 1995). Children with autism often direct their selective attention atypically in the natural environment; attending to aspects that are not relevant at the expense of more typically important information (Fay & Schuler, 1980; Lovaas, Koegel, & Schreibman, 1979; Lovaas & Smith, 1989). Therefore, when interacting with others and learning words, the child with autism may not be attending to the same referent features and input that a typical child is. In fact, children with autism may form strong associates within their mental lexicon, but not necessarily those that would be expected and considered typical. Rather, these associate

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

relationships may be idiosyncratic leading to an atypical lexical organization that is not reflected in associate priming paradigms using standard association norms.

Children with autism seem to have difficulty forming associations from very early in development. Baron-Cohen, Baldwin, & Crowson (1997) found that children with autism frequently associated a name to an incorrect referent during word learning in the natural environment. A child with autism might map the spoken word onto something in his or her immediate line of vision as opposed to what the speaker was actually referencing. For example, the child might learn to label a ball as a chicken because he or she was holding the ball when the speaker referenced a chicken in the yard.

Atypical lexical organization, as may be the case for many people with autism would result in slower and less efficient processing and use of language. There would be less benefit from context and associative relationships typically found to facilitate processing.

Although it is well established that children with autism use language less than their typically developing peers, it is not likely that the lack of association priming for the children with autism can be accounted for by limited exposure to or use of language. This conclusion is supported by the word frequency effects obtained within this study.

Word frequency effects

There was a significant main effect for word frequency. Both groups of participants named high frequency words significantly faster than low frequency words. Word frequency effects on naming words and pictures are well documented (Oldfield & Wingfield, 1965; Humphreys, Riddoch, & Quinlan, 1988). The threshold for activation is lowered by the frequency a word is heard and used. This study relied on the Francis-

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Kucera (1982) word frequency ratings. These frequencies were established by counting words as they appear in print. There is significant research, however, to support the use of this type of rating for tasks other than print, including naming pictures and objects (Snodgrass & Vanderwart, 1982; Jescheniak & Levelt, 1994; Morrison, et al., 1997). More specifically, it has been established that rated word frequencies predict reaction time in the same manner as objective word frequencies (Meschyan & Hernandez, 2002).

Both groups of children processed and used these words with sufficient frequency to lower the threshold for activation. Because both groups performed the same for high frequency words and low frequency words, it is most likely that there was a similar degree of exposure to these words across both groups of children.

Category condition

There was no significant priming effect present for either group within the category condition. Prior research would have predicted interference effects for category priming, at least for the typical children (Alario, Segui, & Ferrand, 2000; La Heij, Dirks, & Kramer, 1990).

There are several possible reasons for the failure to obtain any significant findings within this condition. One possible issue may have been the stimuli. Compromises in stimulus selection were necessary due to restrictions imposed by the research design. In order to obtain twenty categorically related word pairs that were not associatively related and that could be represented in pictures with sufficient name agreement and degree of familiarity, compromises were made with regard to the strength and nature of the categorical relationship.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Two stimulus factors may have affected the reaction time results. The first involves the type of category pairs employed. The stimuli in this study represented both natural kind categories (e.g., animals) as well as artifact or rule governed categories (e.g., body parts). Prior research has indicated that less reliable priming occurs with artifact categories due to the way these categories are represented with the lexicon (Atran, 1989; Moss, Ostrin, Tyler, & Marslen-Wilson, 1985). Artifact categories are organized around functional properties where as natural kind categories are organized around sensory properties. The shared properties for natural kind categories are numerous and densely correlated. The shared properties for artifact categories are fewer and less interrelated, resulting in less reliable priming (Tyler, et al., 2003). Further support for different representation of natural kind and artifact categories comes from the brain damage literature. There is considerable evidence that artifact categories can be selectively impaired with natural kind categories spared and vice versa (Tyler, et al., 2003; Randall et al., 2004).

The strength of membership of a particular word to the respective category is another stimulus factor that could be considered. Not all members of a category may be as well defined or as typical as others and these relationships can affect reaction times (e.g., Larochelle, Richard, & Soulieres, 2000). Categorical relationships have been defined in terms of typicality and category dominance (Larochelle, Richard, & Soulieres, 2000). Category dominance is a measure of how quickly one can name the superordinal category represented by the target. Typicality is defined by the similarity to the prototype. Larochelle et al. (2000) propose that the different category types (natural kind, artifact) are affected differently by these defined relationships. More specifically, they

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

found that reaction times using natural kind categories have been most affected by the typicality of membership where as reaction times with artifact or rule governed categories are most affected by category dominance. Unfortunately, there are no data available for semantic similarity or category dominance that can be used for selecting word pairs (Alario, Segui, & Ferrand, 2000). Therefore, a reliable method for removing weak pairs was not available for a re-analysis of the data.

Future research on the development of category-related word pairs focusing on strength of relationship is needed. In addition, the effects of natural kind categories and rule-governed or artifact categories should be further explored. Previous research has revealed that children with autism may have specific problems with natural kind category development when compared to rule-governed categories (Klinger & Dawson, 1995). The children with autism were able to apply explicit rules for category membership (as is the case for rule-governed or artifact categories) to classify new members but had great difficulties inferring category membership from prototypical members (as is the case with natural kind categories). This may be a function of problems in attending to relevant aspects of the input and synthesizing information, as is proposed to be an issue for children with autism (Frith, 1989; Happe & Frith, 1997; Martin & McDonald, 2003).

Phonological condition

No significant priming effects were obtained for either group within the phonological priming condition. Three of the original twenty pairs had to be removed prior to analysis due to extremely high error rates across both groups. This, along with lost data due to computer error and inadvertent noises, greatly reduced the data available

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

for analysis. Therefore, the lack of any significant findings in this condition may have been due to limited power.

The timing of presentation of the prime and target may have also influenced the reaction time scores obtained. Previous research in rhyme priming has indicated that the presentation timing of the prime and target can affect the magnitude of priming effect (Meyer, et al., 1974; Radeau, et al., 1995). Because all four experimental conditions (identity, rhyme, associate, and category) were included within each block of pictures, the timing was the same for each condition. Although the timing may have been sufficient to obtain associate priming effects, the ISIs may have been too long to obtain rhyme prime effects. Radeau and colleagues (1995) found greatly reduced priming effects when they increased the interstimulus interval between prime and target by as little as 400 ms. A 300 ms. interstimulus interval was employed within this study.

Finally, variability in the age of subjects could have affected these results. Processing abilities change considerably with age (Kail, 1991). Furthermore, there is some evidence that the phonological priming effect can differ between children separated by only 2-3 years of age (Brooks & MacWhinney, 2000). Because the children in this study ranged in age from 6-12 years, there may have been variability in response patterns that masked priming effects in the older children.

Further research needs to be conducted with a greater number of subjects grouped by age and disability to determine the influence of age effects within this paradigm. In addition, a greater number of word pairs and subjects are needed to insure sufficient power to detect potential differences. Finally, more research on the effects of timing

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

variables on the rhyme priming task is needed to allow for better designed future experiments.

Error Analysis

The high error rate for the children with autism was expected. There are a number of factors that could easily explain this finding. Children with autism tend to have problems with sustained attention, often being distracted by unrelated stimuli or even their own self-stimulatory behavior. The interesting finding is that the children with autism made only slightly more naming errors when compared to the typical children. In fact, the difference in the error rate between groups was not even close to being significant. This differs from findings reported for children with SLI who had significantly greater error rates in naming pictures for the children with language impairments when compared to typical children (Lahey & Edwards, 1999; McGregor & Windsor, 1996).

On the surface, the similar error rates along with the similar reaction times within the neutral naming condition suggest little difference between the two groups of children. If these were the only measures employed, it would be logical to conclude that children with autism did not demonstrate any specific lexical processing or organization differences when compared to typically developing children. In fact, this conclusion is similar to what happens within the standard evaluation process for children with autism and in some research studies (Tager-Flusberg, 1985b). If a child with autism scores within normal limits on a receptive or an expressive vocabulary test, he or she is assumed to have no specific deficits in this area. Such tests reveal little or nothing about underlying representation. Children often know enough about a word to correctly

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

identify it on a receptive vocabulary test but don't necessarily know enough about the word to readily access it or use it fluently in every day life (McGregor et al., 2002). Assessment and research tasks need to go beyond a simple picture identification task to assess vocabulary to include reaction time analysis as well as a careful examination of the use of words in the natural environment and the nature of errors made.

Errors across conditions

The only significant error rates involved the errors made by the typical children within the identity condition. The typical children made very few errors in the identity priming condition when compared to the number of errors they made within the other experimental conditions. This is consistent with previous research that found identity priming reduced the likelihood of naming errors on targets (Brooks & MacWhinney, 2000). The unexpected finding was that the children with autism made as many errors in this condition as they did in all the other conditions, despite demonstrating significant priming for the identity pairs that were named correctly. The reason for this finding is not clear. There are several possibilities that may account for this finding. One possible issue may have been wavering attention during the task. The high rate of "non-informative" errors demonstrated by the children with autism suggests that attention may have wavered during the task. A second possibility could have been a side effect of the way the majority of these children have been taught in the past. Most of the children with autism within this study attended schools using discrete trial instruction and other behavioral teaching strategies. In a behavioral educational program, a child may be provided with an item, given an opportunity to perform a task with that item, and if done incorrectly, often given the same item again for a second chance at correct performance.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Prompting is typically provided to the learner at that point to assist him or her in the task. The children with autism may have correctly named a picture and when the identical item followed, believed that the first response was an error and therefore altered the response on the second picture. Further research is needed to examine these possible explanations.

Prime-related errors

Although the typical children made the same amount of errors in related versus unrelated conditions, a closer examination reveals a very interesting difference. In the related conditions (rhyme, categorical, associate), almost one half of the errors were actually prime-related as opposed to unrelated or target-related. In addition, the typical children actually made more errors in one related condition, the category condition, then they did in the neutral condition. These findings provide support for the lexical competition effect proposed by Damian, Vigliocco, & Levelt (2001). Lexical competition results from the activation of a number of lexical entries based on shared features. In a speeded naming task, participants often respond before they have had the opportunity to eliminate all of the strong competitors (Vitkovitch & Rutter, 2000). The greatest potential for lexical competition to occur would be within the category condition due to the greatest overlap of lexical features between the target and the prime. The error data for the children with autism, on the other hand, did not provide evidence of lexical competition. In addition, there was little evidence that the prime picture influenced the naming of the target picture for the children with autism. The majority of the errors were target related or unrelated to either the target or the prime.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Error type

Analysis of the naming errors made by the children revealed differences in the types of errors made. The typical children named pictures with synonyms of the target name more than the children with autism. The target names were established at the time of baseline to insure that picture names remained as primes for intended targets. Synonyms are words with maximally overlapping semantic information such as street and road. In speeded naming tasks, synonyms would be likely activated as candidates because of the shared semantic features and perceptual information from the pictures.

The children with autism made significantly more errors than the typical children in the non-informative category. The non-informative category included responses that may have been unintelligible or unrelated (e.g., what's that?) to either the prime or the target. This category was different from the "no relation" category in which the subject named the picture, but the name appeared unrelated in any way to the picture or the prime.

Although these data are very limited and highly variable, when examined collectively, they can be interpreted as reflecting weak or impoverished lexical representations for the children with autism. Semantic level naming errors may be attributed to lexical competition and impoverished representations for lexical entries (McGregor et al., 2002). Typical children made quite a few errors that could be the result of lexical competition (the greater number of prime related errors, greater number of synonym errors and greater number of errors in the category condition when compared to the other conditions). The children with autism made far more "non-informative" errors which are errors that are unrelated to either the prime or the target. Because the child

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

with autism may have less developed lexical representations, there is less available information to access in naming, in turn results in fewer lexical competition errors. Unfortunately, the lack of significant priming effects for either group in the rhyme and category conditions make this proposal more speculative than conclusive. It will be critical to examine these conditions more carefully and with more subjects to determine if the results from the error analysis actually reflect the proposed differences in underlying representation.

Limitations

The findings within this study can only be applied to children with autism who have no clear cognitive deficits. It will be important to replicate this study with more subjects, especially children with autism with more significant cognitive and linguistic deficits. The naming task was relatively simple and it is very likely that children with more severe deficits could adequately perform the task. The real challenge for research with individuals on the autism spectrum is defining the subjects and the choice of an appropriate control group. This challenge becomes even greater when conducting research with individuals who demonstrate significant cognitive and linguistic deficits.

Tools such as the *Autism Diagnostic Observation Schedule* (ADOS) (Lord, et al., 2000) and the *Autism Diagnostic Inventory-Revised* (ADI-R) (Lord, Rutter, & Le Couteur, 1994) along with more in-depth language tests and language sample analysis will be needed to better define the subjects and their characteristics.

Another concern in a study such as this is the statistical power. A larger number of subjects in each group as well as a greater number of the word pairs to allow for

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

sufficient data for analysis are needed. However, these pose challenges because of the considerable amount of data that is inevitably lost due to participant and computer error.

Directions for future research

This research should be replicated with adolescents and adults. Response latencies and error rates vary considerably as function of age (Brooks & MacWhinney, 2000; Kail, 1991). These differences are most obvious when looking at children, especially the age range of the participants within this study. It was possible that the variability in the age of the subjects (5-2 years) influenced the results and potentially masked lexical effects. A group of older participants would reduce the likelihood of this.

Although this study provides evidence that children with autism may differ in their lexical organization, it provides little in the way of explaining why these differences exist. Differences in word learning strategies and abilities in children with autism may be an important variable influencing lexical organization and representation. Very little controlled research has been done examining the word learning skills in children with autism, despite extensive research with typically developing children. Studies in fast mapping skills and joint attention activities may yield interesting insight into the lexical development and organization of children with autism.

Conclusion

The findings from this study bring into light several important considerations for individuals with autism. Children with autism differ in their lexical processing and organization when compared to typically developing children, contrary to previous research. Even when controlling for vocabulary development and cognition, the children with autism responded differently to tasks examining lexical organization. These

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

findings compel us to re-examine conclusions from prior research with children with autism.

This study has implications for assessment and intervention with children with autism. Although children with autism may have sufficient knowledge about an object to name it in an untimed naming task (as in a standardized expressive vocabulary test) or to recognize it in an array of pictures (as in a standard receptive vocabulary test), this does not necessarily reflect adequate underlying representation or organization. For example, children with specific language impairment are able to identify pictures within the vocabulary test, however, their underlying representations are greatly impoverished, resulting in less efficient processing and access (McGregor, et al., 2002). The lack of typical association priming for the children with autism suggest they will be less efficient in processing and access of lexical information as well.

One important consideration for therapists and clinicians working with children with autism is that it may be necessary to continue to address vocabulary development programming despite age appropriate scores on standardized vocabulary tests. McGregor and Leonard (1989) were able to increase word retrieval sills of children with specific language impairment by increasing their knowledge and expanding the semantic representation of target words. For children with autism, similar efforts addressing associate relationships may be helpful. Due to the strong perceptual and visual processing preferences in children with autism, semantic maps, diagrams and other visual strategies should be considered. Focus on developing categories, inferring category membership and multiple meanings of words may be essential.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

The use of on-line procedures can be a valuable line of research, providing a better understanding of the complex lexical processing and organization of individuals with autism. If children with autism demonstrate atypical lexical organization, as is suggested from the findings in this study, this could explain many of the other deficits present in this population, including language comprehension difficulties, differences in language use, and problems with abstract language. Because these deficit areas continue to challenge parents and therapists with regard to developing effective intervention strategies, a better understanding of the underlying problems is essential.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Appendix A

List of Stimuli

Identity	***Associate***	***Category***	***Rhyme***
Bed	pillow-**bed**	table-**bed**	head-**bed**
Bee	flower-**bee**	fly-**bee**	key-**bee**
Car	street-**car**	bus-**car**	star-**car**
Feet	socks-**feet**	ear-**feet**	street-**feet**
Head	hat-**head**	nose-**head**	bread-**head**
Mouse	cheese-**mouse**	tiger-**mouse**	house-**mouse**
Nail	hammer-**nail**	screw-**nail**	whale-**nail**
Rake	leaf-**rake**	broom-**rake**	cake-**rake**
Spoon	soup-**spoon**	fork-**spoon**	moon-**spoon**
Train	tracks-**train**	boat-**train**	rain-**train**
	ring-**finger**	cow-**horse**	sun-**gun**
	eye-**glasses**	trumpet-**guitar**	truck-**duck**
	hand-**glove**	elephant-**giraffe**	crown-**clown**
	bird-**nest**	banana-**pear**	bear-**chair**
	pen-**paper**	crayon-**pencil**	glue-**shoe**
	soap-**sink**	dollar-**penny**	pie-**tie**
	web-**spider**	pants-**shirt**	hook-**book**
	apple-**tree**	alligator-**snake**	bat-**cat**
	dog-**bone**	whale-**dolphin**	
	chicken-**egg**	piano-**drum**	

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Appendix B

Association Ratings

Prime	Target	Postman & Keppel	EAT*	USF**	Palermo & Jenkins	average rank	Rank
pillow	bed	1	1	15	1	4.5	High
flower	bee	20	18	18	no rating	18.67	Low
dog	bone	5	20	5	9	9.75	low
street	car	3	2	11	2	4.5	high
chicken	egg	no rating	2	4	no rating	3	high
socks	feet	no rating	2	20	no rating	11	low
ring	finger	no rating	2	4	no rating	3	high
eye	glasses	no rating	9	45	no rating	27	low
hand	glove	10	2	2	4	4.5	High
hat	head	no rating	2	4	no rating	3	high
cheese	mouse	2	11	13	2	7	high
hammer	nail	1	1	1	1	1	high
bird	nest	no rating	6	6	no rating	6	high
pen	paper	2	3	4	no rating	3	high
leaf	rake	0	0	0*	no rating	20	low
soap	sink	no rating	18	0	no rating	19	low
web	spider	1	1	1	1	1	high
soup	spoon	20	5	20	no rating	15	low
tracks	train	1	1	5	1	2	high
apple	tree	1	4	20	no rating	8.33	high

* Kiss, G.R., Armstrong, C., Milroy, R., & Piper, J. (1973). An associative thesaurus of English and its computer analysis. In A.J. Aitken, R.W. Bailey, & N. Hamilton-Smith (Eds.), *The computer and literacy studies.* Edinburgh: University Press.

** Nelson, D.L., McEvoy, C.L., & Schreiber, T.A. (1994). The University of South Florida word association, rhyme, and word fragment norms. Retrieved from http://www.usf.edu/freeassociation/

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Appendix C

Age of Acquisition Ratings

Picture	Age of Acquisition (in months)	Picture	Age of Acquisition (in months)
bed	22.1	head	no data
bee	56.5	horse	23.4
bone	no data	mouse	23.4
book	22	nail	68.5
car	21	nest	no data
cat	23.4	paper	no data
chair	22.1	pear	44.5
clown	38.5	pencil	38.5
dolphin	no data	penny	no data
drum	50.5	rake	no data
duck	21.5	shirt	56.5
egg	no data	shoe	21.1
feet	no data	sink	no data
finger	23.4	snake	25.1
giraffe	38.5	spider	25.1
glasses	23.4	spoon	22.1
glove	44.5	tie	no data
guitar	62.5	train	25.1
gun	44.5	tree	22.1

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Appendix D

Word Frequency (Francis & Kucera, 1982)

Word	Frequency	Word	Frequency
bed	127	head	425
bee	11	horse	117
bone	33	mouse	10
book	193	nail	6
car	274	nest	20
cat	23	paper	157
chair	66	pear	6
clown	3	pencil	34
dolphin	1	penny	25
drum	11	rake	11
duck	9	shirt	27
egg	12	shoe	14
feet	283	sink	23
finger	40	snake	44
giraffe	1	spider	2
glasses	29	spoon	6
glove	9	tie	23
guitar	19	train	83
gun	118	tree	59

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Appendix E

Definitions of Errors

1. Semantic General: Response named a more general term or named a superordinate category term (e.g., pear→ fruit)

2. Semantic Specific: Response named a specific but inaccurate instance of the item (e.g., flag→ American flag)

3. Semantic-Part: Response named some part of the object (e.g., feet→toes)

4. Semantic within Category: Response named category but not rated as associated (e.g., dog→ giraffe)

5. Semantic-Associate: Response named some associated relation (e.g., bed→ sleeping; crown→ king)

6. Semantic-Perceptual: Response named was similar in shape or appearance and semantically related (e.g., mouse→ rat; pen→pencil)

7. Perceptual: Response named was similar in shape or appearance but not semantically or associatively related (e.g., egg→ oval)

8. Phonological: Response named rhymed with or contained more than ½ of the same phonemes as target (e.g., snake→ cake; penny →pencil)

9. No relationship: Response named was not phonologically, semantically or perceptually related to target and was not the name of a target or prime previously presented (e.g., ear → battery)

10. Circumlocution: response named was implying target but not actually named

11. Synonym: Response named was a synonym of intended target (e.g., street→ road; boat → ship)

12. Non-informative: Response named could not be placed into any defined category (e.g., "I don't know";"what's that"; unintelligible utterance)

13. Perseverative: Response named a picture presented previously in the given set

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Appendix F

Stimuli Sets

Set 1	Set 2	Set 3	Set 4
nest	phone	carrots	glue
car	giraffe	bowl	shoe
car	book	ear	phone
pizza	rain	feet	lamp
clock	train	kite	balloons
shoe	shovel	sled	street
indian	whistle	whistle	car
dolphin	doctor	rabbit	scissors
leaf	pear	pot	window
rake	head	nail	candle
scissors	dice	nail	head
baby	stove	bulb	alligator
pie	flower	witch	snake
tie	bee	toilet	doctor
penny	pumpkin	zipper	ruler
hammer	door	slide	block
bed	goat	cat	clock
bed	coat	dice	toaster
drum	gift	feather	slide
balloons	soup	paper	doll
apple	spoon	frog	piano
tree	ruler	puzzle	drum
lamp	ear	hand	wagon
sink	glass	glove	kite
tooth	clown	pretzel	rabbit
crayon	bike	door	finger
pencil	mouse	turkey	dice
radio	mouse	pumpkin	thread
puzzle	ladder	lawnmower	bed
shirt	window	straw	cloud
turkey	doll		turkey

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Set 5	Set 6	Set 7	Set 8
indian	screw	flag	door
cheese	nail	chair	zipper
mouse	kite	snake	phone
ladder	witch	kite	pillow
bulb	sled	feet	bed
gift	street	feet	sink
key	feet	star	bone
bee	ruler	car	horse
wagon	radio	egg	banana
phone	web	lamp	pear
bike	spider	frog	clock
soap	penny	guitar	toilet
sink	knife	balloons	slide
whistle	spoon	ladder	bee
duck	dice	spoon	bee
bread	door	spoon	pencil
head	phone	cloud	stove
zipper	hook	radio	crown
heart	book	stove	clown
window	mower	tiger	tie
boat	scissors	mouse	toothbrush
train	toilet	candle	whistle
shovel	bird	witch	elephant
ladder	nest	glasses	giraffe
balloons	baby	ball	hammer
cup	brush	vacuum	rake
lamp	bike	Indian	rake
shark	cake	ring	feather
dolphin	rake	finger	gun
pretzel	umbrella	pizza	wagon

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Set 9	Set 10	Set 11	Set 12
baby	soap	ring	dice
spider	toaster	truck	finger
train	phone	duck	house
train	cow	banana	mouse
gift	horse	scissors	soap
sandwich	candle	gum	camera
doll	flag	broom	dollar
hammer	toilet	rake	table
nail	eye	apple	bed
glove	glasses	phone	car
tree	coat	tracks	shoe
door	tooth	train	pen
soap	mower	drum	screw
bat	moon	pants	fly
cat	spoon	shirt	bee
shovel	Indian	penny	stove
fish	gift	kite	pillow
candle	ruler	whale	trumpet
sled	bus	nail	guitar
carrots	car	feather	boat
pen	sled	clown	ear
paper	pizza	nose	chicken
goat	window	head	egg
kite	socks	hook	truck
pot	feet	ladder	key
cloud	pencil	bulb	sun
hat	drum	radio	gun
head	bear	dog	door
bird	chair	bone	dog
pumpkin	pretzel	heart	soup

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

THE GRADUATE CENTER
THE CITY UNIVERSITY OF NEW YORK

Ph.D. Program in Speech and Hearing Sciences

Appendix G

The Graduate School and University Center
The City University of New York
365 Fifth Avenue
New York, NY 10016-4309
TEL 212.817.8800 FAX 212.817.1537

CONSENT FORM

Lexical Organization in Children with Autism

The purpose of this project is to find out more about how typically developing children and children with autism learn and organize meanings of words. Previous research has shown that a person will be faster at naming a picture if the picture just before was meaningfully related (e.g., horse followed by cow). We are interested in knowing what type of pictures will facilitate naming of subsequent pictures for individuals with autism. More specifically, we will be comparing the responses of children with autism to the responses of a typically developing peer group to determine similarities or differences in naming performances. Approximately twenty children with autism and twenty typically developing children will participate in this project.

The experiment will involve two sessions, each lasting about one hour. The sessions will be conducted at the Genesis School in Plainview, Long Island, at the Eden II School in Staten Island, New York or at the elementary school your child attends in the Massapequa School District. Prior to the experimental sessions, your child will be given a receptive vocabulary test as well as a test of non-verbal intelligence. In addition, your child will be tested for comprehension of all the test items to be used in the experiment. An autism rating scale will be administered. All of this pre-testing will take place in your child's school or home.

The research will involve audio recordings of your child's performance during the naming of pictures presented on a computer monitor. We will ask you child to sit quietly in front of a computer monitor and to name the pictures immediately as they appear on the screen. We will further instruct your child to remain as quiet as possible at all other times during the experimental tasks. There will be approximately five sets of pictures that will be presented with five minute breaks between each set. The breaks will be extended if your child appears to require more time or if he or she requests more time.

This research will help us to understand how children with autism learn and organize vocabulary. It will allow us to better understand the nature of the language deficits present in autism and contribute to the development of more effective treatments.

There are no known or expected risks or hazards of this research. Information collected during this project may be presented or published. Your child's name and all other identifying information will be confidential.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Your child will be fee to ignore any of the activities or to end the session at any time. If, at any time during the experimental session your child demonstrates any behaviors consistent with discomfort or frustration, the session will be immediately terminated. You are free to withdraw your child from this study at any time. You may contact Joanne Gerenser (jgerenser@aol.com) or Dr. Richard Schwartz (rschwartz@gc.cuny.edu) at the Department of Speech and Hearing Sciences at (212) 817-8804 or Hilry Fisher (hfisher@gc.cuny.edu) at the Office of Sponsored Research at (212) 817-7523 if you have any concerns.

You may receive a summary of the findings of this study upon completion of the study. If you are interested in these results, please check the box below and include your preferred mailing address. You will be compensated for any travel or childcare expenses incurred by your participation in this project.

The study described on the front has been explained and I (we) voluntarily consent to my (our) child's participation. I (we) have been informed of the details of the experiment. I (we) understand my (our) child can stop at any time without penalty. I (we) have had the chance to ask questions and have had our questions answered.

______________________________ ____________
Parent's Signature date

______________________________ ____________
Parent's Signature date

______________________________ ____________
Participant date

______________________________ ____________
Researcher's Signature date

☐ yes, please send the findings of this study to:
address:______________________________
____
____

Graduate School & University Center / CUNY
IRB
Approved
02-07-091
Approved: 9/16/02 To Expired: 9/15/03

copies to: Parent (s)
Investigator's File

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Appendix H

Summary of Error by Type

Subject 1*				Subject 2		
Target	**Response**	**Error Type**		**Target**	**Response**	**Error Type**
sink	table	4		fly	mosquito	6
rain	raindrops	2		ear	chalk	9
thread	yarn	4		guitar	instrument	1
soap	wash	5		blocks	Abc	3
sink	snake	8		nail	pipe	6
hook	snake	7		soup	hot	5
spoon	shovel	7		nest	bird nest	2
rake	shovel	4		spider	bug	1
goat	billy goat	2		glove	hand	6
truck	oh I don't know	12		finger	index finger	2
eye	glasses	5		horse	unintelligible	12
tracks	ladder	7		head	face	3
whale	dolphin	4		cat	kitty cat	2
boat	ship	11		bus	truck	6
trumpet	horn	11		elephant	unintelligible	12
quarter	its um	12		nest	crown	7
feet	toes	3		rake	tool	1
mouse	rabbit	4		street	road	11
nail	bat	7		paper	notepad	2
penny	quarter	6		tracks	ladder	7
				whale	shark	4
				book	bible	2
				penny	quarter	6

Subjects 1-15=Typical Children

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Subject 3				Subject 4		
Target	**Response**	**Error Type**		**Target**	**Response**	**Error Type**
cat	kitty	2		crown	king	5
glasses	stove	13		egg	necklace	7
nest	cat	9		rake	don't know	12
rake	shovel	6		spider	bug	1
soup	chicken soup	2		dog	beagle	2
boat	ship	11		fly	bug	1
hook	track	13		bed	bedroom	5
street	road	11		pear	can	9
nest	bird nest	2		mouse	rat	6
sink	bathroom	5		cat	kitten	2
hook	quarter	13		thread	yarn	4
clown	you know, circus	10		rain	I don't know	12
mouse	rat	6		spoon	fork	4
head	face	3		tracks	ladder	7
guitar	violin	6		feet	foot	2
				dolphin	whale	4

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Subject 5				Subject 6		
Target	**Response**	**Error Type**		**Target**	**Response**	**Error Type**
paper	box	7		finger	pointer	2
pear	peach	6		tree	car	13
duck	dog	8		penny	quarter	6
cat	rat	8		screw	nail	6
tree	apple tree	2		hand	finger	3
screw	nail	6		street	road	11
hammer	nail	5		pear	face	7
dolphin	whale	4		glasses	sunglasses	2
nose	what is it	12		sink	bathroom	5
snake	crocodile	13		shirt	t-shirt	2
soap	sink	5		pear	book	13
kite	diamond	7		flower	tulip	2
mouse	rat	6		truck	bus	6
table	chair	5		finger	unintelligible	12
thread	yarn	6		penny	nickel	6
				bone	dogbone	5

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Subject 7				Subject 8		
Target	**Response**	**Error Type**		**Target**	**Response**	**Error Type**
soup	bowl	5		nail	screw	6
ear	bird	9		guitar	egg	13
feet	foot	3		dollar	money	1
street	road	11		crown	nest	7
snake	street	13		tiger	zebra	4
boat	steam boat	2		bus	truck	6
head	bald	5		sink	ruler	9
spider	crab	6		thread	string	6
nail	hammer	5		sink	phone	13
screw	nail	6		glasses	toaster	13
pencil	sled	13		mouse	rat	6
clown	face	3		street	road	11
tree	hand	13		track	ladder	7
boat	ship	11		train	ruler	9
pillow	towel	7		pear	apple	6
train	crane	8		train	railroad train	2
spoon	shovel	6				
shirt	stamp	7				
nail	pencil	7				

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Subject 9				Subject 10		
Target	**Response**	**Error Type**		**Target**	**Response**	**Error Type**
dolphin	whale	4		drum	drumsticks	2
ear	flower	13		shirt	coat	6
thread	string	6		clock	alarm clock	2
sink	tub	4		bus	truck	6
screw	nail	6		screw	nil	6
bee	bumble bee	2		giraffe	It's long	10
broom	rake	6		penny	quarter	6
dollar	money	1		rain	snow	6
pen	pencil	6		thread	yarn	6
puzzle	crayon	13		tiger	lion	4
head	profile	5		cat	tiger	4
bus	school bus	2		soap	don't know	12
nose	kite	13		broom	bat	7
				chicken	chick	2
				cloud	rain cloud	2
				blocks	letters	3
				chair	zoo	9

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Subject 11				Subject 12		
Target	**Response**	**Error Type**		**Target**	**Response**	**Error Type**
street	road	11		thread	yarn	6
bus	school	5		clown	penny	13
pie	apple pie	2		soup	bowl	5
pear	ball	7		screw	nail	6
cat	kitty	2		train	unintelligible	12
drum	crayon	9		fly	bee	6
sink	bathroom	5		tiger	animal	1
flower	dice	13		car	phone	13
bus	truck	6		bee	fly	6
goat	unintelligible	12		hat	paper	13
crown	king	5		broom	sweep	5
clown	circus	5		train	subway	6
duck	dog	8		pen	pencil	6
nose	drum	13		sink	bathroom sink	2
trumpet	dollar	13		car	paint	9
table	door	7		spoon	soup	5
snake	eyes	9		egg	star	13
				whale	dolphin	4

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Subject 13				Subject 14		
Target	**Response**	**Error Type**		**Target**	**Response**	**Error Type**
mouse	face	9		guitar	instrument	1
egg	oval	7		street	road	11
shovel	hammer	4		ear	tack	9
gun	hammer	13		sink	fawcett	3
flower	rose	2		hook	I don't know	12
penny	coin	1		thread	yarn	6
tracks	ladder	7		mouse	rat	6
bus	truck	6		tree	bush	4
finger	thumb	4		clown	circus clown	2
egg	circle	7		chair	Ch to sit	10
nest	bird	5		train	engine	2
train	truck	8		broom	rake	6
ear	unintelligible	12		clown	man	1
dollar	quarter	4		bread	box	7
thread	string	6		glove	hand	6
bed	bedroom	5		bee	fly	6
boat	ship	11		ear	spoon	9
tie	tied	8				
bird	robin	2				

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Subject 15		
Target	**Response**	**Error Type**
dolphin	fish	4
coat	pants	4
egg	circle	7
nose	I don't know	12
rain	clouds	5
dog	cow	4
flower	rose	2
pillow	lunchbox	7
pencil	write	5
tracks	I don't know	12
bed	door	13
fish	snapper	2
tiger	lion	4
street	road	11

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Subject 16*				Subject 17		
Target	**Response**	**Error Type**		**Target**	**Response**	**Error Type**
soup	tomato soup	2		bee	bumble bee	2
screw	nail	6		whale	dolphin	4
bed	unintelligible	12		crown	king	5
pen	finger	13		tiger	unintelligible	12
glove	hand	5		egg	snowball	7
flower	rose	2		glasses	sunglasses	2
whale	dolphin	4		screw	nail	6
guitar	car	13		boat	ship	11
finger	I know	12		dolphin	fish	1
shirt	pants	4		thread	car	13
cat	meow	5		rake	what's that	12
hammer	car	13		paper	square	7
hand	glove	6		dollar	It's one	10
sink	tub	4		mouse	rat	6
tie	shirt	5		soup	bowl	5
pillow	lunchbox	7		tracks	train tracks	2
cake	birthday cake	2		pencil	penny	8
nest	cookie	7		thread	chair	9
drum	music	1		nest	what's that	12
soap	square	7		crayon	bed	13

* Subjects 16-30= Children with Autism

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Subject 18				Subject 19		
Target	**Response**	**Error Type**		**Target**	**Response**	**Error Type**
shirt	t-shirt	2		egg	oval	7
dolphin	whale	4		vacuum	It's p push it	10
train	Thomas	2		car	van	4
penny	money	1		rake	broom	4
chicken	stove	13		book	reading	5
nest	plate	7		finger	hands	1
finger	pointer finger	2		egg	street	9
hook	nail	7		guitar	music	5
finger	pointing	5		pear	fruit	1
socks	mumble	12		bat	tub	13
fly	finger	13		cat	it's a kitty	2
spider	bug	1		fly	spider	4
nail	tool	1		spider	uh oh it's gross	10
elephant	dumbo	2		mouse	cat	5
bee	bzzzz	5		mouse	cheese	13
thread	string	4		penny	quarter	6
nail	knife	7		flower	rose	2
bone	I don't know	12		shirt	coat	4
star	kite	13				
street	unintelligible	12				
cat	kitty cat	2				
kite	triangle	7				
vacuum	bed	9				
glove	hand	6				
clown	man	1				

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Subject 20				Subject 21		
Target	**Response**	**Error Type**		**Target**	**Response**	**Error Type**
finger	ring finger	1		leaf	rake	5
gun	screw	9		soap	wash hands	5
egg	oval	7		fly	bug	1
crown	leaf	9		feet	It's toes	2
tiger	animal	1		ring	canteen	7
crown	what is it	12		thread	string	6
spider	what is it	12		hook	anchor	7
penny	quarter	6		elephant	mumble	12
bird	it flies	5		tie	necklace	5
finger	its not a ring	10		nest	tree	3
sink	tub	4		spider	bug	1
bone	dog	13		dolphin	shark	6
glasses	sunglasses	2		mouse	cheese	13
street	road	11		spider	ant	4
				star	moon	4
				house	horse	8
				web	unintelligible	12
				glasses	unintelligible	12

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Subject 22				Subject 23		
Target	**Response**	**Error Type**		**Target**	**Response**	**Error Type**
gun	hammer	9		nose	tube	7
street	road	11		head	face	3
pie	cake	4		glove	hand	13
tiger	animal	1		ring	circle	7
bus	school bus	2		dollar	money	1
crown	I don't know	12		eye	circle	7
finger	point	5		nose	what	12
mouse	rat	6		feet	shoe	5
soap	wash	5		bear	cow	4
guitar	play music	5		bed	sleep	5
web	paper	9		spider	what -what	12
cheese	unintelligible	12		boat	water	5
spider	spider web	5		rake	broom	4
alligator	unintelligible	12		finger	ring	5
pillow	unintelligible	12		tracks	choo choo tracks	2
giraffe	horse	4		duck	Donald duck	2
dollar	money	1				

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Subject 24				Subject 25		
Target	**Response**	**Error Type**		**Target**	**Response**	**Error Type**
nest	head	9		penny	nickel	6
rain	it's snow	6		tracks	what is it	12
street	road	11		guitar	wait a minute	12
clown	lion	9		thread	yarn	6
dollar	card	7		feet	foot	3
thread	string	6		egg	crystal ball	7
train	track	5		soap	tub	5
dolphin	whale	4		coat	shirt	6
screw	nail	6		street	It's black	10
feet	toes	3		mouse	rat	6
crown	queen	5		spoon	fork	4
boat	sailboat	2				
train	unintelligible	12				
penny	quarter	6				
soap	bath	5				
chair	cheese	8				
egg	ball	7				
boat	sailing	5				
finger	unintelligible	12				

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Subject 26				Subject 27		
Target	**Response**	**Error Type**		**Target**	**Response**	**Error Type**
paper	calendar	7		nest	hat	9
spider	crab	7		pen	pencil	6
finger	fling	8		screw	screwdriver	5
feet	toes	3		pencil	pillow	13
paper	ruler	9		mouse	rat	6
head	face	3		truck	bus	6
nose	don't know	12		sink	bathroom	5
whale	shark	4		finger	hand	5
glove	hand	6		train	engine	5
hook	I don't know	12		rake	broom	4
street	road	11		head	hand	4
crown	king	5		drum	music	5
spider	bug	1		car	cow	9
dollar	money	1		alligator	unintelligible	12
penny	quarter	6				
thread	string	6				
dolphin	shark	6				
train	choo choo train	2				
tree	snake	7				
clown	doctor	13				
bread	sandwich	5				
piano	unintelligible	12				

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Subject 28				Subject 29		
Target	**Response**	**Error Type**		**Target**	**Response**	**Error Type**
bee	beed	8		finger	pointer	2
soap	tub	5		pen	pencil	6
shovel	cat	13		screw	nail	6
truck	screw	13		mouse	rat	6
track	giraffe neck	7		sink	bathroom	5
street	ruler	7		hand	fingers	3
spoon	fork	4		truck	bus	6
hat	shhh	12		train	choo choo	2
drum	do	12		rake	broom	4
moon	face	3		head	human	5
horse	neigh	5		dollar	money	1
rain	snow	6		bee	bzz bzz	5
leaf	unintelligible	12		soup	truck	13
finger	thumb	2		gun	pencil	13
pencil	peepool	8		pie	pizza pie	4
mouse	rat	6		spider	unintelligible	12
				bat	baseball	5

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Subject 30		
Target	**Response**	**Error Type**
guitar	key	13
tiger	cat	6
crown	king	5
tie	bow tie	2
gun	tool	1
penny	quarter	6
bus	what's that	12
bear	polar bear	2
pear	fruit	1
mouse	sit	9
bee	bumble bee	2
soap	wash	5
duck	swimming	5
screw	nail	6
street	fence	7
spider	crab	7
boat	toy ship	2
hook	what's that	12
cake	birthday cake	2
finger	pointer	2
table	toy	9
chicken	bird	6
Bread	it's a loaf	10
Gun	pistol	11

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

References

Alario, F.X., Segui, J., & Ferrand, L (2000). Semantic and associative priming in picture naming. *The Quarterly Journal of Experimental Psychology, 53*, 741-764.

Ameli, R., Courschesne, E., Lincoln, A., Kaufman, A.S., & Grillon, C. (1988). Visual memory processing in high functioning individuals with autism. *Journal of Autism and Developmental Disabilities, 18,* 601-615.

American Psychiatric Association (1994). *Diagnostic and statistical manual of mental disorders,* (4th ed.). Washington, DC: Author.

Anglin, J. (1993). Vocabulary development: A morphological analysis. *Monographs of the Society of Research in Child Development, 58,* 1-166.

Atran, S. (1989). Basic conceptual domains. *Mind and Language, 4,* 3-16.

Baayen, R.H., Piepenbrock, R., & vanRign, H. (1995). *The CELEX lexical database* [CD-ROM]. Philadelphia: University of Pennsylvania, Linguistic Data Consortium.

Bailey, H. (2003). Rapid word learning in preverbal children with autism. Manuscript submitted for publication.

Bajo, M.T. (1988). Semantic facilitation with pictures and words. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 14,* 579-589.

Baldwin, D.A. (1991). Infants' contribution to the achievement of joint reference. *Child Development, 62,* 875-890.

Baldwin, D.A. (1993). Infants' ability to consult the speaker for clues to word reference. *Journal of Child Language, 20,* 395-418.

Baldwin, D.A., Markman, E.M., Bill, B., Desjardins, R.N., Irwin, J.M., Tidball, G.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

(1996). Infants' reliance on a social criterion for establishing word-object relations. *Child Development, 67,* 3135-3153.

Baron-Cohen, S., Baldwin, D.A., & Crowson, M. (1997). Do children with autism use the speaker's direction of gaze strategy to crack the code of language? *Child Development, 69,* 49-57.

Barrett, M.D. (1978). Lexical development and overextension in child language. *Journal of Child Language, 5,* 205-219.

Barry, L., Morrison, C.M., & Ellis, A.W. (1997). Naming of the Snodgrass and Vanderwart pictures: Effects of age of acquisition, frequency, and name agreement. *The Quarterly Journal of Experimental Psychology, 50,* 560-585.

Bartak, L., Rutter, M., & Cox, A. (1975). A comparative study of infantile autism and specific developmental receptive disorders: I: The Children. *British Journal of Psychiatry, 126,* 127-145.

Bartolucci, G., Pierce, S. & Streiner, D. (1980). Cross-sectional studies of grammatical morphemes in autistic and mentally retarded children. *Journal of Autism and Developmental Disorders, 10,* 39-50.

Battig, J. & Montague, R. (1969). Category norms. *Journal of Experimental Psychological Monograph, 80,* 1252-1331.

Becker, C.A. (1979). Semantic context and word frequency effects in visual word recognition. *Journal of Experimental Psychology: Human Perception and Performance, 5,* 523-529.

Beversdorf, D.Q., Anderson, J.M., Manning, S.E., Anderson, S.L., Nodgren, R.E., Felopulos, G.J., Nadeau, S.E., Heilman, K.M. & Bauman, M.L. (1998). The

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

effects of semantic and emotional context on written recall for verbal language in high functioning adults with autism spectrum disorder. *Journal of Neurology, Neurosurgery, and Psychiatry, 65,* 685-692.

Biederman, I., & Cooper, E.E. (1991). Priming contour-deleted images: Evidence for intermediate representations in visual object recognition. *Cognitive Psychology, 23,* 393-419.

Bjorklund, D.F. (1987). How age changes in knowledge base contribute to the development of children's memory: An interpretive review. *Developmental Review, 7,* 93-130.

Bloom, L.M. (1973). *One word at a time: The use of single word utterances before syntax.* The Hague: Mouton.

Blum, N.A., & Freides, D. (1995). Investigating thought disorder in schizophrenia with the lexical decision task, *Schizophrenia Research, 16,* 217-224.

Bock, J.K. (1986). Meaning, sound and syntax: Lexical priming in sentence production. *Journal of Experimental Psychology: Learning, Memory, Cognition, 12,* 575-586.

Boucher, J. (1988). Word fluency in high-functioning autistic children. *Journal of Autism and Developmental Disorders, 18,* 637-645.

Boucher, J. (2003). Language development in autism. *International Journal of Pediatric Otorhinolaryngology, 67,* 159-163.

Bowler, D.M., Matthews, N.J., & Gardiner, J.M. (1997). Asperger's syndrome and memory: Similarity to autism but not amnesia. *Neuropsychologia, 35,* 65-70.

Brian, J.A., Tipper, S.P., Weaver, B. & Bryson, S.E. (2003). Inhibitory mechanisms in autism spectrum disorders: Typical selective inhibition of location versus

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

facilitative perceptual processing. *Journal of Child Psychology and Psychiatry, 44*, 552-560.

Brooks, P.J., & MacWhinney, B. (2000). Phonological priming in children's picture naming. *Journal of Child Language, 27*, 335-366.

Brown, A.S., Neblett, D.R., Jones, T.C., & Mitchell, D.B. (1991). Transfer of processing in repetition priming: Some inappropriate findings. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 17*, 514-525.

Brown, G.D.A., & Watson, F.L. (1987). First in, first out: Word learning age and spoken word frequency as predictors of word familiarity and word naming latency. *Memory & Cognition, 15*, 200-216.

Brown, L., Sherbenor, R., & Johnson, S. (1990). *Test of Nonverbal Intelligence*, Austin, TX: Pro-Ed.

Bruce, V., Carson, D., Burton, A.M., & Ellis, A.W. (2000). Perceptual priming is not a necessary consequence of semantic classification of pictures. *The Quarterly Journal of Experimental Psychology, 53*, 289-323.

Bryk, A.S., & Raudenbush, S.W. (1992). *Hierarchical linear models: Applications and data analysis methods.* Newbury Park, CA: Sage.

Bryson, S. (1983). Interference effects in autistic children: Evidence from the comprehension of single stimuli. *Journal of Abnormal Psychology, 92*, 250-254.

Burach, J.A., & Volkmar, F.R. (1992). Development of low and high functioning autistic children. *Journal of Child Psychology and Psychiatry, 33*, 607-616.

Burack, J.A. (1992). Clarifying developmental issues in the study of autism. *Journal of Child Psychology and Psychiatry, 33*, 617-621.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Burton, M., Jongman, A., & Sereno, J. (1996). Phonological and orthographic priming effects in auditory and visual word recognition. *Working Papers of the Cornell Phonetics Laboratory, 11,* 17-42.

Carey, S. & Bartlett, E. (1978). Acquiring a single new word. *Papers and Reports on Child Language Development, 15,* 17-25.

Carey, S., (1989). The child as word learner. In M. Halle, J. Bresnan, J.G.A., Miller (Eds.). *Linguistic theory and psychological reality.* Cambridge, MA: MIT Press.

Carr, T.H., McCauley, C., Sperber, R.D., & Parmalee, C.M. (1982). Words, pictures and priming: On semantic activation, conscious identification, and the automaticity of information processing. *Journal of Experimental Psychology: Human Perception and Performance, 8,* 757-777.

Carroll, M., Byrne, B., & Krisner, K. (1985). Autobiographical memory and perceptual learning: A developmental study using picture recognition, naming latency, and perceptual identification. *Memory and Cognition, 13,* 273-279.

Carroll, J.B., & White, M.N. (1973). Word frequency and age of acquisition as determiners of picture naming latency. *Quarterly Journal of Experimental Psychology, 25,* 85-95.

Charman, T., Drew, A., Baird, C., & Baird, G. (2003). Measuring early language development in preschool children with autism spectrum disorders using the MacArthur Communicative Development Inventory. *Journal of Child Language, 30,* 213-236.

Chiarello, C., & Richards, L. (1992). Another look at categorical priming in the cerebral hemispheres. *Neuropsychologia, 30,* 381-392.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Chiarello, C., Burgess, C., Richards, L., & Pollack, A. (1990). Semantic and associative priming in the cerebral hemispheres: Some words do, some words don't... sometimes, some places. *Brain and Language, 38,* 75-104.

Cirrin, F.M. (1983). Lexical access in children and adults. *Developmental Psychology, 19,* 452-460.

Cobrinik, L. (1974). Unusual reading ability in severely disturbed children. *Journal of Autism and Childhood Schizophrenia, 4,* 163-175.

Cohen, J. (1969). *Statistical power analysis for the behavior sciences.* Hillsdale, NJ.: Lawrence Erlbaum Associates.

Collins, A.F., & Ellis, A.W. (1992). Phonological priming of lexical retrieval in speech production. *British Journal of Psychology, 83,* 375-388.

Collins, A.M., & Loftus, E.F. (1975). A spreading activation theory of semantic processing. *Psychological Review, 82,* 407-428.

Courchesne, E. (1987). A neuropsychological view of autism. In E. Schopler & G.B. Mesibov (Eds.), *Neurological issues in autism.* New York: Plenum Press.

Crump-Wiegel, C. & Dennis, M. (1986). Development of word finding. *Brain & Language, 27,* 1-23.

Damian, F.M., Vigliocco, G., & Levelt, W.J.M. (2001). Effects of semantic context in the naming of pictures and words. *Cognition, 81,* 77-86.

Dawson, G. (1996). Brief report: Neuropsychology of autism: A report on the state of the science. *Journal of Autism and Developmental Disabilities, 26,* 179-184.

Dawson, G., Munson, J., Estes, A., Osterling, J., McPartland, J., Toth, K., Carver, L, & Abbott, R. (2002). Neurocognitive function and joint attention abilities in

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

young children with autism spectrum disorders versus developmental delay. *Child Development, 73*, 345-358.

Dean, M.P., & Young, A.W. (1997). Repetition priming of homographs and novel objects: Evidence for an item-specific locus. *British Journal of Psychology, 88,* 117-142.

Dean, M.P., Bub, D.N., & Masson, M.E.J. (2001). Interference from related object identification. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 27,* 733-743.

Dennis, M., Lazenby, A.L., & Lockyer, L. (2001). Inferential language in high-function children with autism. *Journal of Autism and Developmental Disorders, 31*, 47-54.

Dollaghan, C. (1987). Fastmapping of normal and language impaired children. *Journal of Speech and Hearing Research, 52,* 218-222.

Dunn, L.M. & Dunn, L.M. (1997). *Peabody Picture Vocabulary Test-Revised,* American Guidance Service, Circle Pines: Minnesota.

Edwards, J., & Lahey, M. (1993). Auditory lexical decision in children and adults: An examination of response factors. *Journal of Speech and Hearing Research 36,* 996-1003.

Elliot, D.E., & Needleman, R.M. (1976). The syndrome of hyperlexia. *Brain and Language, 3,* 339-340.

Eigsti, I.M., & Shapiro, T. (2003). A systems neuroscience approach to autism: Biological, cognitive, and clinical perspectives. *Mental Retardation and Developmental Disabilities Review*, 9, 206-216.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Eskes, G.A., Bryson, S.E., & McCormick, T.A. (1990). Comprehension of concrete and abstract words in autistic children. *Journal of Autism and Developmental Disorders, 20,* 61-72.

Fay, W., & Schuler, A.L. (1980). *Emerging language in autistic children.* Baltimore, MD: University Park Press.

Fein, D., Dunn, M., Allen, D.A., Aram, D.M., Hall, N., Morris, R., & Wilson, B.C. (1996). Language and neuropsychological findings. In I. Rapin (Ed.), *Clinics in developmental medicine: Preschool children with inadequate communication, developmental language disorder, autism, low I.Q.* London: MacKeith.

Forster, K.I. (1981). Priming and the effects of sentence and lexical contexts on naming time: Evidence for autonomous lexical processing. *Quarterly Journal of Experimental Psychology, 33,* 465-495.

Fox, E. (1995). Negative priming from ignored distracters in visual selection: A review. *Psychometric Bulletin and Review, 2*, 145-173.

Francis, W.N., & Kucera, H. (1982). *Frequency analysis of English usage: Lexicon and grammar.* Boston: Houghton Mifflin.

Frith, U. (1989). A new look at language and communication in autism. *British Journal of Disorders of Communication, 24,* 123-150.

Frith, U. (1989). *Autism: Explaining the enigma.* Oxford: Blackwell.

Fyffe, C., & Prior, M. (1978). Evidence from language recoding in autistic, retarded and normal children: A re-examination. *British Journal of Psychology, 49,* 393-402.

Gelman, S.A., & Coley, J.D. (1990). The importance of knowing a dodo is a bird: Categories and inferences in 2 year old children. *Developmental Psychology, 26,*

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

796-804.

Gelman, S.A., & Markman, E.M. (1987). Young children's induction from natural kinds: The role of categories and appearances. *Child Development, 58,* 1532-1541.

Gillberg, C. (1990). Autism and pervasive developmental disorders. *Journal of Child Psychology and Psychiatry, 31,* 99-119.

Glaser, W.R., & Glaser, M.O. (1989). Context effects in Stroop-like word and picture naming. *Journal of Experimental Psychology: Human Perception & Performance, 118,* 13-42.

Glaser, W.R., (1992). Picture naming. *Cognition, 42,* 61-105.

Gluer, K., & Pagin, P. (2003). Meaning theory and autistic speakers. *Mind and Language, 18,* 23-51.

Goldberg, T.E., & Rothermal, R.D. (1984). Hyperlexic children reading. *Brain and Language, 197,* 757-785.

Gordon, J.K., & Baum, S.K. (1994). Rhyme priming in aphasia: The role of *phonological* lexical access. *Brain and Language, 47,* 661-683.

Grandin, T. (1996). Thinking in pictures and other reports on my life with autism. Paper presented at the annual conference of the New Jersey Center for Outreach and Services for the Autistic Community, Inc.

Happe, F. (1993). Communicative competence and theory of mind in autism: A test of relevance theory. *Cognition, 48,* 101-119.

Happe, F., & Frith, U. (1996). The neurology of autism. *Brain, 119,* 1377-1409.

Hermelin, B., & O'Connor, N. (1967). Remembering of words by psychotic and abnormal children. *British Journal of Psychology, 58,* 213-218.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Hermelin, B., & O'Connor, N. (1970). *Psychological experiments with autistic children.* Oxford: Pergamon Press.

Hillinger, M.L. (1980). Priming effects with phonemically similar words: The encoding-bias hypothesis reconsidered. *Memory and Cognition, 8*, 115-123.

Hino, Y., Lupker, S.J., & Sears, C.R. (1997). The effects of word association and meaning frequency in a cross-model lexical decision task: Is the priming due to "semantic" activation? *Canadian Journal of Experimental Psychology, 51,* 195-210.

Hobson, R.P. (1989). Beyond cognition: A theory of autism. In G. Dawson (Ed.), *Autism: Nature, diagnosis, and treatment.* N.Y.: The Guilford Press.

Hobson, R.P. (1993). *Autism and the development of the mind.* Hove, England: Lawrence Erlbaum Associates, Inc.

Howlin, P. (1984). The acquisition of grammatical morphemes in autistic children: A critique and replication of the findings of Bartolucci, Pierce and Streiner, 1980. *Journal of Autism and Developmental Disorders, 14,* 127-136.

Humphreys, G.W., Lloyd-Jones, T.J., & Fias, W. (1995). Semantic interference effects on naming using a postcue procedure: Tapping the links between semantics and phonology with pictures and words. *Journal of Experimental Psychology: Learning, Memory and Cognition, 21,* 961-980.

Humphreys, G.W., Riddoch, M.J., & Quinlan, P.T. (1988). Cascade process in picture identification. *Cognitive Neuropsychology, 5*, 67-103.

Inui, N., Yamanishi, M. & Tada, S. (1995). Simple reaction times and timing of serial reactions of adolescents with mental retardation, autism, and Down Syndrome.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Perceptual Motor Skills, 81, 739-745.

Jerscheniak, J.D. & Levelt, W.J.M. (1994). Word frequency effects in speech production: Retrieval of syntactic information and of phonological form. *Journal of Experimental Psychology: Learning, Memory, & Cognition. 20,* 824-843.

Jolliffe, T., & Baron-Cohen, S. (1997). Are people with autism and Asperger syndrome faster than normal on the Embedded Figure Test? *Journal of Child Psychology and Psychiatry, 38*, 527-534.

Jolliffe, T., & Baron-Cohen, S. (1999). The strange stories: A replication of high functioning adults with autism or Asperger syndrome. *Journal of Autism and Developmental Disorders, 29,* 395-406.

Kail, R. (1991). Processing time declines exponentially during childhood and adolescence. *Developmental Psychology, 27,* 259-266.

Kail, R. (1994). A method for studying the generalized slowing hypothesis in children with specific language impairment. *Journal of Speech and Hearing Research, 37,* 418-421.

Kay, D.A., & Anglin, J. (1982). Overextensions and underextensions in the child's expressive and receptive speech. *Journal of Child Language, 9,* 83-98.

Kjelgaard, M.M., & Tager-Flusberg, H. (2001). An investigation of language impairment in autism: Implications for genetic subgroups. *Language and Cognitive Processes, 16*, 287-308.

Klinger, L.G., & Dawson, G. (1995). A fresh look at categorization abilities in children with autism. In E. Schopler & G. Mesibov (Eds.*), Learning, memory, and cognition in autism.* New York: Plenum Press.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Kiss, G.R., Armstrong, C., Milroy, R., & Piper, J. (1973). An associative thesaurus of English and its computer analysis. In A.J. Aitken, R.W. Bailey, & N. Hamilton-Smith (Eds.), *The computer and literacy studies.* Edinburgh: University Press.

Klinger, M., Burton, P.C., & Pitts, G.S. (2000). Mechanisms of unconscious priming: I. Response competition, not spreading activation. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 26,* 441-455.

Kwapil, R.R., Hegley, D.C., Chapman, L.J., & Chapman, J.P. (1990). Facilitation of word recognition by semantic priming in schizophrenia. *Journal of Abnormal Psychology, 99,* 215-221.

La Heij, W. (1988). Components in Stroop-like interference in picture naming. *Memory & Cognition, 16,* 400-410.

La Heij, W., Dirks, J., & Kramer, P., (1993). Categorical interference and associative priming in picture naming. *British Journal of Psychology, 81,* 511-525.

Lahey, M. & Edwards, J. (1996). Why do children with specific language impairment name pictures more slowly than their peers? *Journal of Speech and Hearing Research, 39,* 1081-1098.

Lahey, M. & Edwards, J. (1999). Naming errors of children with specific language impairment. *Journal of Speech and Hearing Research, 42,* 195-205.

Larochelle, S., Richards, S., & Soulierres, I. (2000). What some effects might not be: The time to verify membership in "well defined" categories. *The Quarterly Journal of Experimental Psychology, 53,* 929-962.

Levelt, W.J.M. (1989). *Speaking: From intention to articulation.* Cambridge, MA: MIT

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Press.

Levelt, W.J.M. (1992). Accessing words in speech production: Stages, processes and representations. *Cognition, 42,* 1-22.

Levelt, W.J.M., Schriefers, H., Vorberg, D., Meyer, A.S., Pechmann, T., & Havinga, J. (1993). The time course of lexical access in speech production: A study of picture naming. *Psychological Review, 98,* 122-142.

Levine, M.N. (1982). *Leiter International Performance Scale.* Western Psychological Services, Los Angelos: California.

Lord, C., & Paul, R. (1997). Language and communication in autism. In D.J. Cohen, & F.R. Volkmar (Eds.), Handbook of autism and pervasive developmental disorders. (2nd Edition), New York: John Wiley.

Lord, C., & O'Neill, P. (1983). Language and communication needs of adolescents with autism. In E. Schopler & G. Mesibov (Eds.), *Autism in adolescents and adults.* New York: Plenum.

Lord, C., Risi, S., Lambrecht, L., Cook, E.H., Leventhal, B.L., DiLavore, P.S. et al. (2000). The Autism Diagnostic Observation Schedule-Generic: A standardized measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism and Developmental Disorders, 30,* 205-223.

Lord, C., Rutter, M., & DiLavore, P. (1997). *Autism Diagnostic Observation Schedule-Generic (ADOS-G).* San Antonio, TX: The Psychological Corporation.

Lord, C., Venter, A., & Schopler, E. (1992). A follow up study of high functioning children. *Journal of Child Psychology and Psychiatry, 33,* 451-463.

Lovaas, O.I., & Smith, T. (1989). A comprehensive behavioral theory of autistic children:

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Paradigm for research and treatment. *Journal of Behavior Therapy and Experimental Psychiatry, 20,* 17-29.

Lovaas, O.I., Koegel, R.I., & Schreibman, L. (1979). Stimulus overselectivity: A review of the research. *Psychological Bulletin, 86,* 1236-1254.

Lupker, S.J. (1984). Semantic priming without association: A second look. *Journal of Verbal Learning and Verbal Behavior, 23,* 709-733.

Lupker, S.J. (1985). Relatedness effects in word and picture naming: Parallels, differences and structural implications. In A.W. Ellis (Ed.), *Progress in psychology of language,* Hillsdale, N.J.: Lawrence Erlbaum Associates, Inc.

Lupker, S.J. (1988). Picture naming: An investigation of the nature of categorical priming. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 14,* 444-455.

Manschreck, T.C., Maher, .A., Milavetz, J.J., Ames, D., Weisstein, C.C., & Schneyer, M.L. (1988). Semantic priming in thought disordered schizophrenic patients. *Schizophrenia Research, 1,* 61-62.

Markman, E.M., & Hutchinson, J.E. (1984). Children's sensitivity to constraints on word meaning: Taxonomic versus thematic relations. *Cognitive Psychology, 16,* 1-27.

Markman, E.M. (1989). *Categorization and naming in children.* Cambridge, Mass: MIT Press.

Marslen-Wilson, W.D. (1975). Sentence perception as an interactive parallel process. *Science, 189,* 226-228.

Marslen-Wilson, W.D. (1992). Access and integration: Projecting sound onto meaning. In W.D. Marslen-Wilson (Ed.), *Lexical representation and processing.*

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Cambridge: M.I.T. Press.

Martin, A. (2001). Functional neuroimaging of semantic memory. In R. Caborza & A. Kingstone (Eds.), *Functional neuroimaging of semantic memory*. Cambridge, MA: MIT Press.

Martin, A., & Chao, L.I. (2001). Semantic memory and the brain: Structure and processes. *Current Opinion in Neurobiology, 11*, 194-201.

Martin, I., & McDonald, S. (2003). Weak central coherence, no theory of mind, or executive dysfunction? Solving the puzzle of pragmatic language disorders. *Brain and Language, 85,* 451-466.

Martin, R.C., & Jensen, C.R. (1988). Phonological priming in the lexical decision task: A failure to replicate. *Memory and Cognition, 16*, 505-521.

McCann, J., & Peppe, S. (2003). Prosody in autism spectrum disorders: A critical review. *International Journal of Communication Disorders, 38*, 76-83.

McClelland, J.L., & Rumelhart, D.E. (1981). An interactive activation model of context effects in letter perception: I. An account of basic findings, *Psychological Review, 88,* 375-407.

McGregor, K.K., & Leonard, L.B. (1989). Facilitating word-finding skills in language-impaired children. *Journal of Speech and Hearing Disorders, 54,* 141-147.

McGregor, K.K., Newman, R.M., Reilly, R.M., & Capone, N.C. (2002). Semantic representation and naming in children with specific language impairment. *Journal of Speech and Hearing Research, 45,* 998-1014.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

McGregor, K.K., & Windsor, J. (1996). Effects of priming on the naming accuracy of preschoolers with word finding deficits. *Journal of Speech and Hearing Research, 39,* 1042-1063.

Menyuk, P. (1978). Language: What's wrong and why? In M. Rutter and E. Schopler (Eds.). *Autism: A reappraisal of concepts and treatment.* N.Y.: Plenum Press.

Menyuk, P., & Quill, K. (1985). Semantic problems in children with autistic children. In E. Schopler & G. Mesibov (Eds.), *Communication problems in children with autism.* N.Y.: Plenum Press.

Mervis, C.B., & Bertrand, J. (1995). Acquisition of novel name-nameless category (N3C) principle. *Child Development, 65,* 1646-1663.

Meschyan, G., & Hernandez, A. (2002). Age of acquisition and word frequency: Determinants of object naming speed and accuracy. *Memory and Cognition, 30,* 262-269.

Meyer, D.E., & Schvaneveldt, R.W. (1971). Facilitation in recognizing pairs of words: Evidence of a dependence between retrieval operations. *Journal of Experimental Psychology, 90,* 227-234.

Miller, C.A., Kail, R., Leonard, L.B. & Tomblin, J.B. (2001). Speech of processing in children with specific language impairment. *Journal of Speech and Hearing Research, 44,* 416-433.

Minshew, N.J., & Goldstein, G. (1993). Is autism an amnesic disorder? Evidence from the California Verbal Learning Test. *Neuropsychology, 7,* 209-216.

Minshew, N.J., Goldstein, G., Muenz, L.R., & Payton, J.B. (1992). Neuropsychological functioning in non-mentally retarded autistic individuals. *Journal of Clinical and*

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Experimental Neuropsychology, 14, 749-761.

Minshew, N.J., Goldstein, G., & Siegel, D. (1995). Speech and language in high functioning autistic individuals. *Neuropsychology, 9*, 255-261.

Mirenda, P., & Erickson, K.A. (2000). Augmentative communication and literacy. In A.M. Wetherby & B.M. Prizant (Eds.), *Autism spectrum disorders: A transactional developmental perspective.* Baltimore: Paul H. Brooks Publishing Co.

Monsell, S. (1991). Age of acquisition, imagery, recall, and the limitations of multiple regression analysis. *Memory & Cognition, 9,* 277-282.

Morrison, C.M., Chapell, T.D., & Ellis, A.W. (1997). Age of acquisition norms for a large set of object names and their relations to adult estimates and other variables. *The Quarterly Journal of Experimental Psychology, 50,* 528-559.

Morrison, C.M., & Ellis, A.W. (1995). Roles of word frequency and age of acquisition in word naming and lexical decision. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 21,* 116-133.

Morrison, C.M., Ellis, A.W., & Quinlan, P.T. (1992). Age of acquisition, not word frequency, affects object naming, not object recognition. *Memory and Cognition, 20,* 205-214.

Morton, J. (1970). A functional model of human memory. In P.A. Norman (Ed.), *Models of human memory.* N.Y.: Academic.

Moss, H.E., Ostrin, R.K., Tyler, L.K., & Marslen-Wilson, W.D. (1995). Accessing different types of semantic information: Evidence from priming. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 21,* 863-883.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Moss, H.E., & Tyler, L.K. (1995). Investigating semantic impairment: The contribution of semantic priming. *Memory, 3*, 359-397.

Neely, J.H., (1991). Semantic priming effects in visual word recognition: A selective review of current findings and theories. In D. Besner & G.W. Humphreys (Eds.) *Basic processes in reading: Visual word recognition*. Hillsdale, NJ: Erlbaum.

Neely, J.H. (1977). Semantic priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited-capacity attention. *Journal of Experimental Psychology, 106*, 226-254.

Nelson, D.L., McEvoy, C.L., & Schreiber, T.A. (1994). The University of South Florida word association, rhyme, and word fragment norms. Retrieved from http://www.usf.edu/freeassociation/.

Ober, B.A., Vinogradov, S., & Shenaut, G.K. (1997). Automatic versus controlled semantic priming in schizophrenia. *Neuropsychology, 4,* 506-513.

Oldfield, R.C. & Wingfield A. (1965). Response latencies in naming objects. *Quarterly Journal of Experimental Psychology, 4,* 272-281.

Ostrin, R.K., & Tyler, L.K. (1993). Automatic access to lexical semantics in aphasia: Evidence from semantic and associative priming. *Brain and Language, 45,* 147-159.

Paivio, A. (1971). *Imagery and verbal Process.* N.Y.: Holt, Rinehart, & Winston.

Paivo, A. (1983). The empirical case for a dual coding. In J.C. Yuille (Ed.). Imagery, memory, and cognition: Essays in honor of Allan Paivio. Hillsdale, N.J.: Erlbaum.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Palermo, D.S., & Jenkins, J.J. (1964). *Word association norms: Grade school though college.* Minneapolis: University of Minnesota Press.

Paul, R., Fischer, M.L., & Cohen, D.J. (1988). Brief report: Sentence comprehension strategies in children with autism and specific language disorders. *Journal of Autism and Developmental Disorders, 18,* 669-679.

Plaisted, K.C. (2001). Reduced generalization in autism: An alternative to weak central coherence. In J. Burack, T. Charman N. Yirmiya, & P.R. Zelazo (Eds.) *The development of autism: Perspectives from theory and research.* Mahwah, N.J.: Lawrence Erlbaum Associates.

Plaisted, K.C. (2000). Aspects of autism that theory of mind cannot explain. In Baron-Cohen, S., Tager-Flusberg, H., & Cohen, D. (Eds.), *Understanding other minds: Perspectives from autism and developmental cognitive neuroscience.* 2nd Edition, Oxford: Oxford University Press.

Plaut, D.C., & Booth, J.R. (2000). Individual and developmental differences in semantic priming: Empirical and computational support for a single mechanism account of lexical processing. *Psychological Review, 107,* 1-46.

Postman, L., & Keppel, G. (1970). *Norms of word association.* New York: Academic Press.

Potter, M.C., & Faulconer, B.A. (1975). Time to understand pictures and words. *Nature, 253,* 437-438.

Potter, M.C. (1979). Mundane symbolism: The relations among objects, names, and ideas. In N.R. Smith & M.B. Franklin (Eds.), *Symbolic functioning in childhood.* Hillsdale, N.J.: Erlbaum.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Pratarelli, M.E., Perry, K.E., & Galloway, M. (1994). Automatic lexical access in children: New evidence from masked identity priming. *Experimental Child Psychology, 58,* 346-358.

Radeau, M. (1983). Semantic priming between spoken words in adults and children. *Canadian Journal of Psychology, 37,* 547-556.

Radeau, M. (1995). Facilitory and inhibitory phonological priming effects as a function of overlap position. *Abstracts of the 36th Annual Meeting of the Psychonomic Society,* pp. 59. Los Angeles: CA.

Radeau, M., Morais, J., & Dewier, A. (1989). Phonological priming in spoken word recognition: Task effects. *Memory & Cognition, 17,* 525-535.

Radeau, M., Morais, J., & Segui, J. (1995). Phonological priming between monosyllabic spoken words. *Journal of Experimental Psychology: Human Perception and Performance, 21,* 1297-1311.

Ramondo, N., & Milech, D. (1984). The nature and specificity of the language coding deficit in autistic children. *British Journal of Psychology, 75,* 95-103.

Randall, B., Moss, H.E., Rodd, J.M., Greer, M., & Tyler, L.K. (2004). Distinctiveness and correlation in conceptual structure: Behavioral and computational studies. *Journal of Experimental Psychology: Learning, Memory and Cognition, 30*, 278-302.

Rapin, I., & Dunn, M. (2003). Update on the language disorders of individuals on the autism spectrum. *Brain and Development, 25*, 166-173.

Raven, J.C. (1969). *Standard progressive matrices.* London: Lewis.

Raynor, K., & Springer, C.J. (1986). Graphemic and semantic similarity effects in the

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

word-picture interference task. *British Journal of Psychology, 77,* 207-222.

Renner, P., Klinger, L.G., Klinger, R.R. (2000). Implicit and explicit memory in autism: Is autism an amnesic disorder? *Journal of Autism and Developmental Disorders, 30,* 3-16.

Rice, M. (1989). Children's language acquisition. *American Psychologist, 44*, 149-156.

Rice, M., Burh, J., & Nemeth, M. (1990). Fast mapping word-learning abilities of language delayed preschoolers. *Journal of speech and Hearing Research, 55,* 33-42.

Ricks, D.M., & Wing, L. (1976). Language, communication and the use of symbols in normal and autistic children. In L. Wing (Ed.), *Early Childhood Autism: Clinical Educational and social aspects,* 2nd edition. Oxford: Pergamon.

Riddoch, M.J., & Humphreys, G.W. (1987). Picture naming. In G.W. Humphreys & M.J. Riddoch (Eds.). *Visual object processing: A cognitive neuropsychological approach.* Hillsdale, N.J.: Erlbaum.

Riddoch, M.J., Humphreys, G.W., Coltheart, M., & Funnell, E. (1988). Semantic systems or system? Neuropsychological evidence re-examined. *Cognitive Neuropsychology, 5,* 3-25.

Romski, M.A., Sevcik, R.A., Robinson, B.F., Mervis, C.B., & Bertrand, J. (1995). Mapping the meanings of novel visual symbols by youth with moderate or severe mental retardation. *American Journal on Mental Retardation, 100,* 391-402.

Rosch, E. (1973). On the internal structure of perceptual and semantic categories. In T.E. Moore (Ed.), *Cognitive development and acquisition of language.* New York: Academic Press.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Ross, B.H. (1999). Post classification category use: The effects of learning to use categories after learning to classify. *Journal of Experimental Psychology: Learning, Memory, and Cognition. 25*, 1743-1757.

Rutter, M., & Schopler, E. (1987). Autism and pervasive developmental disorders: Concepts and diagnostic issues. *Journal of Autism and Developmental Disorder, 17,* 159-183.

Rutter, M. (1978). Language disorder and infantile autism. In M. Rutter & E. Schopler (Eds.), *Autism: A reappraisal of concepts and treatment.* New York: Plenum Press.

Rutter, M. (1983). Cognitive deficits in the pathogenesis of autism. *Journal of Child Psychology & Psychiatry, 24,* 165-176.

Scarborough, D.L., Cortese, C., & Scarborough, H.S. (1977). Frequency and repetition effects in lexical memory. *Journal of Experimental Psychology: Human Perception and Performance, 3,* 1-17.

Scheerer, J.H., Rothman, E., & Goldstein, K. (1945). A case of "Idiot Savant": An Experimental study of personality organization. *Psychological Monograph, 58,* 1-63.

Schopler, E., Reichler, R.J., & Renner, B.R. (1986). *The Childhood Autism Ratings Scale (CARS)) for diagnostic screening and classification of autism.* New York: Irvington.

Schul, R., Stiles, I., Wulfeck, B., & Townsend, J. (2004). How "generalized" is the "slowed processing" in SLI? The case of visiospatial attentional orienting. *Neuropsychologia, 42,* 661-671.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Schulman, C., Yirmiya, N., & Greenbaum, C.W. (1995). From categorization to classification: A comparison among individuals with autism, mental retardation, and normal development. *Journal of Abnormal Psychology, 104*, 601-609.

Schwantes, F.M. (1981). Locus of context effects in children's word recognition. *Child Development, 52,* 683-691.

Schwartz, S. (1981). Language disabilities infantile autism: A brief review and comment. *Applied Psycholinguistics, 2*, 25-31.

Sereno, J. & Jongman, A. (1992). Phonetic priming in auditory word recognition. *Working Papers of the Cornell Phonetics Laboratory, 7,* 151-173.

Sereno, J., & Quene, H. (2002). Facilitation and inhibition using a segmental phonetic priming paradigm. *Working Papers of the Cornell Phonetics Laboratory, 17*, 41-48.

Shah, A., & Frith, U. (1993). An islet of ability in autistic children: A research note. *Journal of Child Psychology and Psychiatry, 24*, 613-620.

Share, D.L., Jason, A.F., Matthews, K., & MacLean, K. (1988). Lexical decision and naming time of young disabled readers with function and content words. *Australian Journal of Psychology, 40,* 11-18.

Shriberg, L.D., Paul, R., McSweeny, J.L., Klin, A., Cohen, D.J., & Volkmar, F.R. (2001). Speech and prosody characteristics of adolescents and adults with high functioning autism and Asperger syndrome. *Journal of Speech and Hearing Research, 44,* 1087-1115.

Simpson, G.B., & Lorsbach, T.C., (1983). The development of automatic and conscious components of contextual facilitation. *Child Development, 54,* 760-772.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Smith, M.C., & Magee, L.E. (1988). Tracing the time course of picture word processing. *Journal of Experimental Psychology: General, 109,* 373-392.

Snodgrass, J.G., & Vanderwart, M. (1980). A standardized set of 260 pictures: Norms for name agreement, image agreement, familiarity and visual complexity. *Journal of Experimental Psychology: Human Learning and Memory, 6,* 174-215.

Sperber, R.D., McCauley, C., Ragain, R., & Weil, C. (1979). Semantic priming effects on picture and word processing. *Memory & Cognition, 7,* 339-345.

Sullivan, M.P., & Riffel, B. (1999). The nature of phonological encoding during spoken word retrieval. *Language and Cognitive Processes, 14,* 15-45.

Swinney, D. & Prather, P. (1989). On the comprehension of lexical ambiguity by young children: Investigations into the development of mental modularity. In D.S. Gorfein (Ed.), *Resolving Semantic Ambiguity.* N.Y.: Springer-Vergag.

Tager-Flusberg, H. (1986). Constraints on the representation of word meaning. In S.A. Kuczag & M.D. Barrett (Eds.), *The development of word meaning.* N.Y.: Springer-Verlog.

Tager-Flusberg, H. (1981). On the nature of linguistic functioning in early infantile autism. *Journal of Autism and Developmental Disorder, 11,* 45-56.

Tager-Flusberg, H. (1985a). Basic level and superordinate level categorization by autistic, M.R. and normal children. *Journal of Experimental Psychology, 40,* 450-469.

Tager-Flusberg, H. (1985b). The conceptual basis for referential word meaning in children with autism. *Child Development, 56,* 1167-1178.

Tager-Flusberg, H. (1985). Basic level and superordinate level categorization by autistic,

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

M.R. and normal children. *Journal of Experimental Psychology, 40,* 450-469.

Tager-Flusberg, H. (1986). Constraints on the representation of word meaning. In S.A. Kuczaj & M.D. Barrett (Eds.), *The Development of Word Meaning.* N.Y.: Springer-Verlog.

Tager-Flusberg, H. (1989). A psycholinguistic perspective on language development in the autistic child. In G. Dawson (Ed.), *Autism: Nature, diagnosis, and treatment.* New York: Guilford.

Tager-Flusberg, H. (1991). Semantic processing in the free recall of autistic children: Further evidence of a cognitive deficit. *Journal of Developmental Psychology, 9,* 413-430.

Tager-Flusberg, H., (1994). Dissociations in form and function in the acquisition of language by autistic children. In H. Tager-Flusberg (Ed.), *Constraints on language acquisition: Studies of atypical children.* Hillsdale, N.J.: Lawrence Erlbaum Associates.

Tager-Flusberg, H. (1996). Current theory and research on language and communication in autism. *Journal of Autism and Developmental Disorders, 26*, 169-172.

Tager-Flusberg, H. (1997). What language reveals about the undersanding of minds in children with autism. In S. Baron-Cohen, H. Tager-Flusberg, & D. Cohen (Eds.), *Understanding others minds: Perspectives from children with autism.* Oxford: Oxford University Press.

Tager-Flusberg, H. (1999). A psychological approach to understanding the social and language impairment in autism. *International Review of Psychiatry, 11*, 325-334.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Tager-Flusberg, H. (2001). A reexamination of the theory of mind hypothesis of autism. In J.A. Burack, T. Charman, N. Yirmiya, & P.R. Zelazo (Eds.), *The development of autism: Perspectives from theory and research.* Mahwah, N.J.: Lawrence Erlbaum, Pub.

Tager-Flusberg, H., Calkins, S., Nolin, T., Baumberger, T., Anderson, M., & Chadwick-Dias, A. (1990). A longitudinal study of language acquisition in autistic and Down syndrome children. *Journal of Autism and Developmental Disorders, 20,* 1-21.

Tager-Flusberg, H., Joseph, R., & Folstein, S. (2001). Current directions in research on autism. *Mental Retardation and Developmental Disabilities Research Review, 7,* 21-29.

Tecchio, F., Benassi, F., Zappasodi, F., Gialloreti, L.E., Palermo, M., Seri, S., & Rossini, P.M. (2003). Auditory sensory processing in autism: A magnetoencephalographic study. *Biological Psychiatry, 54*, 647-654.

Toichi, M., & Kamio, Y. (2001). Verbal association for simple common words in high functioning autism. *Journal of Autism and Developmental Disorders, 31,* 483-490.

Tyler, L.K., Bright, P., Dick, E., Tavares, P., Pilgrim, L., Fletcher, P., Greer, M., & Moss, H. (2003). Do semantic categories activate distinct cortical regions? Evidence for a distributed neural semantic system. Cognitive Neuropsychology, 20, 541-559.

Tyler, L.K., Karmiloff-Smith, A., Voice, J.K., Stevens, T., Grant, J., Udwin, O., Davies, M., & Howlin, P. (1997). Do individuals with Williams syndrome have bizarre

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

semantics? Evidence for lexical organization using on-line tasks, *Cortex, 33*, 515-527.

Tyler, L.K., & Marslen-Wilson, W.D (1977). The on-line effects of semantic context on syntactic processing. *Journal of Verbal Learning and Verbal Behavior, 16,* 683-692.

Tyler, L.K., & Marslen-Wilson, W.D. (1981). Children's processing of spoken language. *Journal of Verbal Learning and Verbal Behavior, 20,* 400-416.

Tyler, L.K. (1992). *Language comprehension: An experimental approach to disordered and normal processing.* Cambridge, Mass: M.I.T. Press.

Tyler, L.K., & Moss, H.E. (1997). Functional properties of concepts: Studies of normal and brain damaged patients. *Cognitive Neuropsychology*, 14, 511-545.

Tyler, L.K., Moss, H.E., Durrant-Pealfield, M.R., & Levy, J.P. (2000). Conceptual structure and the structure of concepts: A distributed account of category specific deficits. *Brain and Language, 35*, 195-231.

Ulrich, R. & Miller, J. (1994). Effects of truncation on reaction time analysis. *Journal of Experimental Psychology: General, 123,* 34-80.

Ungerer, J.A., & Sigman, M. (1987). Categorization skills and receptive language development in autistic children. *Journal of Autism and Developmental Disorders, 17,* 3-16.

Vitkovitch, M., & Humphreys, G.W. (1991). Perseverant responding in speeded picture naming: It's in the links. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 17,* 664-680.

Vitkovitch, M., & Rutter, C. (2000). The effects of response stimulus interval on error

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

priming in sequential object naming. *Visual Cognition, 7*, 645-670.

Vitkovitch, M., Rutter, C., & Read, A. (2001). Inhibitory effects during object name retrieval: The effect of interval between prime and target on picture naming responses. *British Journal of Psychology, 92,* 443-506.

Vriezen, E.R., Moscovitch, M., & Bellos, S.A. (1995). Priming effects in semantic classification tasks. *Journal of Experimental Psychology, Learning, Memory, and Cognition, 21,* 933-946.

Warren, C., & Morton, J. (1982). The effects of priming on picture recognition. *British Journal of Psychology, 73,* 117-129.

Waterhouse, L., & Fein, D. (1982). Language skills in developmentally disabled children. *Brain and Language, 15,* 307-333.

Wheeldon, R., & Monsell, S. (1992). The locus of repetition priming in spoken word production. *The Quarterly Journal of Experimental Psychology, 44,* 723-761.

Winer, G.A. (1980). Class inclusion reasoning in children: A review of the empirical Literature. *Child Development, 51,* 309-312.

Young, M.A. (1993). Supplementing tests of statistical significance: Variance accounted for. *Journal of speech and Hearing Research, 36,* 644-656.

Zelazo, P.R. (2001). A developmental perspective in early autism: Affective, behavioral, and cognitive factors. In J.A. Burack, T. Charman, N. Yirmiya, & P.R. Zelazo (Eds.), *The development of autism: Perspectives from theory and research.* Mahwah, N.J.: Lawrence Erlbaum, Pub.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.