INSTANT MESSENGER USE BY INDIVIDUALS WITH ASPERGER'S SYNDROME

by

Kelly L. Coburn

Submitted to the Faculty of

School of Health and Rehabilitation Sciences in partial fulfillment

of the requirements for the degree of

Bachelor of Philosophy

University of Pittsburgh

2009

UNIVERSITY OF PITTSBURGH

SCHOOL OF HEALTH AND REHABILITION SCIENCES

This thesis was presented

by

Kelly L. Coburn

It was defended on

March 17, 2009

and approved by

Rebecca Kronk, CRNP, PhD, School of Nursing, University of Pittsburgh

Michael Walsh Dickey, PhD, Department of Communication Science and Disorders, University of Pittsburgh

Diane L. Williams, PhD, CCC-SLP, Department of Speech-Language Pathology, Duquesne University

Thesis Director: James L. Coyle, PhD, CCC-SLP, BRS-S, Department of Communication Science and Disorders, University of Pittsburgh

INSTANT MESSENGER USE BY INDIVIDUALS WITH ASPERGER'S SYNDROME

Kelly L Coburn

University of Pittsburgh, 2009

Asperger's Syndrome is an autism spectrum disorder in which patients generally exhibit average or above-average intelligence and linguistic ability, but considerable difficulty building social relationships. Its incidence has increased greatly since the 1990s. Also since the 1990s, personal computers have come into wide use as tools not only for work, but also for social communication (Baron, 1998). Computer-mediated communication (CMC) technologies, such as instant messaging (IM), have become very popular with the general public in this time frame.

In order to determine whether IM will be a useful social tool for people with Asperger's, in this study, a corpus of IM conversations from volunteers both with and without Asperger's, conversing with their peers was collected and analyzed to identify patterns of use of standard English lexemes and characteristic IM lexemes. A lexeme is a minimal unit of semantic meaning, which usually corresponds roughly to a word. Emoticons (such as the smiley ":-)"), acronyms (such as "lol"), characteristic abbreviations (like "probly" for "probably"), and typed representations of non-uttered events (like "*hugs you*" or "I hug you") are examples of characteristic IM lexemes. It was hypothesized that people with Asperger's would use significantly more standard English lexemes, and fewer lexemes that are unique to IM, per sent message than would be used by their neurotypical peers. Additionally, it was hypothesized that people with Asperger's would use fewer sent messages to complete an apparent thought than their neurotypical peers.

Participants were recruited in already-acquainted pairs through a peer mentoring program for college students with autism and developmental disabilities. Conversational partners were matched based on their acquaintance with each other. Each Asperger's and neurotypical participant held one or two fifteen- to twenty-minute conversations using AOL Instant Messenger®.

The conversations were recorded, transcribed and analyzed to compare the use of characteristic IM lexemes and structural aspects of each conversation. The lexemes were counted to determine their frequency in each whole conversation. The number of sent messages in each conversation, the number of sent messages per conversational turn, and the number of lexemes (both IM and standard English) per sent message were counted and compared. Results showed no significant differences between groups on any of the variables, or for the behavior of the control group between conditions, suggesting that people with Asperger's are likely to communicate in this medium in ways that are very similar to their neurotypical peers. Implications of this pilot data and potential directions for future research are discussed.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PREFACE

This work could not have been completed without the help of many people at the University of Pittsburgh. First and foremost, I must extend my deepest gratitude to my thesis advisor, Dr. Jim Coyle, whose dedication to research in the field of speech-language pathology has not only inspired my work, but enabled it. It is difficult to express my appreciation for his enthusiasm for undergraduate research and the time, assistance, and encouragement he has offered me because of it. It is one thing to find an advisor for one's research; it is quite another to find a mentor in one's chosen field. I must also thank Dr. Ellen Cohn for her unfailing diligence in helping me find an advisor for this project!

Thanks to Doc Stewart and the entire staff of the University Honors College, as well as my fellow Brackenridge fellows from the summers of 2007 and 2008. The UHC truly provides incredible opportunities for undergraduates to pursue research, and to find fellowship in a community of other undergraduates who do. This work would not have happened without the support of the Honors College, much less without the interdisciplinary community that allowed the idea to spark.

I owe great thanks to Carolyn Komich Hare and everyone at AHEADD, including the study participants, for their enthusiastic support of this project. I am indebted to Dr. Elaine Rubinstein for her help with the statistical analysis of the data and her tremendous skill in explaining to a very non-math-minded person what all the numbers meant. Finally, thanks to my

family and friends for their support and help, from phone calls, to sending me interesting articles, to editing, to asking real questions, to keeping me awake and motivated on those late nights.

1.0 INTRODUCTION

In recent decades, the incidence of diagnoses of autism and autism spectrum disorders (ASD) has dramatically increased. ASD is currently estimated to affect approximately 1 in 150 children in the United States, and it is four times more likely to occur in males than in females (Centers for Disease Control and Prevention, 2007). People with ASD experience difficulties with language, social communication, and repetitive or restricted behaviors (American Psychiatric Association, 1994). One diagnosis on the spectrum is Asperger's Syndrome, in which patients generally exhibit average or above-average intelligence and linguistic ability, but considerable difficulty building social relationships. ASD includes a broad range of symptoms and disorders, and it can be difficult for clinicians and researchers to distinguish between diagnoses, particularly between Asperger's and high-functioning autism (Parsons & Mitchell, 2002; Rajendran, Mitchell, & Rickards, 2005; Robertson, Tanguay, L'Ecuyer, Sims, & Waltrip, 1999). Since Asperger's is considered part of the autism spectrum, it is reasonable to expect that the symptoms of high-functioning autism will often manifest in people with Asperger's as well.

Also in recent decades, personal computers have come into widespread use as tools not only for work, but also for social communication (Baron, 1998). Computer-mediated communication (CMC) technologies (the wide range of text-based CMC tools, including (but not limited to) instant messaging (IM), email, listservs, and chat rooms) have become very popular with the general public. Many teenagers use IM as their major form of contact with their friends

outside of school (Grinter & Palen, 2002), and IM use is also increasing in many workplaces (Garret & Danziger, 2008). Since IM is so widely used, it may be a useful tool for people with Asperger's, who usually struggle with social communication.

This study attempts to describe the linguistic strategies employed by people with Asperger's Syndrome while using IM. Several features of IM, mostly attributable to the physical and auditory absence of one's conversation partner, may indicate that IM could facilitate social communication for people with Asperger's. Conversely, other features of IM, including overlapping conversation threads and frequent changes of topic, could make IM an uncomfortable communicative environment for people with Asperger's. Therefore, it is important to investigate how people with Asperger's actually use this software, to determine whether it could be useful as a treatment tool for improving social interactions.

1.1 ASPERGER'S SYNDROME AND THE AUTISM SPECTRUM

Autism, as first described by Leo Kanner (1943), is a psychological disorder resulting in severely impaired social interaction and communication. Since Kanner's initial description, other researchers, led by Lorna Wing and Judith Gould (1979), have referred to the major "triad of impairments" in autism, which span the autism spectrum. The triad includes: language deficits and abnormalities; social communication deficits, including impaired relationship skills; restricted or repetitive behaviors and interests, such as self-stimulatory behaviors like hand-flapping or spinning, or more complex interests such as an obsession with a given card game or television show (American Psychiatric Association, 1994). There are also frequently-occurring symptoms outside these domains, such as a need for sameness and routine (Baron-Cohen, Leslie,

& Frith, 1985; Hollander & Nowinski, 2003). Symptoms both within and outside the triad vary widely among individuals with autism and other disorders on the spectrum.

The autism spectrum has been divided into three major classifications: autism, Asperger's Syndrome, and pervasive developmental disorder—not otherwise specified (PDD-NOS) (Prior, et al., 1998). These diagnoses are intended to group people with similar sets of symptoms, although symptoms often vary even within diagnoses. People with Asperger's are sometimes described as having high-functioning autism, based on the likelihood that they will exhibit average to above-average intelligence, and independent living skills. However, there are other key distinctions between the two disorders, the most notable being an increased occurrence of pro-social behaviors (for example, seeking friendships) in Asperger's (Eisenmajer, et al., 1996).

Another major difference between classical autism and Asperger's is that the criteria indicated in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) for autism specify that language must be clinically delayed, meaning that single words are not spoken by two years of age, or that phrase speech is not produced by three years of age (American Psychiatric Association, 1994). Although a language delay is not required to diagnose Asperger's, Eisenmajer et al. (1996) found that nearly half of their sample of people with Asperger's had experienced a delayed onset of language, showing that use of this diagnostic criterion is not consistent among all clinicians, further muddying the distinction between a diagnosis of autism and one of Asperger's. Once language emerges in people with Asperger's, there are several noteworthy differences from their neurotypical peers.

1.1.1 Language in ASD

Both expressive and receptive language are affected in ASD. Grammar and vocabulary are usually relatively intact among people with high-functioning autism and Asperger's Syndrome (Frith & Happé, 1994; Kelley, Paul, Fein, & Naigles, 2006; Landa & Goldberg, 2005; Tanguay, Robertson, & Derrick, 1998). However, these skills may be implemented in ways that set people with ASD apart from their neurotypical peers. The use of obscure, idiosyncratic words and phrases is relatively common (Eisenmajer, et al., 1996; Müller & Schuler, 2006), and formal, pedantic utterances are reported to occur frequently in people with Asperger's (Eisenmajer, et al., 1996; Hollander & Nowinski, 2003). Although people with ASD may follow the rules of language to the letter, their spoken language still seems strange to neurotypical listeners, who are more familiar with the conventions of social language use (Müller & Schuler, 2006). People with ASD also notoriously have problems comprehending abstract and figurative language, such as metaphors, jokes, and irony (Frith & Happé, 1994; Landa & Goldberg, 2005; D. Moore, McGrath, & Thorpe, 2000; Rajendran, et al., 2005).

Pragmatic skills, or skills related to the way language is used to communicate rather than the way language is structured (Owens, 2008), are widely considered to be the most affected aspect of language in ASD (Kelley, et al., 2006; D. Moore, et al., 2000; Müller & Schuler, 2006). Pragmatic difficulties may manifest in any number of ways. People with ASD often have difficulty making and sustaining eye contact, especially while listening to another person speak (Ponnet, Buysse, Roeyers, & Corte, 2005). It may be difficult for them to produce or interpret facial expressions and gestures (Lindner & Rosén, 2006; D. Moore, et al., 2000; Robertson, et al., 1999). Lindner and Rosén (2006) suggested that people with Asperger's may be intellectually able to interpret facial expressions, but they do not use this knowledge to determine

the meaning of their partner's expression during conversation. Prosody, or the rhythmic and intonational characteristics of spoken language, may also be affected in a variety of ways. Prosody has been described as the aspect of speech that makes an autistic speaker's differences most evident to a neurotypical listener (Paul, Augustyn, Klin, & Volkmar, 2005). People with ASD may use a flat intonation pattern, which is typically perceived as monotone, or they may have unusually high-pitched or loud speech (Hollander & Nowinski, 2003; Paul, et al., 2005). Such pragmatic abnormalities have obvious repercussions for interpersonal communication.

While most people gain valuable information from non-verbal communication such as body language, facial expression, and prosody, people with ASD may have difficulty interpreting non-verbal cues. Several reasons for this have been suggested. Individuals with ASD can have trouble integrating information from multiple sources (Nation & Norbury, 2005; O'Connor & Klein, 2004), such as the visual and auditory channels that are present in face-to-face conversation. Understanding non-verbal cues could also relate to the ability to attribute mental states and emotions to others, known as the "theory-of-mind" (Baron-Cohen, et al., 1985). Whatever the reason, in discourse, people with ASD generally rely on the verbal content of a spoken message to derive most of its meaning (Grossman, Klin, Carter, & Volkmar, 2000; Lindner & Rosén, 2006). This creates a risk of missing important information that is conveyed non-verbally, but in the context of IM, where verbal information is primary, this difference could assist people with ASD.

Reading comprehension in ASD is may often be impaired as well (Nation, Clarke, Wright, & Williams, 2006; O'Connor & Klein, 2004). Although some children with ASD may appear to read excessively at a very early age, a condition known as hyperlexia (Nation, et al., 2006), they may not always understand what they are reading. Even children whose word-

reading accuracy scores are very high may have low comprehension scores (Nation, et al., 2006), possibly resulting from the aforementioned difficulty integrating information. People with ASD might also experience problems applying prior knowledge to new situations or making inferences about what they read (Nation & Norbury, 2005; O'Connor & Klein, 2004). All of this can contribute to notably weakened reading comprehension, which is likely to cause problems in a text-based communication medium such as IM. Other reseachers have suggested that reading and writing skills may be intact (Frith & Happé, 1994).

Impairments in two other language-related processes, verbal working memory and attention, may affect the usefulness of IM for people with ASD. Verbal working memory deficits appear in many people with ASD (Kelley, et al., 2006; Landa & Goldberg, 2005), limiting the information from an ongoing spoken conversation that may be accessible. People experiencing these deficits may be helped by the availability of a written record of an IM conversation. Finally, people with ASD can have trouble shifting the focus of their attention between activities or conversation topics (O'Connor & Klein, 2004), which could adversely affect their ability to follow an IM conversation in which topics shift rapidly. The possible implications of these symptoms are discussed further in section 1.3.

1.1.2 Social Symptoms in ASD

As with language symptoms, social symptoms also vary widely among people with ASD. The common image is that of a severely autistic individual who shuts out others and retreats into his or her own universe, never choosing to interact with friends or family members. While this can occur in some more severe forms of ASD, it is much more likely for a person with Asperger's Syndrome to actively seek out friends and try to build relationships (Eisenmajer, et al., 1996).

However, the various symptoms associated with Asperger's and other forms of ASD, particularly those involving language and social communication, tend to make it difficult for those who seek interpersonal contact to make and keep friends (Seltzer, et al., 2003).

1.1.3 Use of Computers by People with ASD

People with ASD have often been reported to enjoy using computers (Goldsmith & LeBlanc, 2004; Mitchell, Parsons, & Leonard, 2007; D. Moore & Taylor, 2000; M. Moore & Calvert, 2000; Rajendran, et al., 2005). This raises the concern that computer use could become an obsession, or a "repetitive behavior" of sorts (D. Moore, et al., 2000), but it also creates the possibility that computers could become useful tools to teach and communicate with individuals with ASD.

There is substantial evidence to suggest that computer programs can be used successfully to teach academic and social skills to students with ASD. Moore and Calvert (2000) showed that children with ASD could learn more vocabulary words from a computer than from a human teacher. Silver and Oakes (2001) created a program called Emotion Trainer to teach children with ASD to interpret facial expressions, and found that participants in their small sample showed significant improvement on some test measures. Researchers have also had success teaching social skills to students with ASD in virtual reality environments (Mitchell, et al., 2007; Parsons & Mitchell, 2002). Although no research has been done thus far into the use of computers by people with ASD for exclusively social communication, one study by Rajendran and Mitchell (2006) found that people with Asperger's Syndrome completed a referential questioning task as efficiently with "text chat" as they did over the telephone. Though there were limitations to the study, it suggests that there is merit in examining communication by

people with Asperger's in varied media. Furthermore, since CMC technologies like IM have become so widely used in modern society, it seems important to explore the possibility that CMC could alleviate some of the communicative difficulties faced by people with disorders on the autism spectrum.

1.2 PERTINENT FEATURES OF CMC

1.2.1 The Language of CMC

The Internet has only grown into popular use since the 1980's, and the language of CMC is still developing at a rapid pace (Baron, 1998). This can be contrasted with the relative stability of a language like English, which has developed over centuries instead of decades. Each user of CMC begins communicating in his or her native tongue, but the nature of the medium requires some adjustments. Most researchers agree that CMC manifests itself as a blend of written and spoken forms of language (Baron, 1998, 2004; Hunnicutt & Magnuson, 2001), which means that it is generally more formal and requires more time to compose than a spoken message, but less formal and more spontaneous than a written message. There are also researchers who argue that CMC is necessarily a written form of communication, because it is text-based (Baron, 1998), but it is hard to deny that some features of spoken language exist in this written medium. Users frequently attempt to make their written communication seem more speech-like for social reasons (Baron, 1998).

Another consequence of the rapid development of CMC language is a lack of enforcement of prescriptive rules. There are websites and books intended to guide the new user

of CMC in its rules and conventions (Wolf, 2000), but ultimately, there is no way to make sure the rules are followed by all users all of the time. It is more common for users to adapt the medium to their own needs (Grinter & Palen, 2002; Herring, 2001), developing their own standards within their own sociolinguistic communities.

Two major factors that shape the linguistic properties of CMC are chronicity and number of speakers. Chronicity refers to the amount of time expected to occur between messages. Asynchronous communication, such as email, usually involves a substantial delay between exchanges, while synchronous communication, such as IM, tends to be immediate. (IM may also be used asynchronously (Baron, 2005), as in the case of college students who remain signed on to the software for hours while they leave their computers, making it possible for their friends to leave messages that can be answered later.) Chronicity tends to affect the style of the message: an asynchronous message is more likely to be edited before it is sent, because the sender has more time to consider his or her writing (Baron, 1998; Herring, 2001). Despite this, even asynchronous CMC messages are still infrequently edited (Baron, 1998), although the reason for this is unclear. Presumably, an instant message would be composed quickly and not edited before it is sent, in order to maintain the pace of the synchronous conversation. Therefore, email messages tend to resemble written communication more closely than speech, and more closely than IMs do. As a result, email is often perceived to be more formal. Similarly, an IM message that is received after a long delay may be perceived to have required more thought and effort, and may thus be perceived as more formal.

The number of participants in a CMC exchange may be one-to-one or one-to-many. IM, the focus of this study, is usually one-to-one, although some users of IM engage in one-to-many

chats. The more common, one-to-one use of IM is of particular value in this research, because it seems logical that people with Asperger's will benefit more from one-on-one interactions.

The focus of the mass media on some aspects of CMC, particularly those that differentiate it from standard written and spoken English, may skew the public's perception of the overuse of characteristic conversational tools. IM employs certain unique lexemes, or minimal units of semantic meaning that usually correspond roughly to a word. Examples of characteristic IM lexemes are emoticons like the smiley ":-)", which are sequences of standard keyboard characters used to imitate facial expressions, or distinctive acronyms such as "lol" for "laughing out loud" or "brb" for "be right back." Some critics suggest that these features will lead to a breakdown of standard written English, and should therefore be discouraged (Thurlow, 2006). Contrary to the popular misconception, research has shown that emoticons and acronyms are not particularly frequent in CMC (Baron, 1998, 2004, 2005; Hancock, 2004). Though they still occur often enough to be a noteworthy feature, most messages can be easily understood by readers who are unfamiliar with the conventions of CMC.

Emoticons arose as a means to include emotional information in text-based messages, in an attempt to overcome the lack of non-verbal cues available in CMC (Herring, 2001). Since their introduction, countless variations on the archetypical smiley ":-)", frowney ":-(", and winkey ";-)" have developed, so that the emoticons of each user are likely to depend on his or her sociolinguistic community. Ideally, emoticons would offer a reliable way to interpret the intentions of a speaker whose verbal meaning is uncertain (for example, in a message employing sarcasm). However, Walther and D'Addario (2001) showed that emoticons in email messages were often interpreted to have an ambiguous meaning. They also showed that in mixed messages, in which the verbal content and the emoticon were seemingly at odds, a negativity

effect was present: any negative attribute of the message made it seem more negative, whether it was the text or the emoticon.

Even though emoticons and other non-verbal visual representations can be used to enhance a CMC message, verbal content still carries most of the meaning in a given exchange (Walther & D'Addario, 2001). Therefore, CMC users tend to rely on words, even when there are emoticons or other non-verbal signals present. Walther and D'Addario (2001) also suggested that some emoticons and acronyms, such as "lol" for "laughing out loud," may serve a phatic function rather than an informative one. Most IM users who include the acronym "lol" in a message are not actually laughing, but use the figure to express approval of the message that immediately preceded it. Emoticons can serve a similar function: a smiley may not always indicate that the conversant is physically smiling, but that he or she is pleased or amused.

The popular media have also commented on the spelling errors that may occur frequently in CMC. However, these "errors" may actually be a method by which CMC users intentionally adapt the medium to their needs. In order to make their text-based communications more like speech, some users spell words the way they pronounce them, such as "probly" for "probably" or "cuz" for "because." Auditory signals, such as a scream or a door slamming, can be represented similarly. Physical actions, such as hugs and kisses or more violent behaviors, are often included textually in CMC communication, particularly in synchronous conversations (Herring, 2001).

One interesting and unexpected feature of CMC communication is that the use of verbal irony may increase (Hancock, 2004). One would expect that in a medium with fewer channels available (for example, in CMC there is only a verbal, visual channel, whereas in face-to-face conversations there are also non-verbal visual and auditory channels), messages would become more task-oriented and less relationship-oriented, and this has been variously debated. Hancock

(2004) found that irony use actually occurred more often in CMC than in face-to-face communication. He speculated that this may have been precisely because there were fewer channels available, so conversants needed to build rapport in different ways since they could not use non-verbal cues to do so. The verbal means by which CMC users build rapport could be of particular value to individuals with ASD, although verbal irony in particular may make it more difficult for them to use CMC comfortably.

The conversational structure of IM is also worth mentioning. Unlike email, in which each message typically stands alone, each IM conversation is comprised of many sent messages. One sent message is defined as the unit of communication transmitted each time a conversant types something and tells the computer to send it. IM users often "chunk" their sent messages, using multiple messages to convey a complete sentence or thought before ending a conversational turn (Baron, 2004, 2005), which means that conversation threads may overlap (Baron, 2004; Herring, 2001). A conversational turn is defined as any sequence of messages sent consecutively by one conversant without receiving a message from his or her partner. One conversant may introduce a new topic before his or her partner has had a chance to finish or respond to an earlier topic, and both threads may continue for a few turns until one is resolved. This creates issues with turn-taking which do not generally occur in face-to-face conversations.

1.2.2 Social Use Patterns of CMC

Two concepts appear to dominate all social use of CMC, including IM: idiosyncrasy and informality. Idiosyncrasy, the ways of using the medium that vary for each individual, applies insofar as users adapt the medium to their own needs: rules are applied very individualistically, and people find ways to express themselves independently of prescriptive rules. They may

strictly follow the norms of their immediate online sociolinguistic community, but these may have nothing to do with the larger offline society. Informality seems to pervade CMC even when it is used for formal purposes (Baron, 1998; Herring, 2001). The formality of a conversation is likely to be determined by the social factors surrounding it: since CMC is fairly easy to adapt structurally, it can be easy to adapt socially as well.

Instead of using the Internet as a tool to meet new people, most users of CMC interact with known partners (Baron, 1998, 2004; Bryant, Sanders-Jackson, & Smallwood, 2006; Grinter & Palen, 2002; Valkenburg & Peter, 2007). There are certainly exceptions to this rule, but particularly in one-to-one communication, the conversants have usually met face-to-face. One study by Bryant et al. (2006) found that teens with few or no friends were unlikely to use IM at all, since it is used to keep in touch with "real life" friends the majority of the time. However, Zhao (2006) refutes this finding, claiming that email users generally communicate with known partners, but chat users tend to communicate with unknown partners. Zhao's claims were made about one-to-many computer-mediated chat, but may also extend to one-to-one IM use. Alternatively, his findings about email, which is another one-to-one medium, may be more closely related to the ways most people use IM.

Just as it is used infrequently to meet new people, IM is used frequently by middle- and high-schoolers to talk with their friends outside of school (Bryant, et al., 2006; Grinter & Palen, 2002). Grinter and Palen (2002) mentioned teens who grew frustrated by peers who did not use IM, since they were harder to contact. Similarly, Valkenburg and Peter (2007) found in a study of Dutch teens that time spent on IM was positively related to time spent with "real life" friends, suggesting that the medium is useful to maintain social ties. Since IM has become such an

important social tool, it makes sense that most teens who use this technology use it regularly (Bryant, et al., 2006).

Finally, CMC creates a possibility for multi-tasking that is unprecedented in face-to-face communication (Baron, 1998, 2004, 2005; Grinter & Palen, 2002). Since the conversation partners do not share physical space, they cannot be entirely certain what each other is doing and whether they have each other's undivided attention (Baron, 2005). It is common for users to carry on multiple IM conversations simultaneously, often while also browsing the Internet or composing email (Baron, 2004, 2005; Grinter & Palen, 2002). This enables many independent social interactions to take place at the same time, but it also creates some risk of self-sabotage if this tool is not managed effectively: Grinter and Palen (2002) reported an incident in which a teen accidentally typed a piece of gossip about one friend into the wrong IM window, and sent it to the very friend the news was about. However, if the risk can be overcome, the ability to multitask allows socialization to occur at the same time as schoolwork or other solitary activities.

1.3 RELATING ASPERGER'S AND IM

The language and social communication symptoms of Asperger's Syndrome and the linguistic and social features of IM could interact to make IM a successful communicative tool for people with Asperger's. Some of the symptoms and features could also clash, meaning that IM would not be useful and could even be detrimental to the social communication of people with Asperger's. It is hard to determine which would be the case without any empirical evidence as to the ways in which people with Asperger's employ the technology.

Several features of IM could facilitate social communication for people with Asperger's. Most notably, the absence of the non-verbal components present in spoken, face-to-face communication could make it easier for people with Asperger's to respond to the verbal content of each message. The fact that the person's communication partner is not visually present when using IM negates the need to make eye contact or interpret facial expressions. Moreover, since there is no auditory signal shared between communication partners, abnormal prosody is eliminated as a communication barrier. The necessary reliance on verbal content might place people with Asperger's at a communicative advantage, since many of them are already accustomed to focusing on words instead of non-verbal cues, and neurotypical people might need to adjust more to that requirement. People who experience verbal working memory deficits might be helped by the written record of an IM conversation, to which they can refer at any point without asking a conversation partner to repeat him- or herself.

Since many people with ASD are fond of computers, it makes sense to encourage them to use the computer as a tool for socialization instead of just solitary activities. The popularity of IM with their neurotypical peers could be socially advantageous for people with Asperger's, who often want to make friends but have difficulty with face-to-face interactions. Furthermore, the growing use of IM in some workplaces (Garret & Danziger, 2008) could make it easier for people with ASD to be successful at work if that technology is, in fact, helpful to them.

Conversely, some features of IM could make the Internet an uncomfortable communicative environment for people with Asperger's. Since people with Asperger's are likely to have trouble with both working memory and self-cuing, IM may pose additional communicative challenges even though a written record of the conversation would be available. The fact that many people with Asperger's do not self-cue could result in a failure to review

earlier parts of the conversation if they forget something, without being reminded to do so. People with Asperger's who have trouble reading might face even greater challenges communicating in a text-based medium, including a lack of comprehension, or difficulty keeping up with the pace set by a partner who expects a synchronous conversation. Other aspects of IM, such as overlapping conversation threads, frequent changes of topic, and the possibility for multitasking might cause problems for people who have difficulty changing the focus of their attention.

The sometimes amorphous and rapidly changing rules, or lack thereof, in CMC language could also make IM difficult for people with Asperger's who require sameness and consistency. When the rules change so rapidly, people with Asperger's may not be able to monitor and respond reliably to the need to modify their own language, especially when a person with Asperger's is interacting with a conversation partner with whom they have not agreed, explicitly or implicitly, upon a set of rules. The general assumption of communicative informality in the medium might not help people with Asperger's, many of whom use extremely formal speech, to communicate more "normally" with neurotypical peers. Although emoticons could serve as a static form of facial expression which do not change from moment to moment and can be reexamined, there is also no hard-and-fast set of rules for what each emoticon means in any context. It may be counterintuitive for people with Asperger's that, in many instances, it is permissible to misspell words when using IM, regardless of whether the misspellings have lexical significance, because spelling rules are still being broken.

Assuming that IM is used most often to keep in contact with people one knows in "real life," it may not be useful to people with Asperger's who have difficulty making and keeping friends. People they have met face-to-face are likely to use IM to keep in touch with their own

"real life" friends, and people they could meet online may do the same thing. Since the goal of IM as a social intervention would be to help people with Asperger's interact more normally with their peers, its success is likely to depend heavily on their ability to interact offline as well.

2.0 PROJECT GOALS AND DESIGN

2.1 SPECIFIC AIMS

This study involves the collection and analysis of a corpus of IM conversations from people with Asperger's Syndrome, conversing with both autistic and neurotypical peers. It is loosely based on Naomi Baron's earlier study of the use of IM among American college students (Baron, 2004, 2005), which provided many of the definitions and some of the methods for this work. Baron also examined a corpus of IM conversations conducted by college-aged individuals, and examined lexical and structural variables. This study first aims to describe the pattern of IM usage in a small cohort of people with Asperger's by constructing a linguistic profile of their IM use, and to serve as a pilot for future research on a larger scale. Additionally, the study aims to measure the types and magnitudes of differences, if any, in IM use between the group of participants with Asperger's and a group of their neurotypical peers. The variables examined to achieve this goal include certain characteristic IM lexemes and structural aspects of each sent message and whole conversation.

2.2 HYPOTHESES

It is hypothesized that people with Asperger's will use significantly more standard English and characteristic IM lexemes per sent message than their neurotypical peers, when communicating both with other people with Asperger's and with people without autism spectrum disorders. Additionally, it is hypothesized that people with Asperger's will use significantly fewer sent messages to complete an apparent thought than their neurotypical peers, in both conditions. Finally, it is hypothesized that people with Asperger's will display significantly less frequent use of characteristic IM lexemes, including emoticons, acronyms, and abbreviations, than their neurotypical peers, in both conditions.

2.3 METHODS

2.3.1 Requirements for Participants

Participants in the experimental group were diagnosed with Asperger's Syndrome at some point prior to their enrollment in the study, between the ages of 18-30 years, and acquainted with at least one other potential participant with Asperger's Syndrome and one participant without Asperger's in the organization from which participants were recruited (discussed in more detail in section 2.3.2.1). Potential participants in the control group were never diagnosed with any form of autism spectrum disorder, were between the ages of 18-30 years, and were acquainted with at least one potential participant with Asperger's Syndrome and one participant without.

All participants were native English speakers and able to read and type sufficiently to conduct a fifteen- to twenty-minute conversation using instant messaging technology.

2.3.2 Design

The study was approved by the University of Pittsburgh Institutional Review Board (Protocol # PRO08020138). It is a two-group, cross-sectional, observational study. True randomization was not feasible because of the small sample size: the intention was to randomly assign participants to hold conversations with one participant in each group whom they had identified as acquaintances, but when recruitment was completed, most participants could only reasonably be assigned to one participant in either group.

2.3.2.1 Recruitment & Demographics

Participants with Asperger's Syndrome and neurotypical participants were recruited in pairs of already-acquainted peers through AHEADD (Achieving in Higher Education with Autism and Developmental Disabilities), an organization in the Pittsburgh area that sponsors a peer mentoring program for college students with autism and developmental disabilities. Potential participants identified other members of the organization with whom they were acquainted. The principal investigator (PI) is a volunteer with AHEADD, and the program's director supports this research and made recruitment advertisements available to potential study participants. Eligibility criteria were specified in the advertisement. Potential participants initiated contact with the PI by telephone or email, and were asked whether they had read the advertisement and still wished to participate, and for their permission to undergo screening. Participants who chose to be screened by telephone gave verbal permission to undergo screening.

The written response of potential participants to the screening email constituted their verbal permission. All but two participants elected email screening. During the screening, the PI asked potential participants their age, whether they have ever been diagnosed with Asperger's Syndrome or any other autism spectrum disorder, whether they have any experience with email (as a proxy for IM use that demonstrated their familiarity with computers as tools for communication), and which other members of AHEADD they had met before.

Recruitment proved to be much more difficult than anticipated within this population. It took several weeks to get any response from willing participants. Two participants in the control group, or "N" group (i.e., neurotypical participants), initially volunteered to participate in the study; three more volunteered after an incentive was offered for participation. Two participants in the experimental group, or "A" group (i.e., those with Asperger's Syndrome), volunteered after the incentive was offered; a third "A" participant volunteered after the incentive was increased. One additional potential "A" participant indicated interest, but did not respond to the screening email. When recruitment ended, the "N" group consisted of 5 participants and the "A" group consisted of 3.

The thesis advisor assigned participants to conversational partners based on mutual indication of acquaintance. Screen names were created for each participant, each incorporating a color word and a randomly generated four-digit number (for example, Tangerine9157 or White7755), to mask participant identity from the PI. The PI remained blinded to the identities and diagnoses of the participants and their conversation partners until after all data had been analyzed. After the participants had been assigned to their conversation partners and study procedures had begun, one "A" participant dropped out, citing lack of time as the reason. As a result, one participant in the "N" group was not able to be paired with any conversation partners.

In summary, recruitment initially yielded an "N" group of 5 and an "A" group of 3, but final participation consisted of an "N" group of 4 and an "A" group of 2.

Table 1. Participant Demographics

	Participant	Age	Conversation Partner(s)
"N" Group (Control)	N1	20	N2, A1
	N2	20	N1
	N3	23	N4, A2
	N4	22	N3
"A" Group (Experimental)	A1	20	N1
	A2	23	N3

Additionally, both members of the "A" group were male, but all members of the "N" group were female. The possible implications of this difference are discussed further in section 4.0.

2.3.2.2 Data Collection

The final corpus consisted of four conversations by six participants. Ideally, each Asperger's and neurotypical participant would have been paired with one participant from each group, forming three sets of conversational dyads: Aspergers/Asperger's (AA), neurotypical/Asperger's (NA), and neurotypical/neurotypical (NN). Because recruitment was less successful than anticipated, only two participants, both from the "N" group, held conversations with both "A" and "N" partners. Every participant held a conversation with an "N" partner, resulting in two NA and two NN conversations.

The participants were directed to conduct one fifteen- to twenty-minute conversation with each partner using AOL Instant Messenger®, which is a very widely-used IM software, from their home computers (or other computers with which they were comfortable), to generate a log file of each conversation with a time stamp indicating the time each message was sent, and to

submit the files electronically to the thesis advisor. Submission to the advisor kept the PI blinded to participant identity and diagnosis during analysis. The thesis advisor assigned the screen names and kept the information about each participant's identity and diagnosis separate from the study data, until after all measurements had been made. In order to further assure anonymity, the thesis advisor reviewed the content of the conversations before sending them to the PI for analysis. All potentially identifying information, such as names and workplaces, was removed and replaced with an indicator such as "(subject stated name)". Once the conversations were collected, data analysis took place.

Although the PI was blinded to the identities of the participants during analysis, it must be noted that because the PI was familiar with all of the participants as a result of their mutual involvement with AHEADD, it was possible to discern their identities from the content of their conversations. Since most of the data analysis relied on counting tokens, not qualitative judgments of conversational content, the challenges to blinding should not have affected the outcome of the numerical analysis.

2.3.2.3 Data Analysis

Six participants (four in the "N" group and two in the "A" group) submitted a total of four conversations. Two of the conversations took place between members of the "N" group (NN conversations) and the other two took place between a member of the "N" group and a member of the "A" group (NA conversations). The two participants with Asperger's did not converse with each other, because they did not identify each other as acquaintances. Non-parametric statistics were employed because the sample size was too small to use parametric tests.

The dependent variables included characteristic IM lexemes and structural aspects of each sent message. Emoticons (such as the smiley ":-)"), acronyms (such as "lol" or "brb"), characteristic abbreviations (like "dunno" for "don't know" or "probly" for "probably"), and typed representations of non-uttered events (like "*hugs you*" or "i hug you") are examples of the characteristic IM lexemes. (Although they may be comprised of more than one word, each description of a non-uttered event may be considered a lexeme because each represents only one concept.) Detailed descriptions of the lexeme types as encountered in the corpus follow in section 2.3.2.3. These lexemes were counted to determine their frequency in each whole conversation.

To examine the practice of "chunking," the number of sent messages in each conversation, the number of sent messages per conversational turn, and the number of lexemes (both characteristic of IM and standard English) per sent message, were counted and compared.

Based on the nature of the variable in question, the unit of analysis was either the conversation (n=4) or the participant (n=6). For some variables (such as the number of characteristic IM lexemes used), it was considered to be more useful to analyze the number in each conversation, but for others (such as mean length of sent message (MLSM), or mean number of sent messages per turn), it was considered to be more useful to analyze the overall number of observations for each participant. For variables analyzed by participant, data for participants involved in two conversations were treated in two different ways. In the first, the two measurements of each variable were averaged, which resulted in a total of six cases for each analysis. In the second, each measurement was treated as a separate observation, which resulted in a total of eight cases rather than six. For example, participant N3 had an MLSM of 3.55 in one conversation and 5.03 in another conversation. Both of these scores contributed to the "N"

group mean in a test where n=8, but the average of the two scores, 4.29, contributed to the group mean in a test where n=6.

The primary analysis performed to test all hypotheses was the small sample or exact form of the non-parametric Mann-Whitney U test. The significance of results for the small sample form of the test can only be evaluated when there is a total sample size of seven or more. Therefore, it was not possible to evaluate the statistical significance of tests where there were six cases.

The Wilcoxon signed ranks test, a non-parametric test designed to analyze paired or matched cases, was used to compare the behavior of the "N" participants in NN versus NA conversations. With only two pairs, statistical significance could not be evaluated. However, results of the Wilcoxon signed ranks test were used to corroborate results of the Mann-Whitney test.

Lexemes were analyzed by type and group. The total number of sent messages per conversation was compared between groups using a Mann-Whitney U test and a Wilcoxon signed ranks test. The number of sent messages per conversational turn and the number of lexemes per sent message in each conversation were also compared between groups using the Mann-Whitney U test and the Wilcoxon signed ranks test.

Not all participants submitted files that were in the HTML format generated by AOL Instant Messenger®. Therefore, it can be inferred that not all participants used that software to conduct their conversations. Since the way lexemes were represented was not different across formats, conversations that were submitted in different formats were not disqualified.

Definitions of "Acronyms" and "Abbreviations"

Acronyms included any instances where letters stood for words or parts of words, such as "b/c" for "because" or "lol" for "laughing out loud." Abbreviations included any shortenings of standard English words, such as: "def" for "definitely"; "sorta" for "sort of"; "u" for "you"; and "ur" for "your," "you're," and "you are."

Standard English contractions were not counted as abbreviations, even when the apostrophe was left out, which happened frequently.

Definition of "Descriptions of Non-Uttered Events"

Since no descriptions of physical non-uttered events took place in this corpus, the category became useful for onomatopoeia and non-word productions (such as laughter written as "haha," or "pshhh," which was used to express sarcasm in N4's conversation with N3). This category also included spellings of words that were not clearly abbreviated, but which were not standard English spellings (including "ya" and "yah" for "yeah," and the one occurrence where a participant typed "need" as "NEEEEED" for emphasis. However, other instances of capitalization for emphasis that were not misspelled were not counted as part of this category).

IM Lexemes in the Corpus

It was not always clear what should be counted as a "meaning unit", because sent messages were measured in lexemes, not morphemes, and because the initial definition of a "description of a non-uttered event" allowed many-word lexemes, For the purposes of this study, the following were counted as distinct lexemes:

- standard English words, and misspellings thereof (whether corrected later or not);
- emoticons;

- acronyms, as defined in section 2.3.2.3;
- abbreviations, as defined in section 2.3.2.3;
- onomatopoeia and non-word productions (such as “haha”)
- numbers (for example, the sent message “i had 4” was counted as three lexemes; so was the sent message “8:30-4,” because it includes three meaning units: “8:30 AM,” “until,” and “4:00 PM.” The figure “-14.60/hr” was counted as one lexeme, but when that participant’s conversation partner later rephrased the same figure as “-14.60 an hour….”, it was counted as three lexemes.);
- website URLs (such as “restaurant.com”);
- compound words that are written as two words (such as “hot tub”);
- multi-word proper names (“Adam Sandler,” names of movies, names of restaurants, class names like “anatomy and physiology”);
- corrections to previous sent messages, even when only a single word or single character (“*yeah,” “?”);
- dates (“october 30”);
- any of the above when contained within parentheses.

Non-standard punctuation marks were not counted as separate lexemes, except in two special cases:

- A question mark was the only character in one sent message (in N1’s conversation with A1), to correct a typographical error in the previous sent message (where a slash / was entered instead of a question mark ?).
- Two question marks appeared at the end of a sent message by N4 in N4’s conversation with N3. The sent message was a declarative statement, and the two

question marks were set off by an ellipsis, indicating that they were part of a different thought and represented a unique meaning: “i dunno..??”

3.0 RESULTS

3.1 DESCRIPTION OF CORPUS

Six participants produced four conversations. The data for variables relating to conversations are listed below in Table 2. As shown in Table 2, conversations ranged from 17 to 26 minutes in length. It is interesting to note that the greatest number of sent messages (87) and conversational turns (60) occurred during the shortest conversation (17 minutes), and that this was an NN conversation.

Table 2. Data by conversation

Conversation	Time (min)	Sent Messages	Turns	Mean SM/Turn	Mean SM/Min
N1N2	20	69	46	1.50	3.45
N3N4	17	87	60	1.45	5.12
N1A1	24	48	36	1.33	2.00
N3A2	26	76	36	2.11	2.92

3.2 DESCRIPTION OF VARIABLES BY PARTICIPANT

The data for variables relating to participants are listed below in Table 3. The last four rows of the table make it possible to compare the behavior of the same "N" participant when conversing with another "N" participant and when conversing with an "A" participant.

Table 3. Data by participant for each conversation

Participant	N1		N2	N3		N4	A1	A2
Partner	N2	A1	N1	N4	A2	N3	N1	N3
Sent Messages	30	20	39	40	22	47	28	47
MLSM	8.83	12.05	6.31	5.03	3.55	7.96	11.57	4.85
Mean SM per Turn	1.3	1.11	1.7	1.33	1.32	1.57	1.56	3.36
Emoticons	1	2	2	1	0	2	1	0
Acronyms	2	0	0	3	2	3	1	0
Abbreviations	0	0	1	7	5	3	0	6
Non-Uttered	3	0	0	13	10	8	0	0

Figure 1 displays the mean values of variables related to participants for each group, and for the entire cohort.

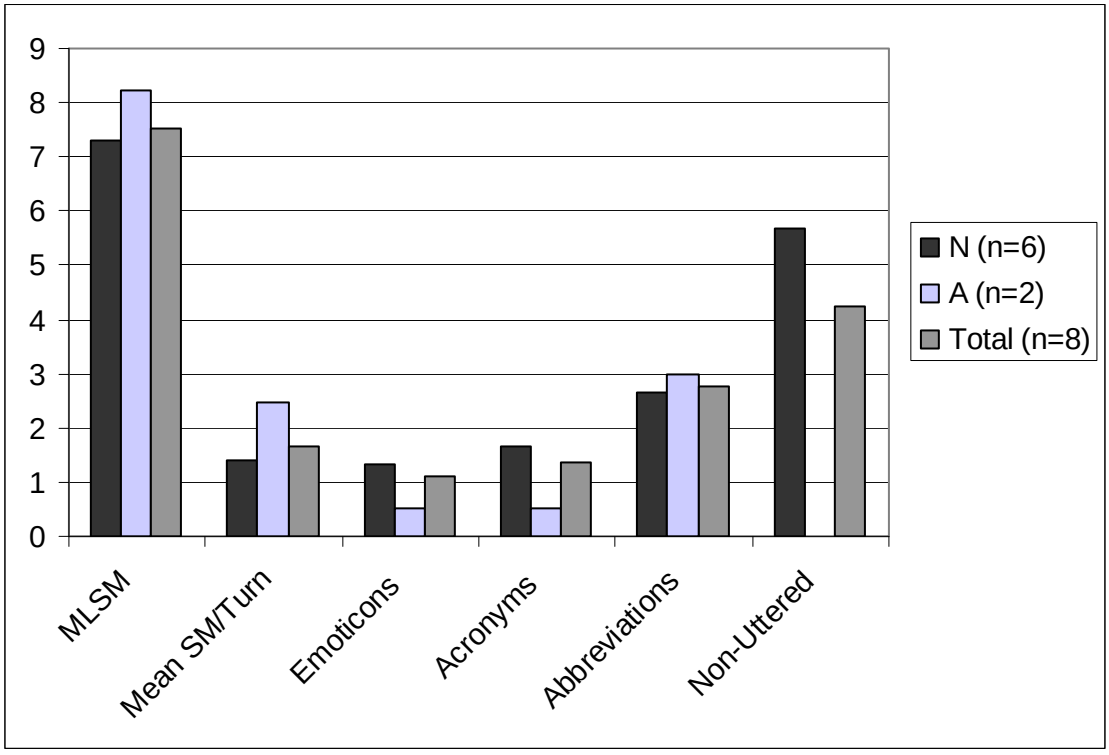

Figure 1. Mean variables by participant for each group

Figure 2 displays the mean for each dependent variable for "N" participants in NN conversations versus NA conversations. Table 4 shows the results of the Mann-Whitney U test

comparing the two groups. It indicates that none of the results were significant or even approached significance at the p=0.05 level. The result for one variable, mean number of sent messages per turn, has a significance of 0.143, which seems to indicate a trend towards longer messages for members of the "A" group.

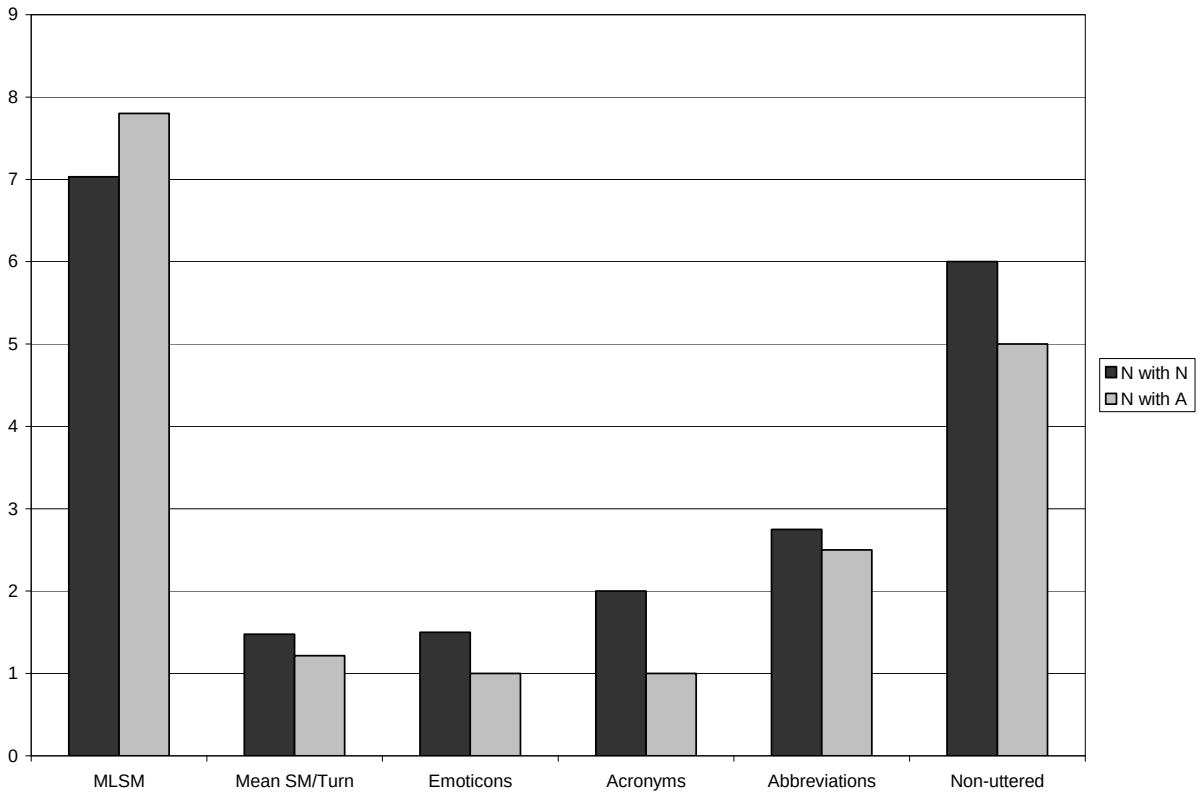

Figure 2. Mean variables for "N" participants in NN and NA conversations

Table 4. Mann-Whitney U results by group (n=8)

	Mean Rank		U	Exact sig (one-tailed)
Variable	**N**	**A**		
Sent messages	4.25	5.25	4.5	0.357
MLSM	4.5	4.5	6	0.571
Mean SM/Turn	3.83	6.5	2	0.143
Emoticons	5.08	2.75	2.5	0.25
Acronyms	5	3	3	0.214
Abbreviations	4.5	4.5	6	0.571
Non-Uttered	5.17	2.5	2	0.214

3.3 LEXEMES PER SENT MESSAGE

The first hypothesis states: "It is hypothesized that people with Asperger's will use significantly more standard English and characteristic IM lexemes per sent message than their neurotypical peers, when communicating both with other people with Asperger's and with people without autism spectrum disorders." It was not possible in the final corpus to determine how people with Asperger's communicated with other people with Asperger's, but it was possible to compare their mean length of sent message (MLSM) in lexemes to that of their neurotypical peers.

This hypothesis was not supported by the results. Table 5 shows the overall MLSM value for each participant. Participants with Asperger's produced slightly more lexemes per sent message, but the difference was not significant. In the Mann-Whitney test comparing overall values for each participant (n=6), the mean MLSM rank of participants in the "A" group was 4.0 as compared to 3.25 for the "N" group (p=0.40). The second Mann-Whitney test, comparing the values for each condition for all participants (n=8), resulted in identical MLSM ranks of 4.50 for both groups (p=0.571). Neither of the test results was significant.

Table 5. MLSM by Participant

	Participant	MLSM (Lexemes)
"N" group	N1	10.44
	N2	6.31
	N3	4.29
	N4	7.96
"A" group	A1	11.57
	A2	4.85

Furthermore, a separate Mann-Whitney test showed that "N" partners in conversations with participants with Asperger's had the same MLSM rank (3.50) as in conversations with other

"N" participants (p=0.60). Therefore, it appears that the "N" participants did not change the length of their sent messages based on their partner's condition.

3.4 CHUNKING OF SENT MESSAGES

The second hypothesis states, "it is hypothesized that people with Asperger's will use significantly fewer sent messages to complete an apparent thought than their neurotypical peers, in both conditions." Again, it was not possible to compare the behavior of people with Asperger's in both conditions, since both members of the "A" group only completed conversations with members of the "N" group. This hypothesis was tested by comparing the mean number of sent messages per turn between the groups.

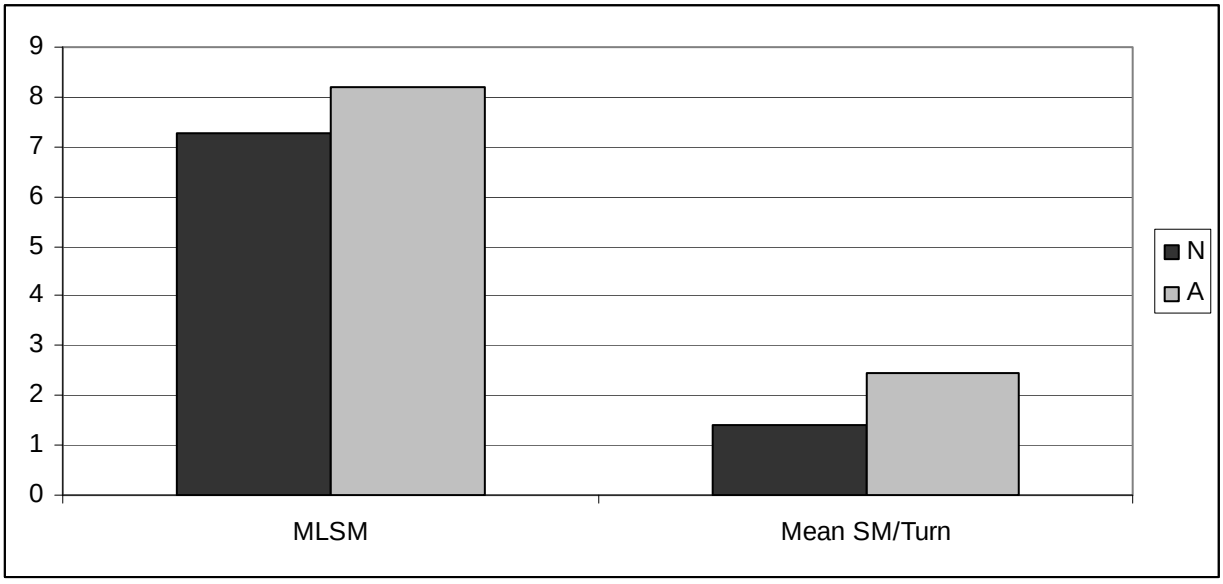

Figure 3. Mean length of sent message and mean sent messages per turn by group

The hypothesis was not supported by the results of either Mann-Whitney U test. Members of the "A" group had a higher mean rank for sent messages per turn (rank=4.50 for

overall scores, n=6, p=0.267; rank=6.50 for separate observations of conversations by participants who held two, n=8, p=0.143) than members of the "N" group (3.00 in the n=6 test, and 3.83 in the n=8 test). The test results were not significant. One "A" participant used fewer mean sent messages per turn than half of the "N" participants, while the other "A" participant used more mean sent messages per turn than any other participant in either group. Table 6 shows the mean sent messages per turn for each participant; Table 7 shows the mean sent messages per turn in each conversation. Figure 3 above compares both the mean length of sent message and the mean sent messages per turn between the groups.

Table 6. Mean Sent Messages per Turn by Participant

	Participant	Mean Sent Messages per Turn
"N" group	N1	1.21
	N2	1.70
	N3	1.33
	N4	1.57
"A" group	A1	1.56
	A2	3.36

Table 7. Mean Sent Messages per Turn by Conversation

Conversation	Mean Sent Messages per Turn
N1N2	1.50
N3N4	1.45
N1A1	1.33
N3A2	2.11

A Mann-Whitney U test comparing values for whole conversations showed that the ranks for mean sent messages per turn were the same (rank=2.50, p=0.667) in conversations which included a partner with Asperger's as in conversations which did not. This result suggests that the neurotypical participants did not vary the number of sent messages per turn based on their partner's condition, and that the sent messages per turn of a conversation partner with Asperger's did not alter the overall average number of sent messages per turn of a conversation. However, a

separate Mann-Whitney test revealed that the mean rank for sent messages per turn of "N" partners conversing with "N" partners was higher (4.25) than that of "N" partners conversing with "A" partners (2.00), although this result was not statistically significant (p=0.133). The low significance value could indicate a trend towards longer messages by "N" participants in conversations with members of the "A" group. In other words, when the mean sent messages per turn of entire conversations were compared, there was no difference between NN and NA conversations. When mean sent messages per turn of participants in the "N" group were compared between conditions, it appears that the neurotypical participants used more sent messages per turn with their neurotypical peers than with peers who have Asperger's. This Mann-Whitney U test was supported by a corresponding Wilcoxon signed ranks test, which revealed that "N" participants used fewer sent messages per turn when conversing with "A" participants than with other "N" participants (mean rank=1.50, p=0.25).

3.5 USE OF IM LEXEMES

The final hypothesis states, "it is hypothesized that people with Asperger's will display significantly less frequent use of characteristic IM lexemes, including emoticons, acronyms, and abbreviations, than their neurotypical peers, in both conditions." Table 8 shows the number of characteristic IM lexemes used by each participant in each conversation, and Figure 4 shows the mean number of each type of lexeme used by each group. Raw data for each category of lexeme are provided in sections 3.5.1, 3.5.2, 3.5.3, and 3.5.4. Although the Mann-Whitney test results were not significant in any case, the results of both the n=6 test, in which the measurements of each variable for participants who held two conversations were averaged, and the n=8 test, in

which each measurement was treated separately, did support this hypothesis for all categories of characteristic IM lexemes. The "A" group had lower mean ranks for use of emoticons (rank=2.75, n=8, p=0.25; rank=1.75, n=6, p=0.133), acronyms (rank=3.00, n=8, p=0.214; rank=2.25, n=6, p=0.20), and descriptions of non-uttered events (rank=2.50, n=8, p=0.214; rank=2.50, n=6, p=0.40) than their peers in the "N" group (emoticons: rank=5.08, n=8; rank=4.38, n=6; acronyms: rank=5.00, n=8; rank=4.12, n=6; non-uttered: rank=5.17, n=8; rank=4.00, n=6). The use of abbreviations was almost the same for both groups, showing equal mean ranks in the n=8 test (rank=4.50, p=0.571) and mean ranks of 3.62 ("N" group) and 3.25 ("A" group) in the n=6 test (p=0.467).

Table 8. Number of Characteristic IM Lexemes

Participant	**Emoticons**		**Acronyms**		**Abbreviations**		**Descriptions of Non-Uttered Events**	
	With N	With A	With N	With A	With N	With A	With N	With A
N1	1	2	2	0	0	0	3	0
N2	2	-	0	-	1	-	0	-
N3	1	0	3	2	7	5	13	10
N4	2	-	3	-	3	-	8	-
A1	1	-	1	-	0	-	0	-
A2	0	-	0	-	6	-	0	-

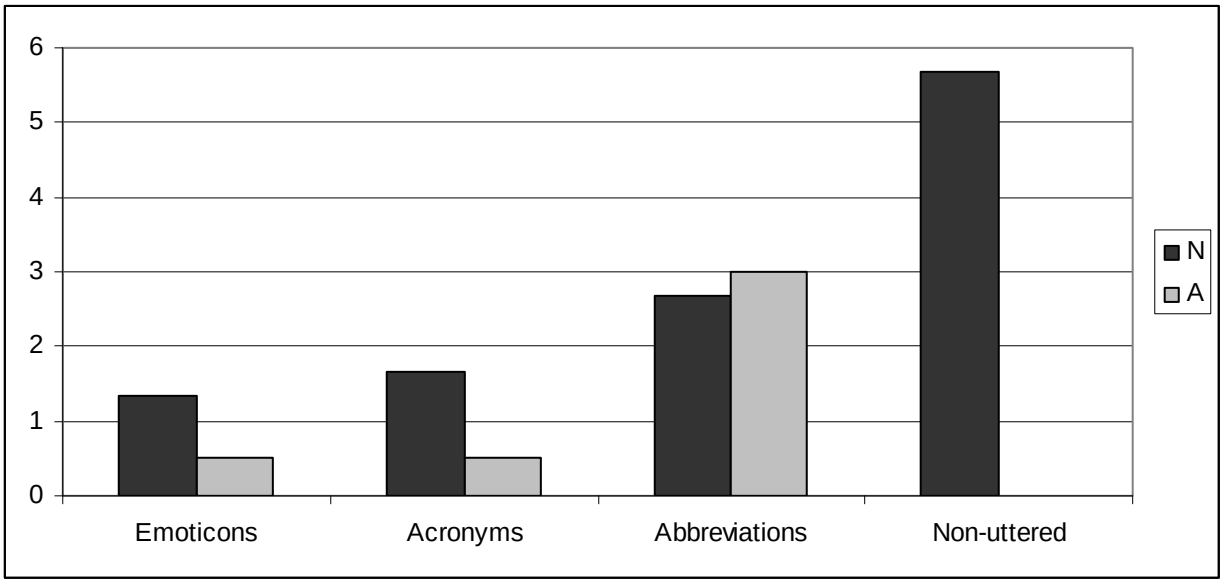

Figure 4. Mean number of IM lexemes by group

Another Mann-Whitney test indicated that members of the "N" group used fewer characteristic IM lexemes when conversing with members of the "A" group than with other members of the "N" group. The difference in ranks was greatest for acronyms (NN rank=4.00, NA rank=2.50, p=0.333), and the difference was smallest for abbreviations (NN rank=3.62, NA rank=3.25, p=0.467) and descriptions of non-uttered events (NN rank=3.62, NA rank=3.25, p=0.467). The results of this test were not significant, but the results for acronyms and descriptions of non-uttered events were supported by a Wilcoxon signed ranks test, which showed higher ranks for the use of these variables by members of the "N" group when conversing with other members of the "N" group (rank=1.50 and p=0.25 for both variables) than with members of the "A" group (rank=0 for both variables). That is, both "N" participants who conversed with "A" participants used fewer acronyms with "A" participants than with "N" participants, and they both also used fewer descriptions of non-uttered events with "A" participants. One of the "N" participants used fewer emoticons with an "A" participant, but the other used more emoticons in that condition. One used more abbreviations with an "A"

participant, and the other used the same number of abbreviations with "N" as with "A" (although as Table 8 shows, that number was zero).

3.5.1 Emoticons

Emoticons were relatively uncommon the corpus, used no more than three times by any one participant (N1, twice in one conversation and once in the other, and all were standard smileys ":-)"), and not used at all by one participant (A2, who only had one conversation). The emoticons used can be found in Table 9. Further discussion of the use of emoticons in the corpus occurs in section 4.1.1.

Table 9. Emoticons in the corpus

Emoticon	Total uses	Participant(s)
:-)	4	N1 N4
:-D	1	N2
>:o	1	N2
:-P	1	N3
;-)	1	N4
:-\	1	A1

3.5.2 Acronyms

Acronyms were also relatively uncommon in the corpus. Most participants used only one or two acronyms if they used any at all, and some of those were acronyms that are commonly used as shorthand in non-IM, written environments (such as "w/" for "with," "hw" for "homework," and "b/c" for "because"). A2 and N2 used no acronyms, and N1 used no acronyms in a conversation with A1, but two in conversation with N2. The participant who used the most acronyms was N3,

with a total of 5 across two conversations (3 in N3's conversation with N4, and 2 in conversation with A2). The acronyms found in the corpus are displayed in Table 10.

Table 10. Acronyms in the corpus

Acronym	Total uses	Participant(s)
hw	1	N1
b/t	1	N1
b/c	3	N3 N4
OMG	1	N3
w/	1	N3
ttyl	1	N3
lol	2	N4
btw	1	A1

3.5.3 Abbreviations

Abbreviations were used somewhat more than emoticons or acronyms, though two participants (N1 and A1) did not use them. The remaining four participants ranged between 1-12 abbreviations total, and between 1-6 abbreviations in a single conversation. The most common abbreviations used were "u" for "you," which occurred 11 times, and its derivatives, "ur" (N=4) and "ru" (N=2). Table 11 shows the abbreviations that occurred in the corpus.

Table 11. Abbreviations in the corpus

Abbreviation	Total uses	Participant(s)
u	11	N2 N3 A2
ur	4	N3
ru	2	N3
u2	1	N3
def. def	2	N3 N4
sorta	1	N4
dunno	1	N4

3.5.4 Descriptions of Non-Uttered Events

Lexemes that ultimately fell into the category “descriptions of non-uttered events” covered an even wider range. Again, some participants used none at all, but some participants used many. N3 used the most of these lexemes by far, and used more in conversation with N4 than with A2. Neither participant in the “A” group used any descriptions of non-uttered events. Table 12 displays the lexemes in this category that appeared in the corpus, organized by the participants who used them. Further discussion of these lexemes can be found in section 4.1.2.

Table 12. Descriptions of non-uttered events in the corpus, by participant

Participant	Partner group	Lexeme	Number of uses
N1	"N"	haha	1
		yep	1
		ya	1
	"A"	-	-
N2	"N"	-	-
N3	"N"	ah	1
		aw	1
		yah	2
		ya	1
		yeahhh	1
		niiice	1
		hahaha	1
		haha	1
		hahha	1
		NEEEEED	1
		ooh	1
		naaaaahh	1
	"A"	yep	2
		sup	1
		oooh	2
		nah	1
		yeahh	1
		yah	2
		Ya	1
N4	"N"	ooo	1
		haha	1
		pshhh	1
		hah	2
		ya	2
		oo	1
A1	"N"	-	-
A2	"N"	-	-

3.6 TOTAL SENT MESSAGES AND SENT MESSAGES PER MINUTE

The total number of sent messages for each participant and in each whole conversation was counted, and the mean sent messages per minute in each conversation were compared, in

order to measure how frequently sent messages were transmitted in the conversations. The length of time between sent messages (specifically whether it is perceived as synchronous or asynchronous, as discussed in section 1.2.1) can affect a conversation partner's reception of an IM conversation.

Despite the instructions to conduct conversations between fifteen and twenty minutes in length, some conversations exceeded twenty minutes. As a result, the duration in minutes of the conversations varied by almost ten minutes. Since the typing speed of most college students was expected to produce many sent messages in ten minutes, the number of sent messages in each conversation was not considered a valuable variable in this study. For that reason, the mean number of sent messages per minute, which can be more easily standardized across conversations, was compared. In the interest of being thorough, the total number of sent messages for each participant and in each conversation was analyzed.

Although the total number of sent messages for each participant or each conversation may not be useful because of the time differences between conversations, these variables were counted and compared. The number of sent messages for each participant in each conversation did not differ significantly between groups. The total number of sent messages for each participant did differ noticeably, with participants in the "N" group having a higher mean rank in the Mann-Whitney test that compared the overall values for each participant ("N" rank=4.12, "A" rank=2.25, $p=0.40$). This can be easily explained by the fact that only "N" participants had multiple conversations, so it is to be expected that the "N" group's score for that variable would be weighted.

A Mann-Whitney test revealed that participants in the "N" group had a higher mean rank for number of sent messages in conversations with "N" participants (rank=4.50) than in

conversations with "A" participants (rank=1.50). That is, neurotypical conversants were more likely to have more total sent messages in conversations with their neurotypical peers. The result was not significant (p=0.067), but had a low enough significance value to suggest a trend towards more sent messages for "N" participants in NN conversations. This result was supported by a Wilcoxon signed ranks test, which indicated that members of the "N" group used more sent messages than their peers in the "A" group ("N" rank=1.50, "A" rank=0, p=0.25). When NN conversations were compared with NA conversations in a Mann-Whitney test, the mean rank for total number of sent messages was only slightly higher for NN conversations (rank=3.00) than for NA conversations (rank=2.00, p=0.333).

A2's conversation with N3 was 26 minutes long. Because it was continuous, the conversation was not truncated for data collection. A1's conversation with N1 was 24 minutes long, and A1 expressed some concern near the end of the conversation that it would be disqualified from the study because it was too long. That same conversation was initiated twice, but N1 was unavailable to chat when A1 first attempted to initiate conversation. Both participants submitted the first greeting sequence as part of their conversation files, but a continuous conversation did not occur until 30 minutes later. In order to keep the conversation closer to the suggested 20-minute limit, data from the first greeting sequence was not counted towards numeric totals. The remaining 24 minutes of continuous conversation were not truncated.

Table 13. Mean sent messages per minute by conversation

Conversation (partners)	Time (min)	Mean Sent Messages per Minute
N1 N2	20	3.45
N3 N4	17	5.12
N1 A1	24	2.00
N3 A2	26	2.92

Table 13 shows the mean sent messages per minute for each conversation. A Mann-Whitney U test showed that NN conversations had a higher mean rank of sent messages per minute (rank=3.50) than NA conversations (rank=1.50, p=0.167). The finding was supported by a Wilcoxon signed ranks test, which also showed a higher rank for the mean sent messages per minute in NN conversations (rank=1.50) than for NA conversations (rank=0, p=0.25). This could be interpreted several ways, and a few possible interpretations are discussed in section 4.2.

3.7 INTRA-RATER RELIABILITY

Since there was only one rater for this study, intra-rater reliability was examined by re-analyzing some of the data and comparing the results. One conversation (between N3 and N4), comprising 25% of the conversations in the corpus, was randomly selected and de-identified by the thesis advisor, then re-analyzed by the principal investigator. Because the amount of data is small, it was not possible to perform a statistical test of intra-rater reliability, but the raw data (as shown in Table 14) indicate a reasonable level of reliability. In only three cases was the percent difference between the measurements greater than 10%, but in each of these cases the difference was only an increase or decrease of 1 observation. The percent difference was caused by the small number of observations for these variables.

Table 14. Intra-rater Reliability Data

	Variable	First measurement	Second measurement	Difference	% difference
Speaker 1	Sent messages	40	39	-1.00	-2.50
	MLSM	5.03	5.08	0.05	0.99
	Mean SM/Turn	1.33	1.34	0.01	0.75
	Emoticons	1	1	0.00	0.00
	Acronyms	3	3	0.00	0.00
	Abbreviations	7	8	1.00	14.29
	Non-Uttered	13	14	1.00	7.69
Speaker 2	Sent messages	47	46	-1.00	-2.13
	MLSM	7.96	7.91	-0.05	-0.63
	Mean SM/Turn	1.57	1.59	0.02	1.27
	Emoticons	2	2	0.00	0.00
	Acronyms	3	3	0.00	0.00
	Abbreviations	3	2	-1.00	-33.33
	Non-Uttered	8	9	1.00	12.50
Conversation	Time (min)	17	17	0.00	0.00
	Sent messages	87	85	-2.00	-2.30
	Turns	60	58	-2.00	-3.33
	Mean SM/Turn	1.45	1.47	0.02	1.38
	Mean SM/Min	5.12	5.00	-0.12	-2.34

3.8 NON-NUMERICAL OBSERVATIONS

There are several aspects of the conversations in the corpus that are worth noting, but which were unanticipated as dependent variables and so were not included in the statistical analysis. These included the use of capitalization, punctuation, contractions, numerals (instead of words for numbers), corrections of errors, and topic changes. Most of these conversational tools can be employed to affect the formality of an IM conversation, so it is interesting to consider how people with Asperger's and their neurotypical peers use them.

3.8.1 Capitalization

The participants showed wide variation in their use of capitalization. In N1's conversation with N2, the use of capitalization varied mostly unpredictably: some proper nouns were capitalized while others were not. However, the first word of a sentence was never capitalized unless it was a proper noun or the pronoun "I." When N1 conversed with A1, N1's capitalization was closer to that of standard written English: the first words of sentences were more frequently (though still not always) capitalized, regardless of proper noun status, and the pronoun "I" was also more frequently (but not always) capitalized, even when not at the beginning of a sentence. Despite N1's increased use of standard capitalization, A1 used no capitalization whatsoever.

In N3's conversation with N4, capitalization was used multiple times for emphasis, which did not occur in any of the other conversations. Some proper nouns were capitalized while others were not, but the capitalized nouns were mostly abbreviations, such as the title of the television show "CSI," or "CHP," the name of a hospital. Names of people, holidays, and sports teams were never capitalized in this conversation.

In N3's conversation with A2, there were no capital letters at all, which is particularly interesting in light of the fact that the other participant with Asperger's Syndrome also used no capital letters. This suggests that use of capitalization may be worth examination in future studies, and it is discussed is more detail in section 4.3.1.

3.8.2 Punctuation

In this corpus, the ends of sentences were almost never punctuated unless with a question mark, exclamation point, or ellipsis, or where the end of a sentence did not correspond with the end of a

sent message. This is not uncommon in IM communication, where the end of a sent message is usually interpreted as the end of a sentence, unless the subsequent sent message is obviously a continuation of the same sentence. N1 was the only participant who ended sentences with a period mid-message. Other participants punctuated sentences that ended mid-message with exclamation points, question marks, or ellipses. Only two participants, N1 and N3, punctuated the ends of sent messages with periods in any circumstance, and N1 was the only one who punctuated the ends of sent messages that were also the ends of sentences with periods. The use of punctuation and its possible implications are discussed in more detail in section 4.3.2.

3.8.3 Contractions

Standard English contractions, such as "don't," "won't," and "I'll," occurred in the corpus in environments similar to those in which they would occur in speech. Contractions did not occur in all grammatically possible environments. Purely qualitatively, it does not appear that participants with Asperger's used contractions any more or less frequently, or in different environments, than their neurotypical peers. However, contractions were not counted as a dependent variable to provide numerical data. The use of contractions is discussed in greater detail in section 4.3.3.

3.8.4 Numerals

Numerals were most often used instead of words for numbers in the corpus. Participant A1 used words for numbers more than any other participant, using a numeral only twice among several

lexemes that indicated number values. Only one other participant, N4, used a number word where a numeral could have occurred, and only did so once.

There were pronominal uses of the word "one," as in the sent message, "i havnt watched a football game since [name] took me to one 2 years ago.." by N4. Such instances are not considered examples of number words being used in place of numerals, because it serves as a pronominal substitute for a noun or noun phrase (in this example, "a football game"), instead of a numerical quantity.

Numerals and number words are discussed further in section 4.3.4.

3.8.5 Corrections of Errors

Few errors appear in the transcripts of the conversations. (Non-standard capitalization and punctuation, including the omission of apostrophes from standard English contractions, were not counted as errors.) Of the errors that did occur and were left uncorrected, five were spelling errors by N4 (two of which, "ot" for "to" and "b enice" for "be nice," are easily explainable by qualities of the medium; namely, the use of a keyboard to transmit messages and the particular hazards that result from using that tool), one was an omission ("[…] with that kid in today" rather than "with that kid in *it* today"), and one was of an ambiguous nature ("not to worse than the average worker" in reference to a work day that lasted "almost 8 hours": this could be interpreted as an omission and a misspelling, where the target was "not *too much* worse than the average worker"; a misuse of "worse than" as a verb; or a case of an unusual grammatical construction with which the PI is so unfamiliar as to find undeterminable).

There was one case of a conversant correcting a typographical error in a subsequent message. In one of N1's messages to A1, N1 accidentally typed a slash "/" instead of a question

mark “?” at the end of a sentence. In the message immediately following the error, N1 sent a single question mark.

Possible interpretations of the occurrence and treatment of errors in this corpus can be found in section 4.3.5.

3.8.6 Topic Changes

As discussed in section 1.2.1, topic changes in IM conversations may occur rapidly or abruptly, and a topic change may not be immediately complete: instead, multiple threads of conversation may overlap until one is resolved. There were a few overlapping conversation threads in the corpus. N3 and N4 seemed to overlap threads without any disruption to the conversation; two threads could be continued simultaneously until one was resolved. However, in one instance, N1 attempted to change the topic of conversation with A1, and A1 appeared either not to notice or to ignore the attempt. Topic changes, overlapping conversation threads, and their implications are discussed in section 4.3.6.

4.0 DISCUSSION

This study shows no major quantitative differences between instant messenger use by individuals with Asperger's Syndrome and their neurotypical peers. The only differences that occur in the numerical data are small, and none are statistically significant. The study is too small to make any definitive statements based on the results. However, it serves as an interesting pilot for a potential future study on a larger scale. The methods of this study could use reexamination and alteration in order to be more useful for future research. The study provides encouraging, if not decisive, pilot data, and a larger sample might expose differences masked by the small sample size in this experiment.

There were qualitative differences between the messages of participants with Asperger's and their neurotypical peers. These are often difficult to describe, much like the qualities of speech considered characteristic of people with ASD. One of the most widely recognized differences in the speech of people with ASD is their prosody, but since prosody does not exist in the text-only media of CMC, it is difficult, if not impossible, to call attention to one's "tone of voice." Some descriptions of non-uttered events might be used as an approximation of prosodic variance, as might capitalization or punctuation, but further investigation would be needed to support those claims.

As mentioned in section 2.3.2.1, both members of the "A" group were male, and all members of the "N" group were female. This gender disparity is not surprising, given that the

majority of individuals diagnosed with autism spectrum disorders are male (Centers for Disease Control and Prevention, 2007). Furthermore, the overwhelming majority of volunteer peer mentors with AHEADD are female. Other studies have examined gender differences in CMC. Baron (2004, 2005) found that males were more likely to "chunk" their IM utterances, and females were more likely to use emoticons. Wolf (2000) found no significant difference between genders for the frequency of emoticon use in asynchronous CMC, but did observe differences in the types of emoticons used. Herring (2000) explored gender differences in social use of CMC, but did not focus on lexical or syntactic variables. It is not unlikely that the gender differences in this population may have some effect on the results, but that variable was not of interest in this study.

4.1 CHARACTERISTIC IM LEXEMES IN THE CORPUS

4.1.1 Emoticons

As described in section 3.5, the "A" group had lower mean ranks for use of emoticons than the "N" group. This could indicate that people with Asperger's are more likely to focus on the verbal content of the instant messages than to include visual, non-verbal expressions of emotion or meaning. This may warrant further investigation with a larger sample.

AOL Instant Messenger® and most other IM clients have a feature where users can select emoticons from a drop-down menu by clicking with the mouse. Most clients also automatically display emoticons as graphics when they are typed as sequences of standard keyboard characters, although users can choose to disable this feature. It is unclear whether the participants typed or

selected their emoticons, and uncertain whether the method of inserting emoticons might have affected the frequency of their use. It would be difficult to control for this variable in a future study without compromising the naturalness of the data, because if participants are instructed to use one method instead of the other, it could affect the way in which they think about emoticons and whether they choose to use them at all. It might serve better to ask participants which method they used after data is collected.

4.1.2 Descriptions of Non-Uttered Events

Neither participant in the "A" group used any descriptions of non-uttered events, which mirrors the tendency of people with Asperger's to use formal constructions in spoken conversation. Descriptions of non-uttered events in CMC, especially those that are derived from misspellings of words in order to make them more speech-like, may correspond roughly to prosodic variations in speech. If that is the case, then it makes sense that people with Asperger's whose prosody differs from that of their neurotypical peers would be unlikely to use such lexemes. It would certainly be interesting to investigate in more depth the choices that people with Asperger's make regarding more and less speech-like constructions in their IM conversations. Descriptions of non-uttered events are also one tool IM users can employ to make their conversations more informal, by visually representing less formal speech patterns, or attention to non-verbal aspects of the conversation or environment.

Of the descriptions of non-uttered events that were used, expressions of laughter and agreement (for example, "haha," "yah," "ya") occurred most, which may suggest that IM users want to make their positive messages more speech-like as a rapport-building tool. It could also

indicate that there are fewer tools available for making negative messages more speech-like, or that these participants were unfamiliar with lexemes that could be used for that purpose.

4.2 NUMBER OF SENT MESSAGES

As described in section 3.6, NN conversations had a higher mean rank for mean sent messages per minute than did NA conversations. The differences in mean sent messages per minute between NN and NA conversations could be explained in several ways. Neurotypical conversants may have a faster typing speed than conversants with Asperger's, enabling them to produce more sent messages in a given time span. Alternatively, conversants with Asperger's may take more time to compose their messages mentally, or to review and edit them once they are already typed. Since the mean sent messages per minute is just that—an average—it could also be that there were fewer lulls in conversations between two neurotypical participants than between participants with Asperger's and their neurotypical peers.

4.3 DISCUSSION OF NON-NUMERICAL OBSERVATIONS

As mentioned in section 3.8, there were several aspects of the conversations that were unanticipated as dependent variables of interest, but which proved interesting for examination. The following descriptions of these features may provide insight into variables of interest for future research.

4.3.1 Capitalization

The observation that participants with Asperger's Syndrome used no capital letters whatsoever in the corpus would appear to contradict the assumption that people with Asperger's are more likely to follow prescriptive rules in their communication. Words that must be capitalized in standard written English, such as proper nouns, the pronoun "I," and words at the beginnings of sentences, were not capitalized by people with Asperger's in this corpus, breaking a major prescriptive rule for written language. Conversely, it could mean that IM users with Asperger's have learned that the prescriptive rule for IM communication is different than that for other forms of written communication; namely, words are not capitalized in IM. It would be very interesting to explore whether other people with Asperger's also do not capitalize in IM, and whether this extends into other forms of CMC as well.

Non-standard capitalization may be used frequently in CMC to approximate prosody, with a word in all-capital letters typically indicating louder speech. If people with Asperger's do not use capitalization this way in IM, it may suggest that they type using a "more monotone" pattern than their neurotypical peers.

Furthermore, the use of capitalization by participants with Asperger's did not differ based on their conversation partner's use of capitalization—even if the neurotypical partner changed their use between conditions. One participant in the A group conversed with a neurotypical partner who used close to standard capitalization, while the other conversed with a partner who used no capitalization. This implies that at least some people with Asperger's do not follow cues from neurotypical partners in communicative situations. It would be difficult, if not impossible, to say whether the "A" participant whose "N" partner used no capitalization was following cues. In that conversation, the "N" partner initiated communication, and there were no capital letters in

the first sent message, so it is possible that the "A" partner followed cues as to capitalization from the very beginning of the conversation.

4.3.2 Punctuation

Only two participants punctuated the ends of sent messages with periods in any circumstance. Twice, N3 used periods at the end of a sent message in which the final lexeme was an abbreviation. N1 punctuated the ends of sent messages with periods even when the end of the message was also the end of a sentence, but only when conversing with a partner who had Asperger's Syndrome. N1 was the only participant who punctuated the ends of sentences that were also the ends of sent messages. Remember that N1 also increased the use of standard capitalization in her NA conversation. It seems plausible that N1 believed her role as a peer mentor with AHEADD extended to the study procedures, and thus attempted to set a good example for her conversation partner, who had also been her mentee, by more closely following the rules of standard written English.

Participant N4 used ellipses more often and in more environments than any other participant. This participant employed ellipses to indicate pauses where standard written English either would not consider a pause to be appropriate or offers no obvious prescriptive rule for how to mark one. One example of this is seen in the sent message, "cool…work..who needs that..pshhh..", where at least the pause between "work" and "who" could be marked with a colon, a comma, a dash, or in some interpretations, even a semi-colon. N4 also used ellipses several times to set off an onomatopoetic lexeme from standard English lexemes, as in "ooo….fun.." and "hah…which is why i work[…]" She ended sent messages with ellipses, which one might expect to mean that another sent message was to follow immediately with more

information on the same topic, but this was not always the case. Often, when N4 ended a sent message with an ellipsis, the next message was sent by N3. Sometimes, these message-final ellipses replaced what would have been other punctuation marks in standard written English, as in the question, "did you hear that they changed our rotations..", which is marked as a question only by the inversion of the subject and verb, not by punctuation. This use of ellipses is probably just an example of the idiosyncratic ways in which IM users can employ the communicative tools available in CMC.

4.3.3 Contractions

As described in section 3.8.3, standard English contractions, such as "don't," "won't," and "I'll," occurred in the corpus in environments in which they could occur in speech. In some cases, the participants did not use contractions even where it was grammatically possible to do so, which stands in contrast to the perception of IM as a medium in which every possible shortcut is taken.

Even when standard English contractions were used, they were not always punctuated with an apostrophe according to the rules of standard written English. In fact, apostrophes were omitted from standard English contractions more often than not in this corpus. There did not appear to be a rule for when to omit or retain the apostrophe, but it may be worth further investigation to determine whether such a rule exists.

4.3.4 Numerals

As mentioned in section 3.8.4, numerals were most often used instead of words for numbers in the corpus. Participant A1 used words for numbers more than any other participant, using a

numeral only twice among several lexemes that indicated number values. Those numerals, 11 and 20, both had values greater than ten; it is common for style manuals of standard written English to prescribe the use of words to express number values of ten or less. This could be a case of a person with Asperger's extending a prescriptive rule for standard written English to the IM medium, or there could be other factors at play. In another conversation, N4 referred to a block of time as being "six weeks long". This was the only other instance of a number word being used where a numeral could have occurred, and it also expressed a number value of less than ten. It is difficult to determine whether these two participants were employing a prescriptive rule from standard written English, or if these are idiosyncratic uses of number words instead of numerals.

4.3.5 Corrections of Errors

Since IM users have the opportunity to review and edit messages before sending them, one might expect that spelling and typographical errors would be fairly uncommon, and that is the case in this corpus, which was also discussed in section 3.8.5. It is not uncommon for IM users to correct spelling or typographical errors by sending a correction as the next sent message, but the likelihood of correction seems to depend on the nature of the error, the location of the error in the message (whether it is sent message-final or not—those errors that are sent-message final are more often corrected), and how egregious the sender finds the error (which is completely idiosyncratic).

4.3.6 Topic Changes

One common symptom of ASD, described in section 1.1.1, is a difficulty changing the focus of one's attention. This was recognized as a possible detriment to communication in the medium of IM, because IM users tend to switch rapidly between conversation topics and even overlap topics at times. Although some conversation threads in the corpus did overlap, this did not appear to affect the ability of the conversants to continue their communication.

There were also some instances in which topic changes seemed abrupt when reading the transcripts of the conversations, but these may have flowed naturally out of lulls in the conversations. It is difficult to make inferences about the reasons for and the naturalness of topic changes in this corpus, because the participants were directed to conduct conversations of a certain length. In a more natural IM conversation, where the participants have no time constraints and one or both may be multi-tasking, it is not uncommon for conversations to fall into lulls that are many minutes or even hours long, or for conversations to end without an explicit closing.

4.4 LIMITATIONS OF THE CURRENT STUDY

One major flaw in the implementation of the study was the ineffectiveness of the blinding procedures. Despite the efforts to mask participant identity, blinding of the PI during analysis was practically ineffective. This was due in large part to the PI's personal acquaintance with all of the participants, and was compounded by the small sample size. Even without identifiers, context clues made it possible to infer which participants were involved in each conversation.

As with any linguistic research study, the observer's paradox may well have come into play. This paradox posits that no linguistic observation in which the conversants are aware that they are being observed can be truly naturalistic. This may be even more applicable to an IM study, in which participants have the opportunity to edit each sent message as many times as they wish before sending it. It is not known whether or how often any of the participants took this opportunity, or what the effect on the data may have been.

4.5 DIRECTIONS FOR FUTURE RESEARCH

Instant messaging could serve as a useful social communication tool for individuals with Asperger's Syndrome, but the current study has been unable to conclusively identify any significant differences or similarities between the IM communication of people with Asperger's and their neurotypical peers. In order to decisively say that IM would or would not be a beneficial communicative intervention for people with Asperger's, further research is needed.

A larger sample size, inclusive of people from more racial, ethnic, economic, and educational backgrounds, would be extremely helpful towards this end. A sample size of two individuals with Asperger's Syndrome is not sufficient to make any generalizations on the topic. Although the data from the control subjects in this study is particularly effective as pilot data to establish methods for the research, it does little to further an understanding of the communicative strategies of people with Asperger's in this medium.

In order to correct the ineffective blinding practices of this study, a future study could be improved by employing a trained team of judges to analyze the transcripts, who were not familiar with any of the study subjects. Employing more than one rater for analysis would also

make it possible to better measure reliability by testing inter-rater reliability, and could potentially tease out nuances of IM communication that the PI in this study might have overlooked.

A naturalistic study of IM conversations by people with Asperger's, not collected in an experimental setting with imposed conditions, would probably be more valuable as a means for understanding the communicative methods of people with Asperger's. Transcripts of conversations involving partners who were not assigned by an outside party, with no time restrictions, could be collected anonymously and analyzed.

Conversely, it would also be beneficial to control for more of the independent variables that could have played a confounding role in this pilot study. Typing speed could be tested, either as part of participant screening in order to control for differences, or as data to be collected and compared. Participants in different groups could be gender-matched in order to better control for possible gender differences in IM communication. Since participants in this study used their own computers and submitted conversations electronically, it is possible that they had friends, relatives, or housemates involved in their conversations, unbeknownst to the researchers. It might be possible to control for the presence of other people by inviting participants to conduct their conversations in a computer lab while researchers are present, although this would risk compromising the naturalness of the data. Additionally, the variables that were controlled in this study could also be more strictly controlled. All of the participants in this study had experience using email, but they were not asked questions about their past IM use or experience with other forms of CMC. The duration and extent of CMC use, and specifically of IM use, could be controlled in future study. Likewise, the duration of acquaintance between conversation partners was not controlled in this study; nor was the history of IM use for each pair. If some pairs of

participants were more familiar with each other or more accustomed to using IM to communicate with each other, this could have presented unmeasurable differences the data.

Administering interviews or surveys about IM practices would also be useful in order to better understand the behaviors and social factors that surround IM use, such as the prevalence of multi-tasking or whether partners are "real life" acquaintances or online friends. Once the social behaviors surrounding IM use, and the variety of behaviors across individuals in this population, are more fully understood, teachers and health professionals will be better prepared to recommend or discourage IM as a means for social communication.

4.6 CONCLUSION

This study examined a corpus of instant messenger conversations between people with Asperger's Syndrome and their neurotypical peers, as well as between pairs of the neurotypical peers, with the goal of describing the linguistic behaviors and strategies employed by each group. The sample size was small, and no significant differences were found between the two groups. Furthermore, no significant differences were found in the behavior of the neurotypical peers when conversing with each other and when conversing with participants with Asperger's. This suggests that IM may be a useful social communication tool for people with Asperger's to interact with their neurotypical peers, but more research is needed in order to better understand how people with Asperger's view the medium and whether and how they actually use it.

BIBLIOGRAPHY

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

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition, 21*, 37-46.

Baron, N. S. (1998). Letters by phone or speech by other means: the linguistics of email. *Language & Communication, 18*, 133-170.

Baron, N. S. (2004). See you Online: Gender Issues in College Student Use of Instant Messaging. *Journal of Language and Social Psychology, 23*(4).

Baron, N. S. (2005). *Instant Messaging by American College Students: A Case Study in Computer-Mediated Communication*. Paper presented at the American Association for the Advancement of Science Annual Meeting.

Bryant, J. A., Sanders-Jackson, A., & Smallwood, A. M. K. (2006). IMing, Text Messaging, and Adolescent Social Networks. *Journal of Computer-Mediated Communication, 11*(2).

Centers for Disease Control and Prevention (2007, February 9). Autism Spectrum Disorders Overview Retrieved March 24, 2009, from http://www.cdc.gov/ncbddd/autism/overview.htm

Eisenmajer, R., Prior, M., Leekam, S., Wing, L., Gould, J., Welham, M., et al. (1996). Comparison of Clinical Symptoms in Autism and Asperger's Disorder. *Journal of the American Academy of Child & Adolescent Psychology, 35*(11), 1523-1531.

Frith, U., & Happé, F. (1994). Language and communication in autistic disorders. *Phil. Trans. R. Soc. Lond. B, 346*, 97-104.

Garret, R. K., & Danziger, J. N. (2008). IM = Interruption Management? Instant Messaging and Disruption in the Workplace. *Journal of Computer-Mediated Communication, 13*, 23-42.

Goldsmith, T. R., & LeBlanc, L. A. (2004). Use of Technology in Interventions for Children with Autism. [Brief Report]. *Journal of Early and Intensive Behavior Intervention, 1*(2), 166-177.

Grinter, R. E., & Palen, L. (2002). *Instant Messaging in Teen Life*. Paper presented at the Computer Supported Cooperative Work.

Grossman, J. B., Klin, A., Carter, A. S., & Volkmar, F. R. (2000). Verbal Bias in Recognition of Facial Emotions in Children with Asperger Syndrome. *Journal of Child Psychology & Psychiatry, 41*(3), 369-379.

Hancock, J. T. (2004). Verbal Irony Use in Face-to-Face and Computer-Mediated Conversations. *Journal of Language and Social Psychology, 23*(4), 447-463.

Herring, S. C. (2000). Gender Differences in CMC: Findings and Implications. *The CPSR Newsletter, 18*(1).

Herring, S. C. (2001). Computer-Mediated Discourse. In D. Tannen, D. Shiffrin & H. Hamilton (Eds.), *Handbook of Discourse Analysis*. Oxford: Blackwell.

Hollander, E., & Nowinski, C. V. (2003). Core symptoms, related disorders, and course of autism. In E. Hollander (Ed.), *Autism Spectrum Disorders*. New York: Marcel Dekker, Inc.

Hunnicutt, S., & Magnuson, T. (2001). Linguistic structures for email and echat. *Lund University, Dept. of Linguistics, Working Papers, 49*, 66-69.

Kanner, L. (1943). Autistic Disturbances of Affective Contact Retrieved August 6, 2007, from http://www.ama.org/br/kannereng12.htm

Kelley, E., Paul, J. J., Fein, D., & Naigles, L. R. (2006). Residual Language Deficits in Optimal Outcome Children with a History of Autism. *Journal of Autism and Developmental Disorders, 36*, 807-828.

Landa, R. J., & Goldberg, M. C. (2005). Language, Social, and Executive Functions in High Functioning Autism: A Continuum of Performance. *Journal of Autism and Developmental Disorders, 35*(5), 557-573.

Lindner, J. L., & Rosén, L. A. (2006). Decoding of Emotion through Facial Expression, Prosody, and Verbal Content in Children and Adolescents with Asperger's Syndrome. *Journal of Autism and Developmental Disorders, 36*, 769-777.

Mitchell, P., Parsons, S., & Leonard, A. (2007). Using Virtual Environments for Teaching Social Understanding to 6 Adolescents with Autistic Spectrum Disorders. *Journal of Autism and Developmental Disorders, 37*, 589-600.

Moore, D., McGrath, P., & Thorpe, J. (2000). Computer-Aided Learning for People with Autism--a Framework for Research and Development. *Innovations in Education and Training International, 37*(3).

Moore, D., & Taylor, J. (2000). Interactive Multimedia Systems for Students with Autism. *Learning, Media, and Technology, 25*(3), 169-177.

Moore, M., & Calvert, S. (2000). Vocabulary Acquisition for Children with Autism: Teacher or Computer Instruction. *Journal of Autism and Developmental Disorders, 30*(4), 359-362.

Müller, E., & Schuler, A. (2006). Verbal Marking of Affect by Children with Asperger Syndrome and High Functioning Autism during Spontaneous Interactions with Family Members. *Journal of Autism and Developmental Disorders, 36,* 1089-1100.

Nation, K., Clarke, P., Wright, B., & Williams, C. (2006). Patterns of Reading Ability in Children with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders, 36,* 911-919.

Nation, K., & Norbury, C. F. (2005). Why Reading Comprehension Fails: Insights From Developmental Disorders. *Topics in Language Disorders, 25*(1), 21-32.

O'Connor, I. M., & Klein, P. D. (2004). Exploration of Strategies for Facilitating the Reading Comprehension of High-Functioning Students with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders, 34*(2), 115-127.

Owens, R. E. (2008). *Language Development: An Introduction*. Boston: Pearson, Allyn & Bacon.

Parsons, S., & Mitchell, P. (2002). The potential of virtual reality in social skills training for people with autistic spectrum disorders. *Journal of Intellectual Disability Research, 46*(5), 430-443.

Paul, R., Augustyn, A., Klin, A., & Volkmar, F. R. (2005). Perception and Production of Prosody by Speakers with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders, 35*(2), 205-220.

Ponnet, K., Buysse, A., Roeyers, H., & Corte, K. D. (2005). Empathic Accuracy in Adults with a Pervasive Developmental Disorder During an Unstructured Conversation with a Typically Developing Stranger. *Journal of Autism and Developmental Disorders, 35*(5), 585-600.

Prior, M., Eisenmajer, R., Leekam, S., Wing, L., Gould, J., Ong, B., et al. (1998). Are There Subgroups within the Autistic Spectrum? A Cluster Analysis of a Group of Children with Autistic Spectrum Disorders. *Journal of Child Psychology & Psychiatry, 39*(6), 893-902.

Rajendran, G., & Mitchell, P. (2006). Text Chat as a Tool for Referential Questioning in Asperger Syndrome. *Journal of Speech, Language, and Hearing Research, 49*, 102-112.

Rajendran, G., Mitchell, P., & Rickards, H. (2005). How do Individuals with Asperger Syndrome Respond to Nonliteral Language and Inappropriate Requests in Computer-mediated Communication? *Journal of Autism and Developmental Disorders, 35*(4), 429-443.

Robertson, J. M., Tanguay, P. E., L'Ecuyer, S., Sims, A., & Waltrip, C. (1999). Domains of social communication handicap in autism spectrum disorder. *Journal of the American Academy of Child & Adolescent Psychology, 38*(6).

Seltzer, M. M., Krauss, M. W., Shattuck, P. T., Orsmond, G., Swe, A., & Lord, C. (2003). The Symptoms of Autism Spectrum Disorders in Adolescence and Adulthood. *Journal of Autism and Developmental Disorders, 33*(6), 565-581.

Silver, M., & Oakes, P. (2001). Evaluation of a new computer intervention to teach people with autism or Asperger syndrom to recognize and predict emotions in others. *autism, 5*(3), 299-316.

Tanguay, P. E., Robertson, J., & Derrick, A. (1998). A Dimensional Clissification of Autism Spectrum Disorder by Social Communication Domains. *Journal of the American Academy of Child & Adolescent Psychology, 37*(3), 271-277.

Thurlow, C. (2006). From Statistical Panic to Moral Panic: The Metadiscursive Construction and Popular Exaggeration of New Media Language in the Print Media. *Journal of Computer-Mediated Communication, 11*(3).

Valkenburg, P. M., & Peter, J. (2007). Online Communication and Adolescent Well-Being: Testing the Stimulation Versus the Displacement Hypothesis. *Journal of Computer-Mediated Communication, 12*, 1169-1182.

Walther, J. B., & D'Addario, K. P. (2001). The Impacts of Emoticons on Message Interpretation in Computer-Mediated Communication. *Social Science Computer Review, 19*(3), 324-347.

Wing, L., & Gould, J. (1979). Severe Impairments of Social Interaction and Associated Abnormalities in Children: Epidemiology and Classification. *Journal of Autism and Developmental Disorders, 9*(1), 11-29.

Wolf, A. (2000). Emotional Expression Online: Gender Differences in Emoticon Use. *CyberPsychology & Behavior, 3*(5), 827-833.

Zhao, S. (2006). Do Internet Users Have More Social Ties?: A Call for Differentiated Analyses of Internet Use. *Journal of Computer-Mediated Communication, 11*(3).