GENDER DIFFERENCES IN PERFORMANCE MEASURES OF INDIVIDUALS WHO USE AUGMENTATIVE AND ALTERNATIVE COMMUNICATION (AAC)

by

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Language samples from 10 adults using an augmentative and alternative communication (AAC) system were analyzed for gender differences in performance measures. Participants (5 female; 5 male) were matched on device, access method, software, experience, age, and education. Each participant was asked to describe the "cookie theft" picture from the Boston Diagnostic Aphasia Examination (BDAE; Goodglass & Kaplan, 1983). The language samples were analyzed on the following two dependent variables: frequency of Semantic Compaction™ language representation use and average communication rate. A dependent samples t-test and the equivalent non-parametric matched-pair Wilcoxon tests were conduced on both variables. The effect size and the power were also calculated and used to support the following results.

There was not a significant difference in the Semantic Compaction™ dependent variable, however there was a large effect size (d=1.11). A power analysis indicated a sample size consisting of 9 pairs (4 more males and 4 more females) would increase the power to 82%. Further research with an increased sample size of 9 pairs of participants may provide more support for the current finding in relation to the use of Semantic Compaction™.

No significant difference was found between the average communication rates of the genders; however the presence of a female outlier was concluded to influence these results. A dependent samples t-test was conducted on the data excluding the pair containing the outlier.

The results of the dependent samples t-test indicated a significant difference between the genders in the average communication rates.

Overall, for both dependent variables, the majority of males were higher on the performance measures than their paired female participants. These observations support a need for future research addressing gender differences in individuals who use AAC. Clinical implications suggest that future research is needed to determine if intervention strategies need to accommodate for differences between genders in their ability to effectively use their device to communicate as fast as they are able. Caution needs to be used when interpreting and applying these results to this population due to the limitations (i.e., small sample size and lack of control of extraneous variable) of the current study.

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PREFACE

The author would like to acknowledge the support of the thesis advisor Katya Hill Ph.D., CCC-SLP and of the additional committee members, Susan Shaiman Ph.D., CCC-SLP and Ellen Cohn Ph.D., CCC-SLP, in the completion of the current document. The author would also like to acknowledge the support of Elaine Rubinstein in the statistical analyses used in the current study.

1.0 INTRODUCTION

The difference between males and females has been a popular topic of research. A significant amount of research addressing gender differences relates to the communication styles of normal speakers. Researchers have previously thought verbal ability favors females beginning in the preschool years when language abilities start to emerge (Hyde & Linn, 1988). Female superiority can further be supported by the higher risk factor for males having language problems as compared to females (Weindrich, Jennen-Steinmetz, Laucht, Esser, & Schmidt, 1998; Hyde & Linn, 1988). However, Hyde and Linn (1988) did a meta-analysis addressing female superiority in verbal ability as compared to males. Hyde and Linn (1988) reviewed 165 articles with the majority of studies supporting no gender difference in verbal ability. The only exception Hyde and Linn's (1988) study found was the males did exceed the females in total talking time. A lack of gender difference in verbal ability, however, does not mean gender differences do not exist in other areas of language.

Research on gender communication styles tends to address stereotypic differences between men and women. Findings describe men as expressing higher dynamism, and women as expressing higher aesthetic quality and socio-intellectual status (Mulac, Incontro, & James, 1985). Although more limited, research findings also show gender differences in characteristics such as lexical richness (also known as semantic diversity) and mean length of utterances (MLU) in conversational speech samples (Golinkoff & Ames, 1979; Singh, 2001). Even less research is dedicated to gender differences in relation to performance measures of individuals who cannot use their natural voice to speak, but must instead communicate through the use of high technology voice output systems, also known as augmentative and alternative communication (AAC). AAC involves the use of an alternative modality, such as writing or the use of symbols, to supplement and/or replace an individual's natural speech (Beukelman & Mirenda, 2005; Lloyd, Fuller, & Arvidson, 1997). The use of high technology devices is one form of AAC that individuals can use to supplement and/or replace an individual's natural speech. Due to the disparity of research in the area of AAC, the current study investigated a possible gender difference in the performance measures of individuals who use aided high technology AAC.

1.1 RESEARCH IN AAC LITERATURE

The previously discussed research related to normal speakers and presented an overview of the gender differences that may exist. Several variables could influence or contribute to gender differences, i.e., the career choices of participants, introversion/extroversion characteristics of the participants, etc. Individuals who use AAC technology, however, do not communicate in the same way as oral speakers. The difference in the mode of communication could result in different characteristics of the language samples of individuals who use AAC as compared to normal speakers. Individuals who use AAC also can vary in achieved performance. Performance can be assessed by analyzing specific summary measurements based on a language sample, which describes how efficiently an individual is able to use his or her AAC device.

Research is lacking that addresses a gender difference in performance measures of individuals who use AAC to communicate. Due to the lack of research, predictions for individuals who use AAC can be based on only research conducted on normal speakers. The best hypothesis is the gender differences indicated in research on normal speakers, such as differences in stereotypes, mean length of utterances, and lexical richness, will be similar for individuals who use AAC. No research, however, is available to help predict if there will be a gender difference in the performance measures relating to effective device use of individuals who use AAC. In order to investigate a potential gender difference in performance measures of individuals who use AAC, it is important first to discuss the process that a language sample is collected and analyzed from an individual's AAC device.

1.2 LANGUAGE SAMPLE COLLECTION AND ANALYSIS

1.2.1 Methods for collecting language samples

Several different methods can be used to collect a language sample for analysis such as having the individual take part in a conversation or an interview with a clinician or a friend; or by having the individual describe a picture. Doyle et al. (2000) and Paul (2001) are two of many resources that address different methods of collecting language samples as mentioned above. These references discuss how different methods can produce different language sample characteristics. Neither of these references addresses individuals who use AAC; however Paul (2001) suggests that conversational samples may be an appropriate method of collecting a language sample. In reference to the current study, using conversation to look at gender differences could be more difficult to control due to various extraneous factors such as the gender of the conversation partner and the topic(s) discussed. If a conversation or interview was used to collect a language sample, a communication partner would have to be introduced into the language sample process, which could have an influence on the language sample produced. Mulac, Wiemann, Widenmann, and Gibson, (1988) conducted a study looking at gender differences of normal speakers in conversations between same-sex and mixed-sex dyads and found these conversations to be different depending on the genders paired. For these reasons, a language sample conducted from a picture description task may help control for the performance differences in conversation partners and in conversation topics when looking at differences between genders in language samples. During a picture description task there is no communication partner used and the topic is focused on the picture presented. The result is a continuous, spontaneous narrative representative of an individual's performance. The Hill (2001) study used a picture description task to collect language samples illustrating the effectiveness of this stimulus with the AAC population.

One such picture stimuli often used is the "cookie theft" picture from the Boston Diagnostic Aphasia Examination (BDAE; Goodglass & Kaplan, 1972). When the BDAE is administered according to the procedure outlined in the manual, the participant is presented with the "cookie theft" picture and told the following directions by the examiner: "Tell me everything you see going on in this picture" (Goodglass & Kaplan, 1972). The examiner then records a verbatim transcript of the language sample produced by the participant. Yorkston and Beukelmen (1980) have described the "cookie theft" picture stimulus as producing predictable speech with enough activity going on in the picture to allow a normal speaker to produce a 30 to 45 second language sample describing the scene portrayed in the picture.

Yorkston and Beukelmen (1980) used the "cookie theft" picture stimulus in a study addressing connected speech samples of aphasic and normal speakers. When looking at samples taken from the normal speakers, the adults produced a mean of 202.9 syllables during the sample (with a standard deviation of 40.2). In addition to the number of syllables produced during the sample, the authors also looked at the number of content units (groupings of information that are always expressed as a unit) expressed during the sample. For the normal speakers, the adults produced a mean of 18 content units (standard deviation of 4.7) and a mean of 41.9 content units per minute (standard deviation of 13.2). The "content units per minute" were used as a measurement of the efficiency of the speaker's communication rate. One might predict that individuals who use AAC may have similar outcomes when describing the "cookie theft" picture as the normal speakers in Yorkston and Beukelmen's (1980) study. Hill's (2001) study in an example of a study that used the "cookie theft" picture as a stimulus to collect language samples of individuals who use AAC in order to analyze performance measures.

1.2.2 Recording and analysis of language samples in AAC

Traditional methods for collecting language samples for individuals who use AAC involve collecting the language samples in a similar manner to how a language sample would be collected for a normal speaker. The clinician observes the client, audio or video records the client in a communicative situation, and then the clinician transcribes the sample and records the timing for how long it takes to produce the responses by hand. When the transcript is complete, the clinician performs the appropriate analyses on the data collected as described in Romich and Hill (1999, 2000). Recording a language sample by hand can be a time-consuming process and it is difficult to determine with precision the time it takes to produce a specific language event or utterance which is used in some performance measures. Therefore new software (language activity monitoring software) has been developed to help with gathering a language sample from an individual who uses AAC in a more efficient manner (Romich & Hill, 1999, 2000; Lesher, Rinkus, Moulton, & Higginbotham, 2000).

Individuals who use AAC technology have three possible methods available on systems to represent and generate language along with how vocabulary or features may be stored and located on the system. These three methods to access stored vocabulary and morphology are termed AAC language representation methods (LRM) and include Semantic Compaction™, single meaning pictures, and alphabetic-based methods (Hill & Romich, 2002). The alphabet-based method includes orthographic word selection, word prediction, and spelling (see section 1.4 for further discussion of LRM).

Language activity monitoring (LAM) software is currently available on several modern AAC devices. When an individual who uses AAC technology produces an utterance, each event is recorded automatically along with the time of the event. The language representation method (LRM) used to select the event is indicated as a three-letter mnemonic. The LAM software records the LRM used to produce a language event in a language sample by indicating a three letter code (i.e., SEM for Semantic Compaction™, SPE for spelling, WPD for word prediction, SMP for single meaning pictures, etc.) before the language event. The time of the production of the event is also recorded using a 24-hour time format (Romich & Hill, 1999, 2000). An example of utterance logfile recorded by LAM look as follows:

10:46:18 SEM "Her"
10:46:23 SPE "f"
10:46:25 SPE "i"
10:46: 28 WPD "first"
10:46:32 SEM "name"
10:46: 36 SEM "is"
10:46:39 SPE "e"
10:46:41 SPE "v"
10:46: 45 SPE "e"

The example logfile above shows the production of the utterance "Her first name is Eve." The words "her," "name," and "is" were all produced using Semantic Compaction™ (SEM); "first" is produced using word prediction (WPD); and "Eve" was produced by spelling out the word (SPE). Each language event has a time associated with the event; for example the word "her" was produced at: 10:46:18. The rest of the language sample would be recorded in the same matter and a transcript of the language sample can be produced.

A language sample also can be collected when the built-in LAM feature is not available in a particular device, as is the case with some older devices. If the device does not have a built-in LAM, a logfile may be captured using universal language activity monitoring (U-LAM) software (Romich & Hill, 1999, 2000). With U-LAM, the AAC device is connected to the computer allowing the U-LAM software to function like a built-in LAM to record a logfile.

A LAM or U-LAM logfile of a language sample is used to generate a language transcript for analysis. Once the logfile is saved to the computer, the logfile can be analyzed using Performance Report Tool (PeRT; Hill & Romich, 2003) software. PeRT software creates an "AAC Performance Report" based on a language sample collected by the LAM or U-LAM software. To create an "AAC Performance Report" the logfile is segmented into utterances. The LRM mnemonic may need to be confirmed by the transcriber. Once the transcription process is complete, the researcher/clinician checks for accuracy and selects to create a report. PeRT automatically calculates seventeen quantitative measures and formats the results into a two-page report (Hill & Romich, 2003). The seventeen quantitative measures describe the communication performance of the individual using the AAC device.

Any of the quantitative measures reported by PeRT might be selected to investigate potential gender differences in individuals who use AAC. In addition to these quantitative performance measures, there are also other variables that could be addressed when looking at gender differences. For example, a pilot study done by Singh (2001) looked at gender differences in lexical richness measures and found males' conversational samples to be more lexically rich than the females' language samples.

Lexical richness, also called lexical diversity, is a measure used to analyze the semantic diversity, as well as the total verbal output, of the vocabulary used by a speaker in a language sample (Paul, 2001). In Singh's (2001) study, the following methods were used to assess the lexical richness of language samples: noun-rate per 100 words; pronoun-rate per 100 words; adjective-rate per 100 words; verb-rate per 100 words; type-token ratio; clause-like semantic units (CSU) per 100 words; Brunet's Index; and Honoré Statistic. The CSU is similar to the mean length of utterances (MLU) used in the PeRT report. The type-token ratio is similar to another lexical richness measurement reported in PeRT looking at the total number of words (TNW) and the total number of different words (TDW) used in a language sample. Type-token ratio, along with TNW and TDW, are ratios that look at the total vocabulary as compared to the overall length of the language sample. The last two methods used to assess lexical richness in Singh's (2001) study are calculated using a formula. Brunet's Index (Brunet, 1978; as cited in Singh, 2001) is calculated by entering the language sample's length (N) and the total vocabulary (V) into the following formula: N^V-0.165 with the lowest score having a more lexically rich language sample. Honoré Statistic (Honoré, 1979; as cited in Singh, 2001) is calculated by using the following formula: 100 x log (N) / [1- (V1 / V)]. In the formula, the N and V are the same as in the Brunet's Index and V1 is the number of words in the language sample that were only used once. For Honoré Statistic, the higher score indicates a more lexically rich language sample.

In addition to the above discussed variables related to performance measures of individuals who use AAC and lexical diversity, language samples also can be looked at in more subjective ways, such as looking at the topic choices discussed. Gender stereotypes, such as dynamism, aesthetic quality, and socio-intellectual status, can also be assessed (Mulac, Incontro, & James, 1985). The table below outlines some examples of different dependent variables that could be collected from language samples and compared between males and females:

Table 1. Possible Dependent Variables for Comparing Gender Differences

PeRt Performance Measures	Lexical Richness Measures	Other Possible Variables
Total and/or complete utterances	Brunet's Index (Brunet, 1978; as cited in Singh, 2001)	Gender stereotypes
MLU in words or morphemes	Honoré Statistic (Honoré, 1979; as cited in Singh, 2001)	Characteristics of dynamism
Peak or average communication rates	Type-token ratio or TNW/TDW	Characteristics of aesthetic quality
Use of LRM (Semantic Compaction™, etc.)	Noun-rate per 100 words	Characteristics of socio-intellectual status
Core Vocabulary Use (%)	Pronoun- rate per 100 words	Use of interjections
Selection Rate/Rate Index	Adjective-rate per 100 words	Word choices
TNW & TDW	Verb- rate per 100 words	Topics discussed
Amount of errors made	CSU or MLU	

Due to the lack of research in gender differences of individuals who use AAC, there is no prior research to support a gender difference in any of the above dependent variables for this population. The conclusion can be made in relation to individuals who use AAC in relation to the variable discussed above; only conclusions about normal speakers can be made. There is no research to support a hypothesis in relation to gender differences on the performance measures calculated by PeRT, with the exception of the measures that overlap with lexical richness. The performance measures can also be calculated by PeRT software and would not be subjected to human error during the calculations as the other variables would. Based on these two conditions, the dependent variables for the current study were narrowed to the performance measures reported using PeRT.

Of the remaining dependent variables, the frequency of Semantic Compaction™ use and the average communication rate were selected. These variables are two important performance measures to an individual who uses AAC because they influence and support achieving the most effective and efficient communication possible. No prior research exists to indicate that one gender would differ from the other on these variables. However, if a difference is present then it would be important for future research to investigate the reasons for a discrepancy. The significance of these two dependent variables is further addressed below.

1.3 COMMUNICATION RATE

One performance measure of importance to an individual who uses AAC is the average communication rate and is measured in words per minute (wpm). The average communication rate is calculated by taking the time the utterance begins, subtracting this number from the time the utterance is completed, and dividing this time difference into the number of words between the start and end times (Hill & Romich, 2002). The number obtained following the calculation indicates the communication rate for the utterance. For a language sample, the average of all the communication rates for the utterances can be computed to obtain an "average communication rate" for the sample.

Beukelman and Mirenda (2005) reference the average communication rate for normal speakers is between 150-250 words per minute and the estimated average communication rate for individuals who use AAC is less than 15 words per minute. The average communication rate of 20 individuals who were considered competent communicators using AAC was 10.3 words per minute (Hill, 2001). The difference between normal speakers and individuals who use AAC is large, which can have an impact on the individuals who use AAC. Beukelman and Yorkston (1982), Koester and Levine (1996), and Venkatagiri (1993, 1994) have stressed the importance of considering the communication rate of an individual who uses AAC and the studies indicate a slower communication rate can have an impact on social interaction for individuals who use AAC.

No research has addressed a difference in the communication rates of males as compared to females using AAC technology. Due to a lack of research in the area of gender differences in communication rates, neither gender can be predicted to outperform the other. However, predictions can be made on the frequency of the communication rate based on individual factors found to affect the communication rate of individuals who use AAC. Several factors can affect the average communication rate of an individual using an AAC device including: the amount of experience the individual has with using an AAC device; the number of errors and self-corrections made when producing an utterance; the individual's speed at selecting an icon or button which could be negatively affected by a physical disability (bits per second); the mode of selection used by the individual; and the language representation methods (LRM) predominantly used by the individual (Hill & Romich, 2002).

1.3.1 Access methods and selection techniques

One factor affecting the average communication rate of an individual who uses AAC is the rate of selecting keys, or the method of selection, used by the individual. Three different selection techniques exist to make a selection on an AAC device. The three access methods include: direct selection, scanning, and coding (i.e., Morse etc.; Beukelman & Mirenda, 2005; Lloyd, Fuller, & Arvidson, 1997; Hill & Romich, 2002). For the current study, all of the participants used direct keyboard selection. Direct selection is often faster because it requires the individual to simply point to make a selection using a keyboard or a touch screen display (Beukelman & Mirenda, 2005; Lloyd, Fuller, & Arvidson, 1997; Hill & Romich, 2002). Several access approaches exist that can be used to direct select including using a keyboard with one's finger, using a headstick or mouthstick, using an optical headpointer, or any other external aid that can be efficiently used by the individual. Individuals who rely on AAC choose and prefer an access method that optimizes their performance (allows the individual to communicate at the fastest rate possible.

The selection technique and the individual's proficiency in using it are factors that determine the selection rate. Selection rate shows how fast an individual is able to make selections and the commonly used unit of measure is bits per second (Hill & Romich, 2002). One factor influencing selection rate is the nature of the associated cognitive task. In AAC system use, this is generally determined by the language representation method being used. Some methods permit automaticity and others do not. Automaticity generally produced higher selection rates. There are other variables besides the language component to consider when interpreting an individual's selection rate that could result in fluctuations in the selection rate (Hill & Romich, 2002). Some examples include the time of day, fatigue, and the individual's current medication.

1.4 LANGUAGE REPRESENTATION METHODS

In addition to the different selection techniques and the selection rate, the different ways to produce a desired response using an AAC device can also affect one's average communication rate. To review, the methods for producing a desired response are known as language representation methods (LRM) and consist of the following: Semantic Compaction™, single meaning pictures, and alphabet-based methods such as orthographic word selection, word prediction, and spelling (Beukelman & Mirenda, 2005; Lloyd, Fuller, & Arvidson, 1997; Hill & Romich, 2002). Baker (1986) described Semantic Compaction™ as using short sequences of symbols to represent words or phrases that follow specific rules to indicate morphology and enhance vocabulary organization. The LRM method termed "single meaning pictures" uses pictures to represent a single word; and the LRM termed "orthographic word selection" uses whole printed words, usually grouped in grammatical categories, to access a desired word (Beukelman & Mirenda, 2005; Lloyd, Fuller, & Arvidson, 1997; Hill & Romich, 2002).

The spelling LRM uses a keyboard or alphabet board to spell out the word(s) desired (Beukelman & Mirenda, 2005; Lloyd, Fuller, & Arvidson, 1997; Hill & Romich, 2002). Due to the time and the number of keystrokes required to spell out a response, the word prediction LRM may be used. Word prediction allows the speaker to begin to type a response and the word prediction feature predicts choices for the next letter or word in the response resulting in the speaker using less keystrokes to create an utterance (Beukelman & Mirenda, 2005; Lloyd, Fuller, & Arvidson, 1997; Hill & Romich, 2002). The different LRMs provide the individual with access to the individual's core and extended vocabulary. An individual's core vocabulary represents 85-95% of what the individual says, and the individual's extended vocabulary representing the other 5-15% of what the individual says (Hill & Romich, 2002).

Some research states using icons is a faster mode of communication for individuals who use AAC as compared to alphabet spelling (Venkatagiri, 1995). Research also states word prediction may not increase the rate of communication for some individuals who use AAC (Venkatagiri, 1993, 1995; Horstmann & Levine, 1990). Overall, however, Semantic Compaction™ has been argued to exceed the other LRM in allowing access to an individual's core vocabulary (Burger, 1997 as cited in Hill & Romich, 2002; Hill, 2001). The individual using an AAC device who has the ability to use any LRM will most likely use a combination of the LRMs when communicating (Hill & Romich, 2002). However, an individual who uses their Semantic Compaction™ mode more frequently will have a more efficient use of core vocabulary and will optimize their communication. The reason Semantic Compaction™ is able to optimize communication is because it reduces the number of key strokes required to complete an utterance (Hill & Romich, 2002). The key stroke reduction, therefore, results in faster communication. During the production of a language sample, individuals who use their AAC device effectively produce about 97% of the words in a language sample using the Semantic Compaction™ LRM (Hill, 2001). The remainder of the language sample is typically produced using spelling (about 7%) and word prediction (about 2%; Hill, 2001). The research addressing the LRM of individuals who use AAC does not address a possible gender difference in the mode of communication used by an individual who uses AAC. Despite a lack of research, based on the above studies, the individual using AAC who has the ability to use all the LRMs, regardless of gender, can be predicted to use the Semantic Compaction™ LRM more often as compared to the other LRMs.

To determine how frequently an individual uses their Semantic Compaction™ LRM during a language sample, all of the words produced using Semantic Compaction™ can be summed. This total can then be divided by the total number of words in the language sample and multiplied by 100 to acquire the frequency of each LRM (Hill & Romich, 2002). For example, if 45 words in a 50 word language sample were produced using Semantic Compaction™, then the frequency of Semantic Compaction™ use for that sample was 90% (calculation: 45/50 x 100).

An area that has yet to be investigated is whether one gender uses Semantic Compaction™ with a higher frequency than the other gender. Since a main purpose of using Semantic Compaction™ is to access core vocabulary, the frequency of Semantic Compaction™ use would be an important measure to ensure both genders are using this LRM optimally to reduce keystrokes for words with a high frequency of occurrence.

1.4.1 The Current Study

Literature addressing language samples of individuals who use natural speech to communicate indicate a gender difference based on socialization processes and gender stereotypes may be present, but the research is inconsistent. There is no research, however, in the AAC literature addressing gender differences in the performance measures of individuals who use an AAC device. Due to this disparity in research, the current study will be a pilot study addressing gender differences in two performance measures of individuals who use AAC. The two performance measures of interest in the current pilot study are: the frequency of Semantic Compaction™ LRM use and the average communication rate of individuals who use AAC. These are two performance measures, as described above, that are important to individuals who use AAC and would give good insight into the individual's ability to effectively use their AAC device.

The research questions for the current study are as follows: 1) Is there a significant difference in the frequency of Semantic Compaction™ language representation method use in language samples collected during a picture description task between males and females who use AAC to communicate? The null hypothesis for this research question is as follows: There will not be a significant difference in the frequency of Semantic Compaction™ language representation method used in language samples collected during a picture description task between males and females who use AAC to communicate. 2) Is there a significant difference in the average communication rate obtained during language samples collected using a picture description task between males and females who use AAC to communicate? The null hypothesis for this research question is as follows: There will not be a significant difference in the average communication rate obtained during language samples collected using a picture description task between males and females who use AAC to communicate.

In summary:

1) Is there a significant difference in the frequency of Semantic Compaction™ language representation method use in language samples collected during a picture description task between males and females who use AAC to communicate?
2) Is there a significant difference in the average communication rate obtained during language samples collected using a picture description task between males and females who use AAC to communicate?

2.0 METHODS

The current study analyzed language samples that were originally collected and outlined in the Hill (2001) study. Data were collected under University of Pittsburgh Instructional Review Board (IRB) approval to Dr. Katya Hill. The procedures and tools used to collect the log file data for the language samples used in the current study were developed and reported in the Romich and Hill (2000) and Hill (2001) studies.

2.1 PARTICIPANTS

The participants used in the current study were selected from the pool of twenty participants described in the Hill (2001) study. Participants identified from the original study were screened to determine the number of female participants available to use in the current study. An equal number of male participants were then selected to create two equal groups of participants based on gender. The Hill (2001) study only included five female participants resulting in the current study using ten participants (5 male and 5 female) who use AAC. The participants' ages ranged from 21 years to 48 years old with a mean age of 27 years for the females and 30.4 years for the males. All of the female participants were Euro-American (n=5), and 3 of the male participants were Euro-American and 2 were African-American. All of the participants used a wheelchair. Three of the female participants lived with their parents, while the rest of the participants lived independently. The participants' level of education ranged from high school to a master of arts and all but two of the participants were employed. Table 1 displays the background characteristics of the paired participants and their devices:

Table 2. Description of Participants

	Participants									
	Pair 1	Pair 1	Pair 2	Pair 2	Pair 3	Pair 3	Pair 4	Pair 4	Pair 5	Pair 5
Gender	F	M	F	M	F	M	F	M	F	M
Age	22	21	21	30	30	23	30	30	32	48
Device	Pathfinder	Pathfinder	Liberator	Liberator	Pathfinder	Pathfinder	Liberator	Liberator	Delta Talker	Liberator
Language Software Program	Unity	Unity	Word-Strategy	Word-Strategy	Unity	Unity	Word-Strategy	Word-Strategy	Unity	Word-Strategy
Access Method	Unassist Direct	Unassist Direct	Optical Headpoint	Mouth-stick	Unassist Direct	Unassist Direct	Unassist Direct	Optical Headpoint	Optical Headpoint	Headstick
Experience w/lang. program	3 weeks	3 weeks	9 year	8 years	2 months	3 months	8 years	7 years	4 years	8 years
Ethnic Background	Euro-American	African American	Euro-American	African American	Euro-American	Euro-American	Euro-American	Euro-American	Euro-American	Euro-American
Wheel chair	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Living Situation	Parents	Independent	Parents	Independent	Independent	Independent	Independent	Independent	Parents	Independent
Education	In College	In College	In College	M.A.	H.S.	Some college	Some college	B.S.	B.S.	Some college
Employed	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The female participants were matched with male participants that had similar backgrounds (age, ethnic background, use of a wheelchair, living situation, education, and/or employment), about the same amount of experience with their device, used the same devices, and who used the same or similar language application software programs on their devices. Only Pair 5 had a difference in their device and language application software programs. The devices and software programs used by these two participants, however, were similar and would not create a difference in the performance measures assessed in the current study. All of the participants used direct selection to access a high technology voice output static or hybrid display device with 128 locations displaying the same icons with a Language Application Program (MAP) that supported the three AAC language representation methods (LRMs). Individuals with a hybrid display had access to a touch screen activity row. All participants also used direct selection as the access method consisting of the following techniques: unassisted access, mouthstick, and optical headpointing techniques. All participants used a direct selection method that optimized their performance and allowed them to communicate at the fastest rate possible based on individualized characteristics. The amount of experience with the language program ranged from 3 weeks to 9 years.

2.2 INSTRUMENTATION/STIMULUS MATERIAL

The language samples used in the current study were previously collected in the Hill (2001) study. The specific data collection procedures for the language sample collection are available in more detail in the Romich and Hill (2000) and Hill (2001) studies. In the Hill (2001) study each participant was asked to describe the "cookie theft" picture from the Boston Diagnostic Aphasia Examination (BDAE) in accordance with the administration directions for the task given in the test manual using their AAC device (Goodglass & Kaplan, 1972).

Traditional and datalogging techniques were used to collect performance data for the study. The AAC device was connected to a computer and U-LAM (Universal Language Activity Monitor) software was used to generate a logfile of language events produced on the device. A video recorder was used to collect a visual record of the procedure (Romich & Hill, 1999, 2000). As described in the Introduction, the U-LAM allows the computer to record the language event and the time stamp for the event. The logfile was manually analyzed in the Hill (2001) study. Systematic Analysis of Language Transcripts (SALT; Miller & Chapman, 1993) was used to manually segment the utterances, to generate the transcripts, and to analyze/report the findings in the Hill (2001) study. For the current study, the researchers who originally collected the language samples used PeRT features to identify the specific LRM for each event, segmented the utterances to generate a transcript, and PeRT was used to automatically calculate the results (Romich & Hill, 1999, 2000). The current study used the two dependent variables automatically calculated in the PeRT report of the results.

Hill (2001) established interrater reliability by having two raters calculate their percentage of agreements and disagreements of 30% of the samples for word-by-word agreement and utterance segmentation. The reported interrater reliability for word-by-word agreement was 100% and the utterance segmentation was 93%. The U- LAM data and the videotape data for 20% of the samples were analyzed for inter-judge reliability using three (3) judges. For inter-judge reliability, 95% agreement was obtained for the word-by-word agreement and 96% agreement was obtained for the utterance segmentation. Interrater reliability for PeRT replicated the original procedures for 50% of the samples and resulted in 100% for word-by-word agreement and 100% for utterance segmentation agreement.

2.3 QUANTITATIVE DATA ANALYSIS FOR THE DEPENDENT VARIABLES

The quantitative data analysis replicated the measures reported in Hill (2001), but used PeRT 1.0 (Performance Report Tool; Hill & Romich, 2003) software analysis tool to obtain specific performance data instead of The Systematic Analysis of Language Transcripts (SALT; Miller & Chapman, 1993) software, which was used to analyze the original language samples in the Hill (2001) study. The dependent variables calculated using PeRT include: the frequency of Semantic Compaction™ LRM used during the language sample and the average communication rate of the participants. The performance measures were limited to two dependent variables to decrease the change of making a Type I error when adding more variables. The selection rate and the rate index could not be calculated for two of the language samples due to limitations of the language samples, resulting in the use of the average communication rate as a dependent variable.

In the current study, PeRT software was used to calculate the frequency of Semantic Compaction™ using a similar procedure as discussed in the Introduction. One of the quantitative measures PeRT software reports is titled "method of generating words (%)" and this measurement provides the frequency of use of the LRMs used in a sample. The frequency of Semantic Compaction™ use is calculated based on the total number of words produced using Semantic Compaction™ divided by the total number of words in the language sample and multiplied by 100 to acquire the frequency of each LRM (Hill & Romich, 2002). PeRT calculated the average communication rate by first calculating the communication rates of all the utterances. The start time, minus the first language event, is subtracted from the time the utterance was completed, and then the time difference is divided into the total number of words between the start and the end times (Hill & Romich, 2002). The communication rates for all the utterances were totaled and divided by the total number of utterances in the language sample resulting in the average communication rate for the participant. PeRT software automatically eliminates the first event and weights the utterances by the number of words to calculate a precise rate (Hill & Romich, 2002).

Inferential statistical testing was used to compare the mean of the five males to the mean of the five females on the different dependent variables. Due to the lack of research addressing gender differences in individuals who use AAC, a prediction of which gender would outperform the other could not be made. Therefore, two-tailed statistical testing was conducted. Cohen (1988) suggested that a significant difference found in a two-tailed statistical test would be stricter versus a one-tailed test and would therefore have more significance.

2.3.1 Alpha level for statistical testing

The alpha level for the statistical tests used to compare the dependent variables was set at 0.10 to determine significance. The larger alpha level of 0.10 was determined for the following reasons: First, the current study is a pilot study or exploratory research so one purpose of the study is to determine if more research is even needed in the area. When doing a pilot study it is appropriate to set your significance level to support what you are looking for in your results (Cozby, 2004). The current study attempts to determine whether a difference exists to support further research in gender differences in the AAC population. A decision needs to be made about which type of error, a Type I or Type II error, would be more substantial (Cozby, 2004; Cohen, 1988; Gay, Mills, & Airasian, 2006). A larger alpha level can be used to help control for a Type II error of accepting the null hypothesis when it is false and this will decrease the chance of missing a possible difference between the genders that could be further researched (Cohen, 1988; Gay, Mills, & Airasian, 2006). However, the larger alpha would increase the risk of a Type I error or rejecting the null hypothesis when it is true and could lead to an incorrect conclusion that there was a difference between the genders (Cohen, 1988; Gay, Mills, & Airasian, 2006).

Gay, Mills, and Airasian (2006) suggested setting an alpha as high as .10 because the goal in exploratory research is not to miss a potential difference. A high alpha, however, would increase the risk of making a Type I error. The current study also has two dependent variables calculated from the same language samples, which would further increase the chances of making a Type I error. In order to control for this increased risk of a Type I error being made secondary to more than one variable being compared on the same data, the Bonferroni correction was applied in the current study. The Bonferroni correction helps to control for these two comparisons being made on the same data by dividing the alpha in half for each variable (Schiavetti & Metz, 2006). One negative aspect of the Bonferroni correction is that it reduced the power; however the larger alpha was also used to help increase the power of the statistical analysis (Schiavetti & Metz, 2006). Therefore, in the current study an alpha level of .10 was originally set and a Bonferroni correction was applied resulting in a final alpha of .05 for all statistical tests.

2.3.2 Inferential testing of dependent variables

In order for parametric statistical tests to be conducted, the data has to represent a normal distribution that replicates the actual distribution in the population. If the data collected does not mirror a normal distribution in a population, than a nonparametric statistical test is conducted (Schiavetti & Metz, 2006). One disadvantage of a nonparametric statistical test is that if the data does meet the requirements of a parametric test and does resemble the normal distribution in the population, then the nonparametric test will not be accurate and the power-efficiency will be reduced (Siegel, 1956).

The average frequencies of Semantic Compaction™ use were all higher frequencies (above 50%) which could support the data not resembling a normal distribution because all of the data falls on the higher end of a bell-shaped curve. If the data were different than a normal distribution, this would argue for the use of a nonparametric statistical test (Schiavetti & Metz, 2006). However, due to the small sample size in the current study, it is difficult to make conclusions about the distribution of the data. If both parametric and nonparametric tests were conducted and if both tests came out with the same result, then the results would provide stronger support for conclusions made based on the limited sample size. In summary, the possibility of the limited data not meeting requirements of a parametric test would support the use of a nonparametric test. The opposing rational is the possibility that the data does support the parametric test analysis, which would limit the effectiveness of the results of a nonparametric test. Conducting both tests and finding the same results would provide significant support for the conclusions made with a limited sample size. Also, by conducting both tests, the effect size could be determined using the parametric test results which would be more meaningful. Therefore, both the parametric and the nonparametric tests were run on the frequency of Semantic Compaction™ dependent variable. Both nonparametric and parametric statistical tests were conducted for the second dependent variable addressed in the current study, the average communication rate, as well. Conducting both tests and finding the same results would provide significant support for the conclusions made with a limited sample size, as discussed above in relation to the Semantic Compaction™ dependent variable.

The male and female participants were paired based on significant factors supporting the use of a matched-pair or dependent samples t-test being conduced versus an independent sample t-test (Schiavetti & Metz, 2006). The equivalent nonparametric test is the nonparametric matched-pair Wilcoxon test (Schiavetti & Metz, 2006; Siegel, 1956). For both the dependent samples t-test and the Wilcoxon test, the p-value of 0.05 (original alpha of .10 with Bonferroni correction applied) was used to determine significance. These two tests were used for both of the dependent variables.

The *Publication Manual of the American Psychological Association* (2001) suggests authors should report the effect size and the results of a power analysis in the results of a study. These measurements will help the readers to better interpret the results of the study being discussed. The effect size and the power analysis for both the dependent variables were calculated using the mean difference of the means and the standard deviation from the parametric test results.

The effect size indicates the strength or the magnitude of the association (the extent to which the changes in the dependent variable are the result of changes in the independent variable) that can be made between the variables and is also reported on a consistent scale that allows comparison between different studies (Cozby, 2004; Schiavetti & Metz, 2006). For the current study a Cohen's d was calculated by dividing the mean difference of the means by the standard deviation and multiplying this number by the square root of 2 (Cohen, 1988). The effect size is then interpreted respectively: a small effect size is demonstrated by a d=.2; a medium effect size is demonstrated by d=.5; and a large effect size is demonstrated by d=.8 (Cohen, 1988). In summary, a large effect size of d=.8 would indicate the independent variable had a large effect on the dependent variable.

A power analysis was also conducted on the Semantic Compaction™ variable. The purpose of conducting a power analysis is to determine the number of participants that are needed to reach a desired alpha level and would help control for making a Type II error (Schiavetti & Metz, 2006; Siegel, 1956). The formula used to calculate the power for the current study was as follows: Power = 1 - β (beta or Type II error; Cozby, 2004; Schiavetti & Metz, 2006).

3.0 RESULTS

The data collected for the dependent variables were continuous and calculated using PeRT 1.0 software analysis tool (Performance Report Tool; Hill & Romich, 2003). The dependent variables were the frequency of Semantic Compaction™ use and the average communication rate of the participants. Both a dependent samples t-test and the equivalent non-parametric matched-pair Wilcoxon test were used to test the following hypothesizes: 1) There will be a significant difference in the frequency of Semantic Compaction™ language representation method used in language samples collected during a picture description task between males and females who use AAC to communicate. 2) There will be a significant difference in the average communication rate obtained during language samples collected using a picture description task between males and females who use AAC to communicate.

When the descriptive data were evaluated for the average communication rates of the participants, a female outlier was noted. The female participant in pair 5 had an average communication rate that far exceeded the average communication rate determined for the population the sample represents. The graph below displays the female outlier compared to the average communication rates of 20 comparable, competent individuals who use AAC from the Hill (2001) study who would be comparable to the participants in the current study:

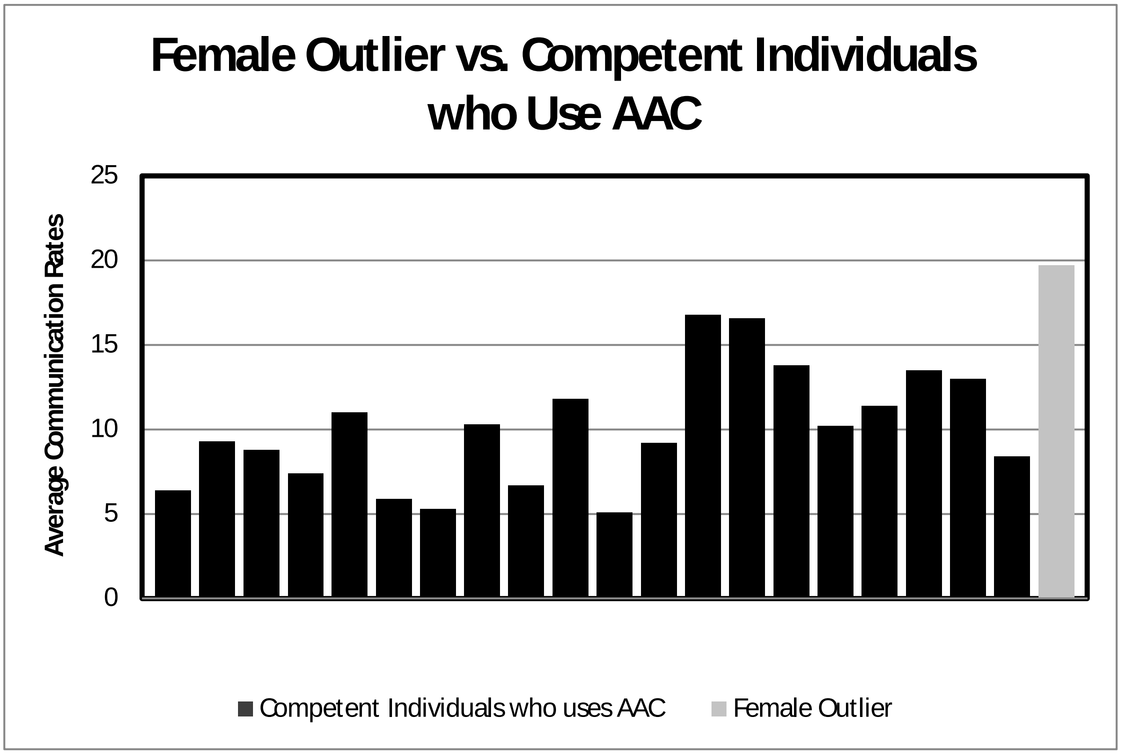

Figure 1. Graph displaying the average communication rates of competent individuals who use AAC as compared to the female outlier (gray column on right).

The gray column on the far right is the female outlier in the current study. As the graph displays, this female participant far exceeded the other average communication rates of the other competent individuals who use AAC and was an outlier for the population. Due to concerns of the outlier contributing to the data not representing the normal distribution of the population and therefore affecting any statistical test run on the data, a separate set of statistical analyzes were conducted on the data minus the pair 5 participants which contained the outlier. Both nonparametric and parametric statistical tests were conducted on the new data with the outlier pair removed and the effect size and the power analysis were computed using the same procedures as explained in the Methods section.

The p-value of 0.05 (original alpha of .10 with Bonferroni correction applied) was used to determine significance for all statistical tests. The effect size and a power analysis were conducted from the parametric test data for the Semantic Compaction™ data and for the average communication rate data that excluded the Pair 5 due to the outlier. The descriptive data reported using PeRT for both dependent variables is displayed in the following table:

Table 3. Descriptive Data for Dependent Variables

	Participants									
	Pair 1	*Pair 1*	*Pair 2*	*Pair 2*	*Pair 3*	*Pair 3*	*Pair 4*	*Pair 4*	*Pair 5*	*Pair 5*
Gender	*F*	*M*	*F*	*M*	*F*	*M*	*F*	*M*	*F*	*M*
Frequency of Semantic Compaction ™ Use	*68.0%*	*73.7%*	*81.5%*	*77.0%*	*81.1%*	*96.1%*	*81.5*	*96.2%*	*90.7*	*92.8%*
Average Communication Rate	*6.45*	*10.19*	*5.60*	*10.09*	*7.82*	*9.67*	*5.45*	*9.14*	*19.71*	*9.69*

3.1 FREQUENCY OF SEMANTIC COMPACTION™ USE RESULTS

The descriptive statistics for the first dependent variable, the frequency of Semantic Compaction™ language representation method used, is as follows. The mean frequency of use of Semantic Compaction™ for males was 87.16 (SD=10.93) and for females was 80.56 (SD=8.10). The range for the females was 22.70 (minimum=68 and maximum=90.7) and the range for males was 22.50 (minimum=73.7 and maximum=96.2). The variance for the females was 65.658 and variance for males was 119.463. Figure 1 displays a comparison of the genders in their frequency of Semantic Compaction™ use:

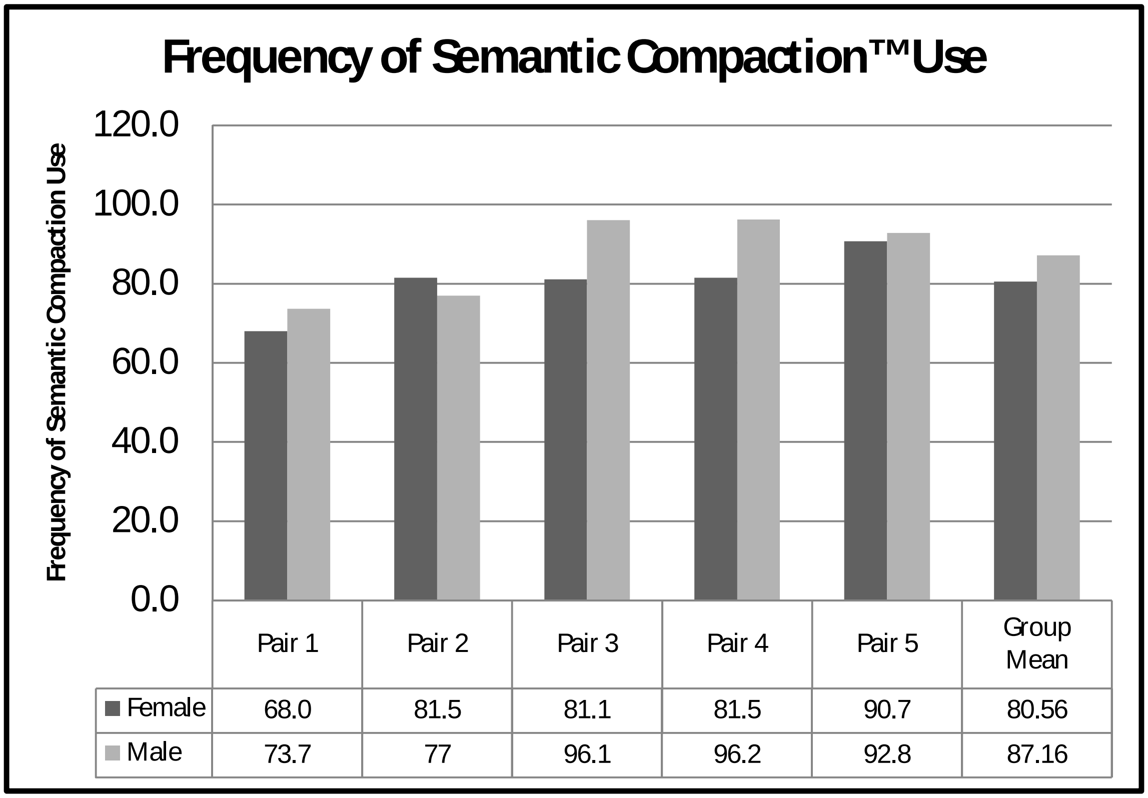

Figure 2. Graph displaying frequency of use of Semantic Compaction™ language representation method for the 5 pairs of male (n=5) and female (n=5) participants and the group means for the genders.

The frequency of use of the language representation methods indicated that the five pairs used similar frequencies of language representation method use. Pairs with less experience using their AAC system used word prediction more in the language sample than the more experienced pairs. Pair 1, with the least experience, were the only two participants to use single meaning pictures during the language sample. A nonsignificant trend indicating a higher frequency of use for Semantic Compaction™ increasing with experience was observed. Males with more experience tended to use Semantic Compaction™ about 89% of the time and females tended to use Semantic Compaction™ slightly less with about 84% of the time. Only one female reached a frequency of 90% use of Semantic Compaction™ as compared to 3 males reaching over 90% use of Semantic Compaction™. The female with the highest frequency of use of Semantic Compaction™ also achieved the fastest average communication rate in the current study.

A nonparametric matched-pair Wilcoxon test between the two dependent variables (frequency of Semantic Compaction™ use and the participant's gender) was computed. The inferential analysis indicated there was insufficient evidence to suggest a significant difference between the males' and the females' use of Semantic Compaction™ supporting a conclusion to retain the null hypothesis for the first research question, $z = |-1.483|$ ($p = .05$) with $p = .138$.

A dependent samples t-test between the two dependent variables (frequency of Semantic Compaction™ use and the participant's gender) was computed. The inferential analysis indicated there was insufficient evidence to suggest a significant difference between the males' and the females' use of Semantic Compaction™ supporting a conclusion to retain the null hypothesis for the first research question, ($t(4) = .153$, $p > .05$).

The calculated effect size for the parametric test conducted was $d=1.11$. An effect size of $d=1.11$ is larger than $d=.8$ and is considered a large effect size (Cohen, 1988). The observed power for this effect size if 47% (the usual goal is 80%). Assuming the same effect size for the population, with 8 pairs of participants (3 more male and 3 more female participants) the power would be 76% which is closer to the target of 80%. Assuming the same effect size for the population, with 9 pairs of participants (4 more male and 4 more female participants) the power would be 82%. If the power is increased through the addition of participants, the statistical power will be improved to allow the researcher to reach a set alpha to determine more accurately if the null hypothesis should be retained or rejected.

3.2 AVERAGE COMMUNICATION RATE RESULTS

The descriptive statistics for the the average communication rate, is as follows. The mean average communication rate for males was 9.76 words per minute (SD=0.42) and for females was 9.01 words per minute (SD=6.06). The range for the females was 14.26 (minimum=5.45 and maximum=17.71) and the range for males was 1.05 (minimum=9.14 and maximum=10.19). The variance for the females was 36.69 and variance for males was 0.173. Figure 2 displays a comparison of the genders in their average communication rates:

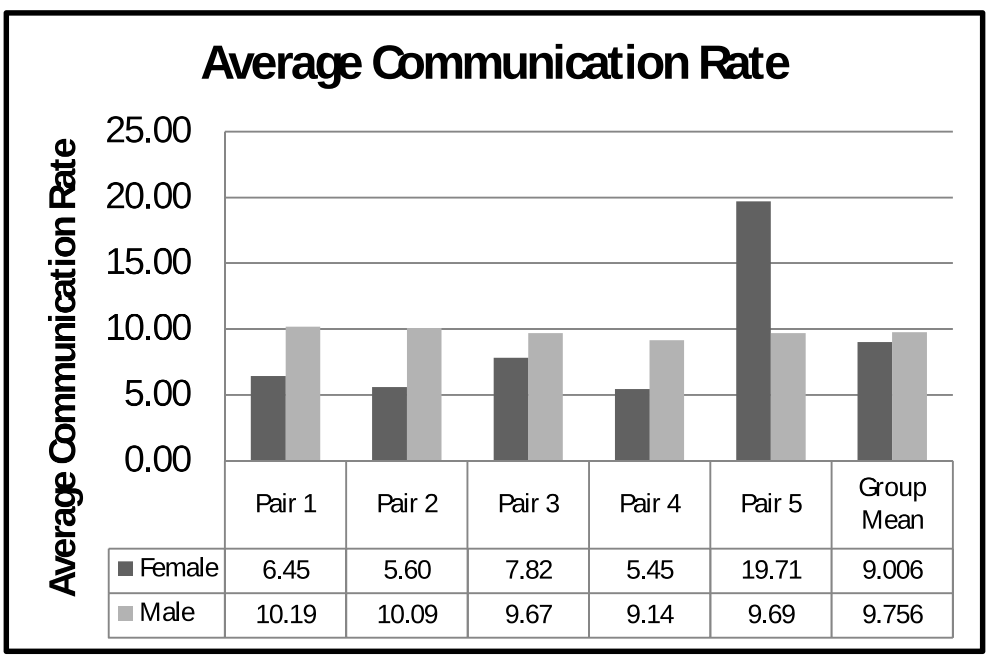

Figure 3. Graph displaying average communication rate for the 5 pairs of male (n=5) and female (n=5) participants and the group means for the genders.

As previously discussed, the female in pair 5 with an average communication rate of 19.71 words per minute significantly out-performed all participants in the study and represented an outlier in the sample. With the exception of the single female outlier, all other females had lower communication rates than their paired male participant. No trend was observed in relation to experience. In relation to Semantic Compaction™ use, the four participants that used Semantic Compaction™ over 90% (all male with the expectation of the female outlier) of the time also had average communication rates of 9 words per minute or higher.

A nonparametric matched-pair Wilcoxon test between the two dependent variables (average communication rate and the participant's gender) was computed. The inferential analysis indicated there was insufficient evidence to suggest a significant difference between the males' and the females' average communication rates supporting a conclusion to retain the null hypothesis for the second research question, $z = |-.674|$ ($p = .05$) with $p = .500$ and $p = .625$.

A dependent samples t-test between the two dependent variables (average communication rate and the participant's gender) was computed. The inferential analysis indicated there was insufficient evidence to suggest a significant difference between the males' and the females' average communication rates supporting a conclusion to retain the null hypothesis for the second research question, ($t(4) = .7.97$, $p > .05$).

Due to the presence of the female outlier in pair 5, the parametric and nonparametric inferential tests were re-conducted with the exclusion of the pair 5 participants. Without pair 5 in the data, the mean average communication rate for males was 9.7725 words per minute (SD=0.478) and for females was 6.33 words per minute (SD=1.087). The range for the females was 2.37 (minimum=5.45 and maximum=7.82) and the range for males was 1.05

(minimum=9.14 and maximum=10.19). The variance for the females was 1.181 and variance for males was 0.229. The results of these further analyzes are reported below:

A nonparametric matched-pair Wilcoxon test between the two dependent variables (average communication rate and the participant's gender) was computed. There was no significant difference between the males' and the females' average communication rates supporting a conclusion to retain the null hypothesis for the second research question, z = |-1.826| (p = .05) with asymp. p =.068 and exact p = .125.

A dependent samples t-test between the two dependent variables (average communication rate and the participant's gender) was computed. The inferential analysis indicated there was a significant difference between the males' and the females' average communication rates supporting the rejection of the null hypothesis for the second research question, (t (3) =.009, p>.05).

The calculated effect size for the parametric test conducted on the average communication rate variable for the data excluding the outlier pair was d=4.33. An effect size of d=4.33 is larger then d=.8 and is considered a large effect size (Cohen, 1988). The observed power for this effect size if 100% even with only four pairs of participants.

4.0 DISCUSSION

Overall, the results of the current study indicate there is not a significant difference between the genders on either of the dependent variables. In the Method section, it was outlined that a similar result on both the parametric and the nonparametric tests would be needed to support a decision to retain or reject the null hypothesis. Due to only one parametric test supporting a decision to reject the null hypothesis, the overall conclusion would be to retain the null hypothesis for both dependent variables. Retaining the null hypothesis for both variables would support the interpretation that there is not a gender difference in the frequency of Semantic Compaction™ use and average communication rate for individuals who use AAC. The results and further interpretation of each dependent variable will be discussed more thoroughly below.

The results indicate there is not a significant difference between males and females in the frequency of Semantic Compaction™ use. The conclusion was supported by both the parametric and the nonparametric statistical tests conducted, supporting an accurate interpretation of the participants in the current study. As the previous literature supports, a combination of different language representation methods were used by all participants with Semantic Compaction™ being the predominate method used by all participants (Hill & Romich, 2002; Hill, 2001). The more effective use of Semantic Compaction™, as related to other language representation methods, has an impact on the communication rate of the participants. While the results of the current study did not support a significant difference, it is important to note that the current study had a limited number of participants. By increasing the number of participants, this could provide increased support for the conclusion of no significant difference between the genders, or it could support a difference between the genders on this variable.

One observation made when reviewing the descriptive statistics for the participants' performance on the Semantic Compaction™ variable addressed in the current study was the males did tend to be higher on this dependent variable than females. While there was not enough evidence to support a significant difference between the genders, the limited sample size may not accurately represent all individuals who use AAC. A larger sample size may have given more insight into a possible gender difference on this performance measure.

For the Semantic Compaction™ variable there was a large effect size of d=1.11 which indicated that the gender (independent variable) did have a large effect on the frequency of use of Semantic Compaction™ (dependent variable). The power analysis indicated the power for the current study in relation to the Semantic Compaction™ variable was only 47%; however if the total pairs included in the study had totaled 9 (4 more female and 4 more male participants) then the power would have rose to 82%. If the power is raised, this will provide the researcher with more confidence in their decision to retain the null hypothesis. The current study does not support the conclusion that adding more participants would indicate a significant difference between the genders, however it could help in increase the power behind the decisions made based on the statistical tests.

The results indicate there is not a significant difference between males and females in the average communication rates when the data included the female outlier, however a significant difference was found between the genders when the pair containing the outlier was excluded from analysis. As the previous literature supports, all of the average communication rates, with the exception of the female outlier, were under 15 words per minute (wpm; Foulds, 1980, 1987 as cited in Beukelman & Mirenda, 2005). When the female outlier was excluded, the mean for the average communication rate of the females dropped to 6.33 wpm which is lower when compared to the male mean of 9.77wpm. From the perspective of an individual who uses AAC to communicate where the norm for this population is typically less than 15wpm, a 3wpm difference is considered large. As previously discussed, a reduced average communication rate can have an impact on socialization; therefore it is important that both genders have similar communication rates to ensure one gender is not at a disadvantage to the other (Beukelman & Yorkston, 1982; Koester & Levine, 1996; Venkatagiri, 1993, 1994).

A possible gender difference in the average communication rate is worth investigating further, as the above statements support. Conclusions made from the current study in relation to average communication rate of individuals who use AAC are cautioned due to a statistical finding being found only in the parametric test with the pair 5 participants removed. The significant finding on this one parametric test, however, was also supported by a large effect size of d=4.33 and a power of 100% with only the four pairs included. The large effect size and the high power do provide support for a possible gender difference for this dependent variable if a more controlled study was conducted.

One observation made when reviewing the descriptive statistics for the participants' performance on both of the dependent variables was the males tended to be higher, but not significant, on both dependent variables. Figures 2 and 3 above both display the comparisons of the genders in each individual pair as well as the group means. The two figures display slightly higher male scores for most pairs of participants. While there was limited evidence to support this difference was significant between the genders in the current study, the limited sample size may not accurately represent all individuals who use AAC high technology. A larger sample size may have given more insight into a possible gender difference on these two performance measures.

The slight performance differences favoring males noted in the descriptive data in relation to Semantic Compaction™ use and average communication rate may be related to the methods used in intervention to train the individual to use the device. The difference could also be related to the amount of training provided to the individual. If these hypothesizes are true, they could have potential implications for clinical intervention. If there is a significant difference between the genders favoring males on performance measures, then females using AAC high technology may require intervention strategies designed specifically to build communication competence in domains related to strategic and operational skills. For example, females may need intervention targeting effective use of their Semantic Compaction™ LRM to create a faster average communication rate. Due to the limited evidence in the current study it is unclear whether additional intervention for females is needed at this time; however further research would shed more light on this question.

The two dependent variables addressed in the current study are just two of many performance measures that contribute to the optimized communication of an individual who uses AAC high technology. The Semantic Compaction™ use and the average communication rate do not give a complete picture of the different genders' abilities. Other performance measures such as mean length of utterance in words, peak communication rate, total number of words, different word roots, core vocabulary use, or selection rate could provide additional insights into possible gender differences.

When looking at the descriptive data for the participants regardless of gender, the higher frequencies of Semantic Compaction™ appeared to relate to experience. The relationship was not analyzed using inferential testing, however, so no formal conclusions, only observations, can be made at this time. The individuals with less experience were noted to use more word prediction during their language samples which is not a rate enhancement strategy (Venkatagiri, 1993, 1995; Horstmann & Levine, 1990). The difference in language representation use associated with experience may indicate that more experienced individuals who use AAC high technology may learn to use Semantic Compaction™ to a greater extent to maximize communication. The descriptive data also showed the pair of participants with the least experience were the only participants to use single meaning pictures to communicate. The less experienced participants' use of both word prediction and single meaning pictures may have decreased the frequency of use of Semantic Compaction™ use for these individuals.

The results of the current study also indicated there was a female outlier whose communication rate far exceeded the other participants. If this individual is able to almost double the other individuals' communication rates, then it may be beneficial to investigate the reasons behind the outlier's performance and why her paired male equivalent was not at the same level of performance. The two participants were matched; however there were several extraneous variables not controlled for which could account for the differences in communication rate. There are several possible variables, such as intervention, system training, personality characteristics (i.e., openness, consciousness, extraversion, agreeableness, and neuroticism), motivation, and selection rate, which were not controlled for in the current study which could have influenced the female outlier.

In addition to these possible extraneous variables, it was also observed that the female outlier used an optical headpointer while the paired male used a headstick. Both individuals should have been using the direct access method that is optimal for them. According to the American Speech-Language-Hearing Association (ASHA; 2005), speech pathologists that service individuals who use AAC should have knowledge of all various selection methods and should be using evidence-based practice to correctly determine the optimal selection method for the individual. However, due to the large differences between the outlier and the paired male's communication rates, it is possible that the male in the pair may have been incorrectly assessed in relation to the appropriate direct selection access method. Further research is needed to further address the reasons for the female outlier in the current study.

4.1 LIMITATIONS OF STUDY

One limitation of the current study is that the participants' selection rate was not controlled. Hill & Romich (2002) indicated that selection rate is needed to accurately interpret the communication rate. To help compensate for selection rate differences, another performance measurement can be used: rate index. Rate index is the average communication rate divided by the selection rate and is indicated by words per bit (Hill & Romich, 2002). The rate index adjusts for selection rates in order for the average communication rate to be interpreted more accurately (Hill & Romich, 2002). Therefore, if two individuals have similar characteristics and devices but different selection rates, their rate indexes can still be compared in terms of efficiency.

Due to limitations of the language samples of the male and female participants in Pair 1, the selection rate and rate index for the current study's participants could not be computed and compared. Therefore, communication rate was used as a dependent variable for comparison between the genders. A suggestion for future research is to look at possible gender differences in the rate index which would control for differences in selection rate between participants. One caution to consider in relation to rate index is a rate index measurement does not exclude a language processing component. The individual who uses AAC must first think of a desired word(s) before selecting an icon(s). Currently, a measurement that controls for this processing component is not available.

As already mentioned, a limited number of participants were included in the sample. The language samples used in the current study were previously collected for different purposes in the Hill (2001) study; therefore the sample size was restricted to the females available as participants in the Hill (2001) study. A small sample size is a limitation for the current study because no generalization can be made with a limited number of participants.

The power of 47% demonstrated in relation to the Semantic Compaction™ variable is a low power; however the population being addressed is very small. Beukelman and Ansel (1995) estimated that 8-12 people per 1000 of the population cannot communicate effectively using their natural speech. Hill and Romich (2002) went further to estimate the percentage to be about 10-20 million people worldwide. These estimates are further decreased if you were to eliminate those individuals who do not use AAC to communicate and who are unable to communicate as effectively as the participants in the current study (i.e., are unable to use a high technology device). When looking at gender differences in this population, the numbers of qualifying paired participants lowers even more due to the higher percentage of individuals requiring AAC to be predominately male. The participants in the current study were all diagnosed with cerebral palsy. The incidence for cerebral palsy is only about 3.7 cases per 1000 in the population with a male to female ratio of about 1.4:1 (Yeargin-Allsopp, Van Naarden Braun, Doernberg, Benedict, Kirby, & Durkin, 2008). This makes it difficult to find female participants to match to equivalent male participants to conduct research addressing gender differences for this population.

Due to the current study using previously collected language samples taken from the Hill (2001) study, there was also a limitation on the extraneous variables that could be controlled for in the current study. The generalization of results is further limited by the lack of control of other variables in relation to males and females. Some examples of extraneous variables in relation to the participants are as follows: the participants' career choices; intervention received addressing their device use; personality characteristics (i.e., openness, consciousness, extraversion, agreeableness, and neuroticism); and medication used. The Hill (2001) study did control for time of day and energy level. The procedures used to control for these two extraneous variables are available in the Hill (2001) study. In addition to the extraneous variables mentioned, the context in which the conversational sample was taken could also affect the results. It is recommended that future research control for these extraneous variables when looking at gender differences in individuals who use AAC. The current study used a picture description task to generate a language sample; future research could use alternative methods for generating a language sample such as using interview questions, conversation, or story telling to see if there is a difference in the performance between the genders. Despite the limited number of participants and lack of control of variables, the current study can give some insight into possible approaches to future research.

4.2 SUMMARY

In conclusion, there is insufficient evidence to support a significant gender difference in males and females who use AAC in the frequency of Semantic Compaction™ use for the current study. There was, however, some support for a significant difference between genders in their average communication rate. Due to several limitations in the current study, such as a limited sample size and lack of control for selection rate, these conclusions should be taken with caution. Further, more controlled research is needed in the area of gender differences in individuals who use AAC to confirm the findings in the current pilot study. The issues identified in the descriptive data and in the statistical testing in the current study do provide some insight into future research questions that could be addressed. To support the American Speech-Language-Hearing Association's (ASHA; 2005) postion on AAC assessment and intervention, evidence-based practice needs to be used to ensure the individual using AAC is provided access to the optimal communication possible. To ensure that this service is being appropriately provided, it needs to be investigated if there should be different considerations when addressing different genders in assessment and intervention of individuals who use AAC.

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