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Efficiency of low-tech augmentative and alternative communication (AAC) access methods

Brittany Davis
University of Northern Iowa

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EFFICIENCY OF LOW-TECH AUGMENTATIVE AND ALTERNATIVE COMMUNICATION (AAC) ACCESS METHODS

An Abstract of a Thesis
Submitted
in Partial Fulfillment
of the Requirements for the Degree
Master of Arts

Brittany Davis
University of Northern Iowa
December 2020
ABSTRACT

Augmentative and alternative communication (AAC) implementation and intervention continues to be a critical component of the speech-language pathology scope of practice (ASHA, 2020a). As communication has become increasingly technological, there is a growing need for individuals using AAC to participate remotely using their preferred method of AAC (DeRuyter et al., 2007). While digital communication uses high-tech materials, low-tech AAC is still a viable and preferred option for some individuals (Roman et al., 2010). The instruction and use of low-tech AAC is still highly relevant in various settings such as intensive care units (Garrett et al., 2007). Research on use of low-tech AAC systems in telecommunication and the instruction of low-tech communication AAC methods via telepractice is limited. This paper focuses on participants’ experience with learning a modality of communication, low-tech AAC, over Zoom (Zoom Communications Video Communications Inc., 2020). Using a descriptive-comparative design to evaluate efficiency, three participants, who were non-users of AAC, learned, utilized, and reported preferences of low-tech methods of Eye-Transfer (E-Tran) or Partner-Assisted Scanning (PAS), in a 90-minute session. Participants used the methods in the role of the person using AAC first, and then as the communication partner. Method efficiency was evaluated by comparing duration of messages, spelling accuracy, and user preferences amongst participants. The results indicated E-Tran was faster than PAS for two participants who tried both methods. The two participants who tried both methods also had higher accuracy using PAS and preferred PAS overall in the telecommunication setting.
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This Study by: Brittany Davis

Entitled: Efficiency of Low-Tech Augmentative and Alternative Communication (AAC) Access Methods

has been approved as meeting the thesis requirement for the Degree of Master of Arts

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Dr. Jaime Gilbert, Thesis Committee Member

Date ________________________________________________________________

Dr. Jennifer Waldron, Dean, Graduate College
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INTRODUCTION

Augmentative and alternative communication (AAC) is an area of practice and research involving the compensation for temporary or permanent limitations and participation restrictions of verbal speech, or to supplement speech (American Speech Language Hearing Association [ASHA], 2020c). Individuals who rely on AAC typically have severe restrictions to verbal speech, such as in the following populations: individuals with Autism Spectrum Disorder, individuals with cognitive deficits, individuals who have suffered stroke, individuals with neurogenic diseases such as Amyotrophic Lateral Sclerosis (ALS), and many others (Beukelman & Light, 2020).

AAC enables individuals to engage in interactions that satisfy communicative purposes typically achieved through verbal speech such as expression of wants and needs, transferring information, creating social connections, maintaining social conventions, and practicing social etiquette (Beukelman & Light, 2020; Light, 1988). People who rely on AAC to communicate typically depend on multiple AAC supports because communication environment, context, communication partners, and communicative goals are always changing. Ultimately, the AAC supports are in place to help the individual achieve communication competence which involves efficiently and effectively communicating messages and the ability to communicate a variety of unique and individualized messages given one’s circumstances and physical abilities (Light, 1988).

AAC and assistive technology (AT) are pertinent communication modalities for individuals who acquire communication impairments after disease or injuries. According
to Garrett et al. (2007), AAC is highly impactful in the intensive care unit for helping patients communicate needs and participate in pain assessment and decision-making with family members and the medical team. Several studies have described the benefits of providing a variety of AAC methods, such as gestures/signals, communication boards, and speech generators in the intensive care unit (Costello, 2000; Dowden et al., 1986; Garrett et al., 2007; Fried-Oken et al., 1991).

According to the American Speech-Language Hearing Association’s (ASHA) website, AAC can be categorized by aided and unaided systems (ASHA, 2020b). Unaided AAC is a system that does not require any specific tools for communication. Unaided systems include gestures, signs, facial expressions, and so forth. Aided AAC systems require tools, devices, or materials that are beyond what you can create with your own body to communicate. Aided systems may be broken into two types: high-tech and low-tech (ASHA, 2020b). Low-tech aids may be a pencil and paper or communication symbol board. High-tech items in aided systems are typically digital devices, such as digital tablets with an option to voice text into audible speech.

Aided systems often require training to operate the system effectively. A speech-language pathologist may intervene to help the person using AAC select a system and learn to communicate effectively (ASHA, 2020b). These interventions are likely to be completed in cooperation with other professionals such as occupational therapists, physical therapists, and educators. The speech-language pathologist may consult with the person using AAC to determine which methods work best with their physical abilities. After the method of AAC is chosen, the speech-language pathologist will work to improve the
person’s skills so they can become a more efficient communicator. Part of the intervention also includes teaching the communication partners, the people talking to someone who uses AAC, how to understand or interpret the messages in aided and unaided systems.

According to ASHA (2020b), as speech-language pathologists implement AAC intervention, they must continuously make decisions to “promote communicative competence and language and literacy development, as well as modifications to AAC systems to support changes in communication needs over time” (ASHA, 2020b, para. 26). For example, when working with aided systems, speech-language pathologists work towards expanding the vocabulary of the devices in order to keep up with the person’s linguistic needs while exploring updates to make the system faster to use. The speech-language pathologist would ensure the person using AAC always has the ability to communicate, especially as the social climate and context of communication change.

One example of a social climate change is the 2020 COVID-19 health crisis, in which in-person communication was restricted in order to slow viral spread (Centers for Disease Control and Prevention, 2020). Many skilled nursing facilities and hospitals restricted in-person visitations. Nonessential health and therapy appointments were provided remotely, and elderly individuals or those who had underlying health conditions were encouraged to isolate themselves in their homes. This greatly increased the demand for telecommunication as a part of everyday communication.
While the COVID-19 crisis exacerbated the need for remote communication, the need and use of digital communication (i.e. videoconferencing) was already growing, according to Vorderer et al. (2017), who stated digital communication was already becoming necessary to participate in society. As technology advances, a majority of individuals need to become familiar with and utilize technology to communicate on a daily basis (Vorderer et al., 2017). While remote appointments were not standard, some professionals in the healthcare field already utilized telepractice, such as in the field of speech-language pathology. ASHA (2020d, para. 1) defined telepractice as “the application of telecommunications technology to the delivery of speech language pathology and audiology professional services at a distance by linking clinician to client or clinician to clinician for assessment, intervention, and/or consultation.”

Furthermore, additional studies indicated that remote telepractice may be just as effective and well-tolerated as in-person intervention (Hall et al., 2014; LoPresti et al., 2015). One example is a study by LoPresti et al. (2015), in which 66 individuals receiving AAC teletherapy and 38 individuals receiving computer access intervention reported high satisfaction with the quality of AAC telepractice instruction, and overall satisfaction was nearly identical to in-person services weighing costs and benefits of telerehabilitation. Additionally, a single-subject study by Hall et al. (2014) compared the progress made through in-person therapy versus a combination of in-person and teletherapy. The study measured the achievement of short-term goals based on acquisition of grammatical morphemes and found performance therapy outcomes were comparable for in-person and teletherapy (Hall et al., 2014).
Speech-language pathologists are required to determine which method of AAC will best suit clients, keeping in mind that different individuals require different systems, and needs may vary depending on the setting (McNaughton & Light, 2013). A high-tech system may not fit every setting and there are many benefits of low-technology aided communication systems.

According to Roman et al. (2010), low-tech systems may provide flexibility in timing and pace when encoding a message. Low-tech systems are often portable, do not require electricity to charge or batteries to operate, are often inexpensive, require minimal assembly and set up, do not require insurance approval, and are more readily available in facilities or in hospice (Roman et al., 2010). Therefore, depending on circumstance, low-technology access may be preferable. According to a study by Doyle and Phillips (2001), individuals with late-stage ALS reportedly preferred low-tech AAC over high-tech systems when motoric function and speech were severely impaired but volitional eye movement was spared. It’s possible there may be instances of individuals who would need to access a low-tech AAC system in a teletherapy setting or during a personal video conference to communicate with friends or family.

Roman et al. (2010) compared three low-tech approaches, Eye-Transfer (E-Tran), partner-assisted scanning (PAS), and EyeLink amongst individuals with ALS to determine the speed, ease of use, and preference of the various methods. Swift (2012) expanded on Roman et al. (2010) and examined seven pairs of typical adults to determine which method amongst E-Tran, PAS, and EyeLink was best for rate and preference, as well as how rate and preference changed over two to three weeks of use. However, these
studies only examined word-level messages. A smaller study by James and Saddoris (2016a) examined words and phrases across the three methods of low-tech eye gaze communication; however, they did not examine novel messages.

Additionally, Roman et al. (2010) and Swift (2012) did not measure novel messages in their respective studies, and it is unclear as to how novelty affects the rate of encoding messages. Lastly, Roman et al. (2010) examined individuals with ALS and their communication partners, whereas Swift (2012) examined pairs of typical adults who kept consistent roles of “user” and “communication partner” (Swift, 2012, p. 29).

The present study aimed to compare two types of low-technology aided communication systems, E-Tran and PAS, for timing (i.e. duration of messages), accuracy (i.e. correct symbol selection and spelling), and user preferences within the telecommunication setting with pre-determined and novel messages. This study also examined the role of the communication partner by asking the participant to first take a turn as the person using AAC and then switch roles to take a brief turn as the communication partner. Eye-Link was not examined as this study was remote and eye contact, or “link,” could not be achieved through a webcam.

E-Tran, is a “a communication display which is accessed by eye gaze and is a suitable option for individuals who have to rely on their eyes to select an option” (Lloyd et al., 1997, p. 528). An E-Tran board is usually made from a piece of see-through plexiglass (Perspex) with the center cut out, enabling a person who uses AAC to sit across from a partner and send a message by gazing at the symbols (Bornman, n.d.; Lloyd et al., 1997). The E-Tran board is organized so the symbols or group of symbols are spread out
on around the edges of the plexiglass board. Both parties involved in communication determine the symbols and placement on the board.

When the person using AAC intends to communicate a message, he or she will look towards one of the symbols or groups of symbols. The spacing on the board should be sufficient to allow the communication partner to track the person’s gaze and recognize the intended symbol or group of symbols. Typically, there is an agreed upon method between the person using AAC and a communication partner to confirm a symbol and move on to another symbol or to complete the overall message. For example, after a person has communicated the first letter in a message by looking at it, he or she may look back to the center of the board before looking at the second letter in the target word. Likewise, in order to complete a message, the person using AAC may look in a particular direction to confirm the message is complete.

Unlike E-Tran, partner-assisted scanning (PAS) is not a specific communication display, as the term “scanning” simply refers to systematically presenting choices until the desired item can be selected (Beukelman & Light, 2020, p. 255). According to Lloyd et al. (1997), partner-assisted scanning is a technique in which the communication partner verbally, tactiley, or visually presents choices to the person using AAC. Therefore, partner-assisted scanning can be used with a variety of communication boards and materials because it is a method for navigating through columns/rows/groups of symbols. For example, if a low-tech visual display containing the alphabet is utilized, in order to begin the message, the communication partner would offer each row of letters to the person using AAC. If the desired letter was in the row is pointed to, the person using AAC could
confirm by looking in an established direction, for example looking up for “yes.” The communication partner then offers each letter of the alphabet in that row until the person using AAC looks up again to confirm “yes” to select the letter. The scanning and selection continues until the message is complete. This requires an established signal, such as looking to the left or right, to confirm message completion.

The current study aimed to examine the relationships among timing, accuracy, and preferences when encoding words and phrases using two types of low-tech eye-gaze AAC over a videoconference. This study also examined the preferences for learning new methods of communication reported by participants. For the purpose of this study, participants were instructed to use E-Tran or PAS via videoconference over Zoom, a video communication app (Zoom Video Communications, 2020).
METHODS

Participants

The participants in the study were three young adults attending a Midwestern university. The participants were students studying communication sciences and disorders. The participants did not use AAC as a primary modality of communication, but may have been exposed to information about AAC systems through the educational curriculum. The depth of their specific knowledge of AAC was unknown at the time of the study. Two participants chose to participate in accessing two methods of low-tech AAC (E-Tran and PAS), and one participant requested to access one method (PAS).

Materials

Participants who chose E-Tran printed the *Speakbook 4th Edition Nonverbal Communication System* E-Tran board (Joyce, 2011; Figure 1) in color ink. The participant cut out the groups of letters and attached them to his/her laptop or computer screen around the camera with tape. The participant’s configuration of the E-Tran board was left-to-right in alphabetical order. The researcher placed the respective rectangles in the opposite configuration, from right-to-left in order to accommodate the mirroring effect of the cameras (pictured below in Figure 2).

Participants who chose PAS printed a black and white copy of the *EyeLink2* (Northern Speech Therapy, n.d.) board. The *EyeLink2* board is pictured in Figure 3. There were no modifications necessary regarding the mirroring of the cameras, as the scanning was verbal (i.e. stating “this row” or “a, b, c”) and visual (i.e., pointing to each row and each letter).
Google Docs and Google Drive (Google LLC., 2020a; Google, LLC., 2020b) were used to share the predetermined words and phrases list with the participants. The predetermined words and phrases are listed in Appendix B. The participants attended research sessions via Zoom video conferencing software (Zoom Video Communications, Inc., 2020). Training videos (James & Saddoris, 2016b; James & Saddoris, 2016c) were uploaded for access on a private YouTube (YouTube LLC., 2020) account. The videos included an overview of the communication board and several examples demonstrating the process of encoding messages. Post-participation interview questions were prepared and stored on a Google Doc (Google, 2020a) and are listed in Appendix C and D.
Figure 1: E-Tran Board

Note: *Speakbook 4th Edition Nonverbal Communication System* (Joyce, 2011)
Figure 2: E-Tran Configuration to Accommodate Mirroring Effects

Note: The participant’s configuration is left-to-right. The researcher’s configuration is right-to-left in order to account for mirroring effects of webcams.
Figure 3: PAS Board

Note: *EyeLink2* alphabet board (Northern Speech Therapy, n.d.)
Procedure

Participants were emailed the communication boards to print at home prior to participation. They received an email invitation to attend a live videoconference on Zoom (Zoom Video Communications, Inc, 2020) for one 90 minute session per method. However, if the procedures were completed in less than 90 minutes, the video conference ended early. The Zoom meetings were recorded for later data analysis. Participants accessed a list of words and phrases in a document in Google Drive (Google, 2020b) at the time of the meeting.

Participants watched an instructional video (James & Saddoris, 2016b; James & Saddoris, 2016c) on YouTube (YouTube LLC., 2020) about their method of choice (E-Tran or PAS) as an introduction to the method. The video was presented during the Zoom conference using the “share screen” option (Zoom Video Communications, 2020).

After the video, the researcher guided the participant to match eye movements with the chosen communication board configuration. For E-Tran, the researcher instructed the participant look at letters at random in order to determine if the communication boards were calibrated appropriately with the participant’s gaze. The participant looked in each of the six color group locations to ensure the researcher could interpret their eye gaze through the webcam. For PAS, the participant calibrated gaze with the researcher by looking up and then down to definitively indicate “yes” or “no” respectively.
The participant was instructed to access the three “practice” words shared on the words list document to ensure he/she comprehended the training and was able to successfully encode messages. For example, participants were asked to encode the word “dog” as a test message. The test messages are listed in Appendix A. Once the test words were completed, the participant was randomly assigned one of the words or phrases from the list to encode. After the participant had encoded five words and five phrases, he/she was also asked to generate five novel words for the researcher to decode.

After the participant was finished encoding his/her five unique words, the roles of person using AAC and the communication partner were reversed. In the case of E-Tran, the participant used the cutouts on the edges of his/her screen to determine the message spelled by the researcher. Participants calibrated their E-Tran cutouts with the researcher before decoding messages. When the participant used PAS, he/she was asked to scan through each row verbally and point to each letter with a finger while holding the EyeLink2 board for the researcher. The participant decoded messages in the new role of the communication partner for five novel messages. Throughout the data collection, the participants did not have any time constraints and were not informed of their accuracy regarding encoding and decoding messages.

After the participant decoded five messages from the researcher, he/she was interviewed regarding his/her experience learning and using the selected method of communication (PAS or E-Tran). If the participant participated in one method
of low-tech communication, he/she was verbally asked the questions listed in Appendix C. If the participant tried both methods, he/she was verbally asked the questions listed in Appendix D, which contained additional preference questions about the two methods.

**Data Analysis**

The video recordings were analyzed for the duration of each predetermined word, phrase, and novel word using frame-by-frame video playback. Timing of encoding words and messages using E-Tran and PAS were measured to the hundredth of a second using video timestamps as shown in Figure 4. The beginning time was noted when the participant directed eye gaze towards the first letter or symbol of a message for E-Tran or when looking up/down when prompted for PAS. The end time was noted when the participant directed eye gaze towards the symbol or location to confirm “message complete.”

The researcher analyzed the participants’ accuracy when encoding and decoding messages. In the role of the person using AAC, errors in accuracy were scored when participants misspelled words/phrases by omitting letters or selecting an incorrect row or group of letters. When in the role of the communication partner, errors were scored if the participants misinterpreted the words/phrases spelled by the researcher. Lastly, the participants’ interview responses were examined by the researcher to determine preference using the systems.
Figure 4: Format of Timing Data

Note: The timing data is displayed in minutes and examines total time to the hundredth of a second.

**Reliability**

Inter-rater reliability was completed on the timing data for each video by a research assistant for 33% of the PAS and 50% of the E-Tran of the time trials collected. Before analyzing the research data, the rater completed 16 trials to learn and practice measuring timing of messages on “mock” videos, which were created by the researcher, according to guidelines. Once high levels of agreement were met during the training, the rater completed process with the research data. The researcher completed data collection on all participation videos. The data was then measured by the inter-rater, who was randomly assigned the E-Tran 2 and PAS 2 videos. Once the inter-rater’s measures were complete, the duration scores were compared to determine agreement. Agreement was defined as measurements within ±00:00.05 seconds (five-hundredths of a second). Reliability measures were completed by dividing the number of trials with agreement by the total number of trials. The inter-rater reliability was found to be 93.33% for both E-Tran and PAS respectively.
RESULTS

This study aimed to examine the relationship between timing, accuracy, and user preferences across two forms of low-tech AAC: E-Tran and PAS. Two participants encoded messages in both E-Tran and PAS. One participant encoded messages in PAS alone.

Timing

The duration of each message was recorded for all of the participant’s trials of predetermined words and phrases in Table 1. Participants who used E-Tran (n=2) had a mean duration of 00:42.19 across five predetermined words and a mean duration of 01:20.98 across five predetermined phrases. Participants who used PAS (n=3) had a mean duration of 01:29.32 across five predetermined words and a mean duration of 3:32.21 across five predetermined phrases. Therefore, participants completed their messages faster with E-Tran when compared to PAS. The total time the participants needed to encode words and phrases in E-Tran was nearly half the time required for PAS. The timing data from the novel words was variable by participant and method, and it appeared novelty affected rate differently depending on the method and individual participant.

The timing of each trial was graphed to illustrate the unique timing amongst the participants in each trial. Their individual variances can be seen in Figure 5. The PAS symbol selection rates in pre-determined and novel messages were similar across all three participants. Both participants who used E-Tran experienced variability in their symbol selection rate depending on the context (i.e., depending on if the symbol selected was in a
predetermined word, a novel word, or in a phrase). Table 1 shows the timing data collected for each method.

Table 2 illustrates the average rate at which the participants selected each symbol of a message using E-Tran and PAS, that is, the symbol selection rate. The symbol selection rate was calculated by calculating the total time for a message and dividing it by the number of symbols in the message. The symbol selection rate was used to compare predetermined words and phrases with novel messages so that length of the message would not influence the results. The predetermined words and phrases mentioned in Table 2 are listed in Appendix B.
Table 1

*Timing Data for E-Tran and PAS*

<table>
<thead>
<tr>
<th></th>
<th>E-Tran 1</th>
<th>E-Tran 2</th>
<th>PAS 1</th>
<th>PAS 2</th>
<th>PAS 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>word 1</td>
<td>00:15.97</td>
<td>00:21.96</td>
<td>01:03.85</td>
<td>00:50.78</td>
<td>00:53.86</td>
</tr>
<tr>
<td>word 2</td>
<td>00:33.09</td>
<td>00:38.86</td>
<td>01:32.08</td>
<td>01:18.88</td>
<td>01:25.17</td>
</tr>
<tr>
<td>word 3</td>
<td>00:45.08</td>
<td>01:13.94</td>
<td>01:58.18</td>
<td>01:43.20</td>
<td>02:15.92</td>
</tr>
<tr>
<td>word 4</td>
<td>00:23.85</td>
<td>00:23.15</td>
<td>01:20.01</td>
<td>01:27.04</td>
<td>01:14.99</td>
</tr>
<tr>
<td>word 5</td>
<td>01:39.99</td>
<td>00:54.97</td>
<td>01:54.00</td>
<td>1:28.93</td>
<td>1:52.93</td>
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<tr>
<td>phrase 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>phrase 2</td>
<td>01:18.18</td>
<td>01:56.79</td>
<td>04:33.91</td>
<td>3:00.91</td>
<td>02:04.99</td>
</tr>
<tr>
<td>phrase 3</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>phrase 4</td>
<td>01:21.11</td>
<td>01:20.95</td>
<td>04:05.02</td>
<td>03:56.02</td>
<td>03:41.08</td>
</tr>
<tr>
<td>phrase 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The timing of each method is listed. Participants encoded messages faster using E-Tran than PAS in all trial messages. The data point for Participant 1’s use of E-Tran on phrase 1 was not obtained on video due to technical difficulties.
Table 2

*Rate of Symbol Selection for E-Tran and PAS*

<table>
<thead>
<tr>
<th></th>
<th>Participant 1</th>
<th>Participant 2</th>
<th>Participant 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E-Tran</td>
<td>PAS</td>
<td>E-Tran</td>
</tr>
<tr>
<td>Predetermined</td>
<td>00:10.34</td>
<td>00:24.82</td>
<td>00:09.99</td>
</tr>
<tr>
<td>Words</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Novel Words</td>
<td>00:06.79</td>
<td>00:24.22</td>
<td>00:08.48</td>
</tr>
<tr>
<td>Predetermined</td>
<td>00:09.20</td>
<td>00:22.38</td>
<td>00:06.93</td>
</tr>
<tr>
<td>Phrases</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The rate of symbol selection is the average time per selection of a symbol in a message. E-Tran rates were faster than PAS rates across all contexts. E-Tran messages appeared to be encoded over two times faster than PAS messages.
Figure 5: Timing of Methods and Trials

Note: The timing for each message is graphed for each method and participant. The data point for Participant 1’s use of E-Tran on phrase 1 was not obtained on video due to technical difficulties.
Accuracy

The accuracy data indicated participants who tried both methods made more errors using E-Tran than PAS. In order to compare accuracy among trials, the total percentage of errors per trial was calculated. Percentage of errors per trial is the number of errors made per trial divided by the total number of errors, as shown in Figure 6.

Across all the participants, there were 13 selection errors. The E-Tran 1 trial accounted for 4 out of the 13 errors when the participant attempted to encode the word “drink.” The participant mistakenly selected the wrong color groups when encoding “d” and “i” and made an error by selecting “space” instead of “backspace” twice while correcting himself/herself. Participant 1 using E-Tran made three more errors throughout participation and was accountable for 7 of the 13 errors. Overall, E-Tran trials made up 8 of the 13 total errors.
Figure 6: Percentage of Total Errors by Method

Note: Percentages were determined by dividing the number of errors per participation video by the total number of errors across all participants.

Role Reversal: Accuracy Decoding Messages

After encoding five novel words, the participants acted as the communication partner to decode five messages from the researcher. Both participants using E-Tran successfully received the messages as the communication partner with minimal errors, that
is, small errors such as determining the green tab versus the white tab or forgetting to confirm a letter aloud. All three participants who used PAS were able to successfully decode the messages without errors.

Preference

After the participants finished encoding and decoding messages using E-Tran and PAS, and practiced decoding messages as the communication partner, they were interviewed regarding their preferences using the methods. The results of the interviews indicated preferences were variable. The two participants who used E-Tran both agreed upon two pros of E-Tran: E-Tran was reportedly easy to learn, and they were satisfied with the colors used/layout of the board components. Regarding the cons of E-Tran, both participants reported having difficulty remembering both letter location and where the colors were located on the board. Both agreed that E-Tran seemed faster than PAS.

All three participants who used PAS agreed PAS was easy to use/navigate due to the partner tracking/providing each symbol as an option. The participants who tried both methods both preferred PAS over E-Tran, and felt they would use it if verbal speech became compromised. The two participants who tried both methods reported they preferred the partner to scan for them because there was less confusion regarding where their gaze was directed. However, both participants who tried E-Tran and PAS noted that PAS seemed slower than E-Tran, PAS could be more fatiguing to one’s eyes, and reported they had difficulty paying attention to the scanning. Lastly, all three participants reported PAS could be fatiguing the eyes of the person using AAC. It should be noted, the partici-
pants agreed to look up or down for every item presented, which may have increased fatigue more than if they had sustained a downward gaze until the desired letter was presented. It should be noted eye movements were selected to use in this study, however, other motor movements may be used to signaling PAS in other contexts.
DISCUSSION

Timing

Whereas participants and data sets were limited, it was clear the participants were faster at encoding messages using E-Tran. The data sets were analyzed for rate of symbol selection, in which PAS appeared to take over twice the time of E-Tran. The results from a digital setting appeared to be consistent with previous in-person findings (Swift, 2012; Roman et al., 2010) Both Roman et al. (2010) and Swift (2012) found EyeLink was the fastest method, E-Tran was the second fastest, and PAS was the slowest method among the participants. James and Saddoris (2016a) found E-Tran to be the fastest method amongst the three.

In this study, it is likely E-Tran was superior in selection rate to PAS. One possibility for this could be because E-Tran allowed the participants to use direct selection whereas PAS required indirect/scanned selection. Direct selection is an access method that allows the person using AAC to select the symbol from a group of symbols (ASHA, 2020b). Indirect selection is an access method in which symbols are presented sequentially (ASHA, 2020b). Direct selection is known to be more efficient and less demanding of the working memory than indirect selection; however, it can require more accurate and coordinated motor movements (ASHA, 2020b). All three participants in the study had typical motoric abilities; therefore, direct selection would be the ideal choice when considering speed/rate of use among access methods.

E-Tran remained the fastest method across all contexts (i.e., determined words, novel words, and determined phrases). The time taken was determined by calculating the
symbol selection rate (rate at which the participants selected symbols in a message). The rates for each in Table 2 indicated the participants’ rates were comparable across contexts using PAS. The participants who used E-Tran indicated certain contexts may have increased symbol selection rate, as one participant increased rate in the novel words context, and the other increased rate in the phrase-level context. It is hypothesized there were differences in rate depending on the context due to the cognitive-linguistic demands of using AAC and the individual differences in processing language in various contexts.

Thistle and Wilkinson (2013) noted navigation, joint attention, device operation, and rate of message preparation all place demands on the working memory during AAC use. During tasks at the multi-word or phrase-level, “individuals using AAC must maintain full goal-message in mind (calling upon short-term memory) while searching through multiple symbols and/or navigating multiple pages (calling upon long-term memory), and correcting any errors that occur along the way” (Thistle & Wilkinson, 2013, p. 237).

Therefore, there are different demands when encoding longer messages versus shorter messages, and unique demands when reading and encoding determined words versus generating a novel message of one’s own and encoding it. Given there are a multitude of cognitive processes involved in using AAC, individual strengths and weaknesses in memory and processing skills may play a role in which contexts bring about the most timely messages.

**Accuracy**

Even though participants were faster using E-Tran, they made fewer errors using PAS than E-Tran. However, amongst the two participants who trialed both methods, it
was evident one participant found E-Tran to be significantly more challenging in accuracy than PAS. Whereas the second participant had more comparable accuracy, but ultimately made slightly more mistakes using E-Tran.

An E-Tran board is usually made from a piece of see-through Plexiglass (Perspex, n.d.) enabling a person who uses AAC to sit across from a partner and send a message by gazing at the symbols (Lloyd et al., 1997, p. 529); this differs greatly from the setup of E-Tran in the current study, in which each the person using AAC and the communication partner had their own sets of symbols symbol groups (paper cutouts as pictured in Figure 3) surrounding a webcam. During the study, there were multiple instances in which the participants and the researcher needed to recalibrate eye gaze with placement of the cutouts in order to achieve more consistent symbol agreement across the 6 locations of the cutouts. Contrary to E-Tran, PAS only required the participants to look up or down, which was easier to discriminate. During PAS, the participants could also rely on the visual scanning, the communication partner pointing to each letter, plus the auditory scanning (i.e., stating “this row” and scanning through each letter). These factors combined could have accounted for fewer errors in PAS.

The results of the accuracy data indicate the instruction of various methods of AAC must be individualized and certain methods, such as E-Tran, may require increased practice before mastery is achieved. This is especially true when the communication environment is novel, such as in the telecommunication setting. Despite minor user error, the participants successfully encoded the ten predetermined messages and five novel
words, as well as decoded messages as the communication partner, during the videoconferences. Therefore, low-tech AAC proved to be feasible in the telecommunication setting, but certain methods, such as E-Tran, may require increased instruction and practice to learn and use the adapted systems.

**Role Reversal**

All participants in the study successfully decoded the messages as the communication partner. During E-Tran, each of the two participants demonstrated minimal error, such as misinterpreting the direction of the researcher’s gaze or forgetting to confirm a letter after the researcher selected a symbol. It should be noted the error involving gaze may be attributed to the modified configuration of the E-Tran board and the orientation of the cutout pieces. When interpreting messages sent in PAS as communication partners, none of the participants demonstrated errors. As mentioned previously, there was less interpretation of gaze in PAS than in E-Tran. During the PAS trials, two participants noted slight eye and/or arm fatigue from using and holding the PAS board. All the participants in the study had average motoric abilities, however, the participation time using PAS was approximately 90 minutes, whereas E-Tran sessions lasted approximately 50 minutes. Therefore, the participants may have been fatigued as they neared the end of the 90 minute PAS sessions.

In the current study the participant was able to experience both roles, the individual using AAC and the communication partner, which allowed them to draw additional conclusions regarding preference of each method. It is clear the role reversal activity would be impacted if a participant was physically unable to hold the PAS board or had
vision difficulties, as two participants described fatigue in the interview. One participant noted eye fatigue and another noted arm fatigue when holding the PAS board. According to McNaughton and Light (2013) considering communication partner needs is an element of the maximizing communication, because communication is a “two-way street” and “success ultimately depends on both the individual who requires AAC and his or her communication partners” (McNaughton & Light, 2013, pp. 301-302; Blackstone et al., 2007).

**Preference**

The two participants who used both methods reported they preferred PAS. This contradicted the findings of Swift (2012) mentioned earlier, which found PAS was the least preferred out of E-Tran, EyeLink, and PAS. During the post-participation interviews, both participants reportedly liked the direct selection, speed, and colors used in E-Tran, but felt more assured in their accuracy using PAS. The factors influencing accuracy previously mentioned, particularly the agreement between the direction the participant felt he/she was looking and the direction that the researcher perceived him/her to be looking when using E-Tran versus PAS, may have made the participants feel better overall about the indirect selection used in PAS. Additionally, both participants trialed PAS after E-Tran but the time between methods was spaced by a week or greater between sessions. The preferences reported may have been impacted by the order of the methods if participants could not recall specific aspects of E-Tran after completing PAS.
Each participant also had unique comments about preferences using both methods. Two participants noted they felt low-tech AAC is not ideal during emergency situations that require fast communication. The comment may have been related to the time needed to spell messages versus selecting whole-words. Another participant noted that both systems may be improved if they contained personalized phrases, versus only letters, to improve speed of encoding messages. Lastly, two participants felt PAS may be easier for a communication partner to use, and PAS may be more flexible for when the communication partner is sitting beside, and not directly in front of, the AAC user.

Research Limitations

There are several limitations to the current study with regards to the participants. Firstly, the participants were students studying communication sciences and disorders at a Midwestern university who did not use AAC. The participants’ prior knowledge of AAC and how to use various methods of AAC was unclear. It would be reasonable to suggest the students had known some procedures, but asked clarification questions and made mistakes that suggested they had not practiced extensively. Therefore, it is impossible to predict if exposure to AAC via the educational curriculum had influenced the learning/practicing process used in this study more than it would have for individuals who had no prior knowledge of AAC or who had been learning to use AAC for the first time. Likewise, the participants were assumed to have the technology available to access videoconferencing and were not trained on how to use and operate Zoom (Zoom Video Communications, 2020). It is uncertain of how their familiarity with Zoom (Zoom Video Communications, 2020) and other technologies assisted their use and practice of AAC during the study.
Additionally, the data available in the study was limited due to the small number of participants. While all three participants provided data for PAS, there were only two data sets for E-Tran, therefore limiting the possibility of determining trends in the data in any of the three areas studied: timing, accuracy, and user preference. The small sample collected does not yield enough information to apply to the overall population of people who may use AAC.

**Future Research**

The current study has provided ample opportunity for further research on the subject of low-tech AAC usage within the telecommunication context. Expanding the number of participants would greatly improve the data trends and stability of statistical outcomes, and allow for more accurate analysis. Furthermore, recruiting individuals from a wide range of ages, educational backgrounds, physical abilities, and technological knowledge would allow the conclusions to be more applicable to a wider population of people who use AAC.

Additionally, trialing more low-tech AAC methods would be a realistic expansion of the current study. When trialing AAC methods, speech-language pathologists often trial multiple methods of AAC, as no one method of AAC is compatible for all people, in all environments, with all communication partners, and for all-stages of the lifespan. As McNaughton and Light (2013) stated “We need to ensure that there is a wide range of options available to meet the needs and skills of the many different individuals who would benefit from AAC as well as to accommodate changes in these needs and skills over time” (p. 200). Therefore, incorporating more methods of AAC would help researchers in
the future to understand which methods are effective for teaching AAC remotely and which methods of AAC may be suitable for remote communication amongst a diverse sample of participants.

Lastly, the data collected when encoding pre-determined words and phrases cannot compare to generating messages at the phrase-level and sentence-level that may occur when an individual is first exposed to AAC and must generate actual wants/needs. The component of data collection in which the participant generated words to encode was intended to simulate the task of encoding unwritten/un-established messages; however, this was done at word-level and not at sentence or phrase-level. Further research may allow for better understanding of which methods are preferable at conversational level.
CONCLUSION

This study examined the rate, accuracy, and user preferences low-tech communication using only eye movements for access within the telecommunication setting. The existing data suggests E-Tran was faster for some people using AAC than PAS, but PAS may be superior for making fewer mistakes in encoding messages. Preferences using systems were variable. It was evident many factors including accuracy, timing, and preference may vary depending on communication context, particularly in telecommunication.

Therefore, individualized considerations must be made when considering which AAC methods best suit an AAC user. Additionally, low-tech AAC instruction and use was feasible in the telecommunication setting. The use of low-tech AAC and the integration and instruction of low-tech AAC in the telecommunication setting should be explored further to allow individuals who rely on low-tech AAC to participate in conversation with communication partners in a variety of contexts and settings.
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APPENDIX A

PRACTICE MESSAGES

1. dog
2. paint
3. great
APPENDIX B

WORD AND PHRASE LIST

1. no
2. more
3. Friday
4. yes
5. drink
6. I want that
7. I don’t know
8. thank you
9. how are you
10. what time

Note: Typical capitalization and punctuation was disregarded when encoding messages.
APPENDIX C

QUESTIONS ASKED TO PARTICIPANTS WHO PARTICIPATED IN ONE METHOD

1. What helped your efficiency (timeliness and accuracy) using the method you tried?

2. What may have hindered your efficiency (timeliness and accuracy) using the method you tried?

3. Why might you consider using this method if verbal communication was not possible?

4. Why might you consider not using this method if verbal communication was not possible?
APPENDIX D

QUESTIONS ASKED TO PARTICIPANTS WHO PARTICIPATED IN BOTH METHODS

1. Which method did you prefer?
2. Which elements did you like about the method(s) you tried?
3. Which elements did you dislike about the method(s) you tried?
4. Which method did you feel was the easiest to use?
5. Which method was the most efficient and/or timely?
6. Which method do you feel you made the least mistakes with while using?
7. Which method could you see yourself using if necessary?