

Interacting With Persons Who Have ALS

Time, Media, Modality, and Collaboration via Speech-Generating Devices

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Individuals with amyotrophic lateral sclerosis (ALS) in later stages may rely on a variety of modalities to communicate. The current study used conversational analysis techniques to examine naturalistic face-to-face interaction between a man with late-stage ALS and his wife to understand the types of accommodations they made to ensure that successful meaning was established. Three extracts of talk were selected from a corpus of 30 videotaped interactions between a man with ALS interacting either with his wife or the first author of the study. The extracts were examined for the type of communicative resources used and the ways in which conversants worked together to maintain the temporal-sequential demands of in-person interaction. Conversants used a variety of communication modalities during their social interactions including voice, body, gestures, a speech-generating device (SGD), and the SGD screen to construct utterances for one another, establish meaning, and stay in-time. The pair were successful and maintained conversation expectations in many ways similar to those with nonimpaired voices and bodies. Conversations including an SGD are a highly coordinated and interactive affair that is experienced jointly by all conversants. In this study, the conversational partners were aware of, and sensitive to, the temporal-sequential demands of in-person interaction and the modality restrictions associated with SGD use. Clinical and device design recommendations are discussed. **Key words:** *amyotrophic lateral sclerosis, augmentative and alternative communication, conversation analysis, in-person interaction*

INTEGRATING a high-tech augmentative and alternative communication (AAC) system such as a computer-based tablet with synthesized speech to assist in carrying out a conversation can be complicated. Individuals whose natural speech is not adequate to

meet their daily communication needs have to make a variety of choices about what communication modalities to employ and when to use them to produce their conversational turn while attempting to meet temporal expectations placed on them by the spoken language community (Higginbotham & Wilkins, 1999; Robillard, 1999). In this article, we account for some of the intricacies and choices made by users and their communication partners to construct coherent conversations as well as the challenges they face in doing so. To illustrate some of the ways that speakers using AAC and their partners work to manage their conversations, we present an analysis of three stretches of interaction produced by J., an individual with late-stage amyotrophic lateral sclerosis (ALS), and T., his wife, during everyday conversations taking place in their

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home. To appreciate the accomplishments of this dyad, we first present some of the contemporary views on the study of conversation and its application to augmentative and alternative communication. Terminology relevant to the study of conversation is introduced in the following section.¹

WHAT IS CONVERSATION?

In this article, we define the term *conversation* as naturally occurring talk. This is an inclusive definition inviting the reader to inspect the ways in which talk—spoken, written, gestured, and so forth—is used within social interaction. This perspective is embraced by a number of methodologies including conversation and discourse analysis, ethnography, and microanalysis (Higginbotham & Engelke, 2013; LeBaron, 2005; Meredith, 2015; Ochs, Graesch, Mittman, Bradbury, & Repetti, 2005). Here are some of the aspects of conversation that are important to our discussion of communication modality and AAC use:

- *Conversation is ubiquitous.* Conversation is a primary means through which culture and communicative meaning are constituted. Its basic, though not only, form is conducted in person, that is, its participants are both *co-present* (in the same space) and *co-temporal* (present at the same time). *Face-to-face* interaction is a type of *in-person* interaction in which participants are in close proximity and able to see one another's faces. In contrast to face-to-face interaction, texting does not require the interactants to be either co-present or co-temporal to converse with one another.
- *Conversations are performed and experienced.* Conversations are accomplished by performers: speakers and addressees (i.e., persons to whom one is speaking). Conversations are spontaneous, and coordinated interactive productions are carried out through multiple communication modalities (Higginbotham & Yoder, 1982). At the same time as a conversation is being performed, it is being experienced by its participants. To account for what goes on in a conversation, researchers need to be concerned about describing the performance and looking for behavioral evidence as to how a conversation is experienced by its performers.
- *Conversation is experienced in-time.* Conversation operates on an *enchronic* timescale, that is, the time frame in which humans engage in the move-by-move exchange of turns and talk. The enchronic timescale of face-to-face interaction—the formative environment for language development—is, temporally speaking, a high-pressure realm (Clark, 1996; Enfield, 2017). Most conversations are conducted at a rapid pace with few gaps within or between speaking turns. Silent gaps are to be avoided, and when they occur, they are often perceived by the conversation partner as being indicative of a problem on the part of the current speaker (Schegloff, Jefferson, & Sacks, 1974). The term *in-time* refers to the enchronic timescale of conversational interaction. Staying in-time presents difficulties for many individuals who use AAC devices, and failure to do so can lead to a multitude of problems (Higginbotham, Fulcher, & Seale, 2016).
- *Conversation is emergent.* A basic property of spoken conversation is that it is *sequentially structured*. Participants produce their communicative actions and derive meaning from the preceding actions with respect to their sequential position within the interaction (Atkinson, Heritage, & Oatley, 1984). That is, each utterance or communicative action is

¹In this article, we introduce several terms reflecting the analytical orientation of the authors. The term *conversant* is synonymous with interlocutor, referring to an individual engaged in conversation. *Augmented speaker* and *vocal speaker* refer to individuals who use augmentative means or their voice, respectively, to issue linguistic utterances. These terms are precise and nonpejorative.

affected by the preceding context and at the same time, and in turn, shapes subsequent utterances and actions in the conversation (Higginbotham & Engelke, 2013). When it is in everyone's interest to cooperate, conversants strategize to make their contributions understandable to their addressee by anticipating what their partner needs to correctly understand the speaker's intentions. This activity, referred to as *recipient design*, is a fundamental feature of most forms of interaction, including conversation (Schegloff et al., 1974). As noted by Goodwin (1979), we design our talk on an ongoing basis to meet the perceived needs of one's interlocutor. In response, our partner is obliged to provide feedback as to the success of our contribution through his or her attention, actions (e.g., head nod, gaze and facial gesture, verbal tokens such as "ok," "uh-huh"), or a spoken response that demonstrates the prior utterance was understood. This ongoing display of coordinated actions used to establish and maintain meaning during conversation is called *grounding* (Clark, 1996; Clark & Brennan, 1991). Conversants use a wide variety of grounding strategies to evidence their understanding of an ongoing conversation, related, in part, to the purpose of the conversation, the interaction media, and communication modalities available for interaction (Clark, 1996; Clark & Brennan, 1991; Goodwin, 2018).

USING MULTIPLE MODALITIES FOR IN-PERSON INTERACTION

When people talk, they perform their conversations with their bodies—intonation and vocal qualities, facial and limb gestures—in relation to the interaction media, objects, and context in which the interaction occurs. Conversation is a multimodal co-performance in which the participants coordinate their presentations through time to make their contributions understandable to their partner. In

this article, we define *modality* as the various media, objects, and context (e.g., time, place, common ground) used to formulate utterances during interaction by virtue of the conventional sign system(s) and the forms of reasoning available to the speaker (D. Wilkins, personal communication, 2009). The choice of which resources to use shifts depending on a variety of factors, both internal and external to the participants in the interaction, to ensure utterances are grounded and designed with their recipients' needs in mind (Clark & Brennan, 1991; Deppermann, 2013; Levinson & Holler, 2014; Levinson & Wilkins, 2006; Wilkins, 2009). Modalities involving gesture, body orientation, and voice² are commonly employed during utterance production to ensure that it is appropriate and meaningful for one's conversational partner to achieve successful interaction (Beeke, Maxim, & Wilkinson, 2007; Damico, Simmons-Mackie, & Wilson, 2006; Goodwin, 1979, 2000, 2018; Jewitt, 2008; Schegloff et al., 1974; Streeck, Goodwin, & LeBaron, 2011).

AUGMENTATIVE AND ALTERNATIVE COMMUNICATION: A HYBRID COMMUNICATION MEDIUM

In our relatively recent evolutionary history, humans have begun to use new forms of media for interaction: handwriting, printing, e-mailing, telephoning, texting, social networking, video conferencing, and so forth. Each interaction medium provides different technological features that extend communication beyond the boundaries of in-person interaction (e.g., texting and e-mailing interactions do not require participants to be in the same physical space or communicate at the same time; Seale, Bisantz, & Higginbotham, 2019). At the same time, its users develop the means to compensate for the media's inability to achieve the communication flexibility of

²In this article the term *voice* refers to both the acoustic and perceptual qualities of vocalizations, inclusive of speech, paralanguage, and vocal quality.

in-person interaction (e.g., use of emoticons in text messaging and e-mails to provide emotion/affiliative information that is generally available during in-person interaction).³

Within this general framework, speech-generating devices (SGDs)⁴ such as mobile devices or other computer-based systems producing synthesized speech can be seen as a hybrid interaction medium. They are equipped, *by design*, with typing tools to compose text or graphic-based messages but purposed to serve as a “talking” tool for in-person interaction. In fact, SGDs are doubly hybrid in that they not only employ properties of both spoken and text-based media but also the augmented speaker’s partner utilizes oral speech to communicate, as opposed to the same media form as the augmented speaker. Table 1 provides a list of some of the media features associated with in-person and long-distance interactions, including SGD use (Clark, 1996; Clark & Brennan, 1991; Higginbotham & Caves, 2002; Higginbotham et al., 2016; Seale et al., 2019). It should be noted that all forms of AAC technology can be considered within this framework (Hanson, Beukelman, & Yorkston, 2013; Johnston, Reichle, Feeley, & Jones, 2012).

To appreciate the hybrid nature of the SGD interaction medium, it is important to understand the media characteristics of these technologies in contrast to spoken and text-based communication. In-person interaction is both *co-temporal* (i.e., communicate in the

same time frame) and *co-present* (i.e., participants are in the same place). Talk produced with the mouth is well adapted to in-person constraints as it is audible and is produced with few temporal gaps between speaking turns, enabling a mostly successful style of social interaction within an enchronic timescale (Clark, 1996; Clark & Brennan, 1991). Phone calls possess many of the same features as in-person interaction, but the lack of co-presence forces participants to do more interactive work with their voices, perhaps making the adherence to the sequential aspects of turn taking so critical for successful grounding.

Speech-generating devices are used in in-person contexts to engage in conversation but possess the compositional features of text-based systems, including some ability to revise one’s compositions before issuing them as utterances. For example, a person using an SGD could start composing his or her utterance while checking for completeness and accuracy of that utterance. If the utterance is not sufficient, it can be revised and changed before the conversational partner hears the utterance. This is different from face-to-face interaction involving two vocal speakers, as message composition and delivery comprise an essentially simultaneous process, and if a problem occurs, it is repaired interactively before proceeding further in the conversation (Clark, 1996). The doubly hybrid nature of SGD use comes to bear when the individual using an SGD is compelled to interact within the temporal-sequential expectancies of in-person interaction of the spoken speech community and their means for utterance composition—the SGD introduces significant delays in utterance production (Higginbotham et al., 2016). For example, in response to the current topic of conversation (e.g., a book everyone is reading), a person using an SGD may begin composing his or her utterance. As he or she is typing how much he or she liked the book, the other oral communicators move on to a new conversational topic. When the SGD user produces an utterance, it may no longer be relevant to the ongoing conversation,

³The terms *communication modality* and *interaction media* are related and can be used interchangeably at times. The distinction between the two terms is a matter of focus: *communication modality*, while including communication technology, originates from the individual’s propensities to use the modality for communication. *Interaction media*, while including the individuals, centers on media properties, interaction characteristics, and communication costs associated with the particular medium selected.

⁴In this article, we use the term *speech-generating device* (SGD) to refer to any device that allows for text-to-speech synthesis. When the term *AAC devices* is used, it refers to the broad range of systems, tools, and technologies that individuals with complex communication needs may use to support or replace vocal speech.

Table 1. Features required for successful grounding within the situations that the media is used

Features	Media							
	Communication In-Person				Communication at a Distance			
	Oral Speech	Letter Board	SGD w/Visual Display	Phone	E-mail	Text Message	Social Media	
Context								
<i>Co-temporal:</i> Participants can communicate within the same time.	+	+	+	+	–	–	–	
<i>Co-present:</i> Participants are in the same physical environment.	+	+	+	–	–	–	–	
Media properties								
<i>Permanent:</i> Participants' actions leave a record or artifact.	–	–	±	–	+	+	+	
<i>Audible:</i> The medium is audible.	+	–	+	+	–	–	±	
<i>Visible:</i> The medium is visible.	–	+	±	–	+	+	+	
<i>Extrinsic production:</i> The message is composed and issued outside the body.	–	+	+	–	+	+	+	
Interaction restrictions								
<i>Sequence:</i> Turn sequence needs to be preserved.	+	+	+ ^a	+	–	–	–	
<i>Time:</i> Participants need to take turns with little or no temporal gap between them.	+	+	– ^a	+	–	– ^a	–	
Interaction adaptations								
<i>Simultaneous:</i> Participants can send and receive signals simultaneously.	+	+	±	+ ^a	–	–	–	
<i>Review/Revise:</i> Participants can review and revise utterance before speaking and/or after receiving.	–	–	+	–	+	+	+	
<i>Directness:</i> Utterance can be directed to specific individual.	+	+	–	+	+	+	–	
<i>Self-expression:</i> Participants take actions as themselves and when to take them.	+	–	±	+	+	+	±	

Note. – = feature or property not operative for specific interaction mode; + = feature or property operative for specific interaction medium; ± = feature or property available and optional in given circumstances; SGD = speech-generating device. Copyright 2019 by Jeff Higginbotham. Used with permission.

^aInability to comply to the societal standard puts the speaker's utterance at risk of being misheard or misunderstood.

being *out-of-context* to the other conversants (Robillard, 1999). Furthermore, it is common for interlocutors to refuse to interact with the augmented speaker or abruptly shift their attention to speaking with someone else. Robillard indicates that these *not now* actions occur because the interlocutor does not have enough time to wait until the augmented speaker finishes his or her utterance composition. Thus, provided with technologies designed for written composition, augmented speakers have to find alternate ways to deal with the enchronic in-time problem to engage in successful interactions.

AAC-MEDIATED IN-PERSON INTERACTIONS

As previously stated, conversants design utterances with their partner in mind, offer contributions in a constrained temporal order, and layer multiple communicative resources to ensure meaning is achieved. These expectations are in place for all speakers regardless of differences in bodies or voices. Speakers who have bodies that do not allow them to conform to the typically accepted cultural expectations of talk may need to make adaptations to ensure that recipient design, grounding, and staying in-time are maintained and achieved (Bloch & Wilkinson, 2004; Higginbotham & Wilkins, 1999; Robillard, 1999). The maintenance of recipient design has been examined in several personal accounts. Robillard (1999), a social scientist, wrote about his experiences in communicating throughout his physical decline due to a diagnosis of ALS. Robillard communicated through lip movements and/or alphabet boards that were interpreted and vocalized by his communication partners. He discussed how his body and voice breached the social contract of in-person interaction, which limited his ability to be an active participant in the conversational landscape. For example, Robillard writes:

The institutionalized, naturalized, socially consensual order of conversation has a rhythm, a time order, that assumes an intersubjective coordination

of physical human bodies. Having a body that could not inhabit this time order breached the normalized conversational environment every time I tried to talk. (p. 63)

He also noted that it is not just his inability to produce intelligible speech in time that makes communication difficult but also his inability to access other communicative resources such as gestures, facial expressions, and head movements when constructing utterances that put him at a disadvantage during in-person interaction.

Speech-generating devices offer potential solutions to address some of these problems as they were designed so that individuals could compose intelligible messages that are acoustically available to other conversational recipients. Although these devices ensure text-to-speech capabilities, their design may not account for all aspects of in-person interaction such as grounding, modality, and timing (Brennan, 1998; Higginbotham & Caves, 2002; Higginbotham et al., 2016; Higginbotham & Wilkins, 1999; Müller & Soto, 2002). Speech-generating devices may force communicators to select specific resources (e.g., type instead of gesture) and make adaptations to recipient design (e.g., cannot change written composition to meet real-time needs of the partner) so that successful mutual meaning can be achieved. Even with potential issues regarding in-time interaction with SGD, research in AAC-mediated conversations has demonstrated that interactants frequently employ multiple strategies to ground contributions and maintain close timing, including (1) partners filling-in almost completed contributions; (2) use of voice, gestures, and objects in the environment in conjunction with SGD output; (3) co-participatory reliance on the SGD display screen; and (4) establishing an *interaction policy* (Bloch, 2005; Bloch & Wilkinson, 2004; Higginbotham, 2009; Higginbotham et al., 2016; Higginbotham & Wilkins, 1999; Wilkinson, Bloch, & Clarke, 2011). These strategies are described in more detail in the following text.

Filling-in almost completed contributions

When augmented speakers use a letter board as their primary means of utterance construction and delivery, the speaking partner tends to fill-in parts of the utterance that have not yet been completed by the augmented speaker. For example, a complete contribution might be produced over multiple turns as the conversational partner fills in parts of the contribution based on semantic and syntactic cues (Bloch, 2005; Higginbotham, Mathy-Laikko, & Yoder, 1988). This allows the individual using a letter board to hold the conversation floor and keep timing delays at a minimum as quick turn taking is maintained, even though complete contributions are not given in one turn. By co-constructing a single utterance over multiple turns, the speaking partner must be an active participant as he or she is responsible for grounding the augmented speaker's actions through word and letter repetitions, and repeating or recasting the completed utterance (Bloch, 2005; Higginbotham, 1989).

Gesture and object use

Individuals with impaired voice and bodies may choose to use gestures, pointing, facial expressions, and vocalizations to ground utterances even when an SGD is available. For example, Hörmeyer and Renner (2013) found that individuals with complex communication needs typically delivered confirmations and denials via gestures, head nodding, and head shaking instead of using an SGD. Similarly, Pilesjö (2014) investigated the communication modalities utilized by a girl with complex communication needs with her family and teachers during in-person interaction. The girl in this study used specific hand movements, arm movements, and eye gaze to index wanted items in her environment. Also, Higginbotham (2009) showed how an augmented speaker and a vocal speaker used the SGD and available physical artifacts (e.g., a clock) to establish how long they had until a speaking engagement started.

SGD display screen

During AAC-mediated interactions, vocal speakers orient themselves so that they can see the SGD display screen and use the information displayed as a resource for their talk and continuing interactions (Bloch, 2011; Higginbotham, 1989; Higginbotham & Engelke, 2013; Luo, 2009; Norén, Svensson, & Telford, 2013; Wilkinson et al., 2011). For example, Bloch (2005) and Higginbotham and Engelke (2013) used conversation analysis techniques to examine the talk and actions involving individuals with ALS and their communication partners during in-person interaction. Bloch (2005) found that the vocal speaker would consistently complete the augmented speaker's partially composed utterance because they had visual access to the SGD screen. Similarly, Higginbotham and Engelke (2013) documented that a vocal speaker visually referenced contributions that were in the process of being typed by an individual using an SGD and used these in-process utterances to answer her ongoing questions. Higginbotham (1989) noted that when participants did not have access to the electronic output display, four times more repair sequences were observed than when the participants had visual access to the electronic output display. Furthermore, Higginbotham et al. (2016) documented the interaction of a woman with ALS and her husband in which the woman would physically give her iPad to her husband so that he could read her contribution off the SGD screen. This strategy enabled the husband to clearly receive his wife's contribution as he found the text-to-speech output difficult to understand. Also, the wife's contribution was permanently displayed for the husband to reference as he completed the directions ensuring he did not have to ask for follow-up repetitions that could prolong the duration of the task (Higginbotham et al., 2016).

Establishing an "interaction policy"

As evident in previous research, individuals with impaired voices and bodies and their nonimpaired conversational partners are

sensitive to the timing delays and modifications needed when conducting in-person interaction with an SGD (Higginbotham et al., 2016). When examining a database of conversations from 27 individuals with ALS and their communication partners, Higginbotham et al. (2016) noted that a number of vocal speakers would attempt to establish conversational guidelines to collaborate with the augmented speaker. For example, vocal speakers would tell the augmented speaker how to organize his or her contribution and preferred modes of delivery. Typically, vocal speakers would instruct the types of words to use, the length of the utterance, and how they would like it delivered (e.g., one word at a time, reading off the screen). These strategies allowed for the minimization of timing delays and assurance of intelligibility—from the vocal speaker's point of view.

CURRENT STUDY

The utilization of an SGD during in-person interaction changes the way in which utterances are constructed and changes the resources conversants select. Although research has shown that augmented speakers and their vocal speaking partners can be successful and maintain some conversational expectations, SGD-mediated interaction continues to be problematic in terms of timing delays and grounding. Also, given the conversational constraints an SGD places on in-person interaction, the augmented speaker may be a less active communicator, causing his or her conversational partner to assume a lack of communicative competence. For the current study, we selected SGD-mediated interactions that were relatively nonproblematic and contained accommodations to interaction that allowed the conversants to be successful communicators. The rationale for examining these successful interactions is to document and understand the types of accommodations used to achieve success in recipient design, grounding, and timing. With this information in mind, the field may be able to create devices and clinical recommendations to help increase the likelihood of

sufficient grounding and timing in augmented interactions. The specific aim of the current investigation is to examine the accommodations and strategies an augmented speaker and a vocal speaker use to successfully design utterances, ground meaning, and stay in time during SGD-mediated interaction.

METHOD

Participants and conversational dyads

The following analysis focused on J., a man in his late 50s with bulbar ALS, and his wife of more than 25 years, T. Prior to his diagnosis, he worked as a lawyer and enjoyed interacting and conversing with others. J.'s wife T., a woman in her mid-50s, worked as a physician and medical director at a local college. Approximately 9 months after receiving the diagnosis, J. began to use a Lightwriter (Model SL35M) AAC device to compensate for his speech intelligibility problems.⁵ The video segments used in this study were taken from a corpus of 30 videotaped sessions involving J. interacting with his wife or the first author. The analysis presented in the following text was conducted 1 month after J. had received his AAC device.⁶ At that time, J. actively used his severely dysarthric speech for interaction. J. demonstrated difficulty walking and used a cane for support. Also, J.'s movement in his left dominant hand was limited and therefore he relied primarily on his right arm and hand for gesturing, grasping, and device use. The video was taped while J. and T. were having lunch at their home. The video included lunch preparation, mealtime, and cleanup. Topical

⁵The Lightwriter is a text-to-speech output device, where there is a keyboard, one screen facing the device user, and a second screen facing outward. The user can compose utterances letter by letter and then can control the type of speech output used to present their utterance to their speaker.

⁶In addition to the Lightwriter, J. also was using a whiteboard, speech supplementation letter board, and started using a Dynavox VMax in anticipation of his future need to utilize eye tracking. While a variety of modalities were available, J. preferred to use his Lightwriter.

talk focused on current events, the couple's children, and J.'s medical status. In the majority of the video, J. was seated at the dining room table with his back facing the entrance to the kitchen. T. would enter and exit the dining room from the kitchen entrance behind J. and would sit on the right of him or stand on either side of him depending on the activity in which they were engaging. One video camera was used to capture the interaction and was placed directly in front of the dining room table facing J. so that all actions occurring in the dining room and entrance to the kitchen were captured.

Transcription and analysis

A detailed descriptive analysis of the interaction between J. and T. was undertaken. The analysis was motivated by contemporary research in talk-in-interaction and conversation analysis (Bloch, 2005; Clark, 1996; Goodwin, 2000; Jefferson, 2004; Ten Have, 2007). For the purposes of this study, the term *talk* refers to auditory and visible actions produced by conversants during

conversational activity. Speech, intonation, gestures, overlapping speech, pauses, SGD output, object use, and all other actions were transcribed using conventions developed by Jefferson and colleagues (Jefferson, 2004; Ten Have, 2007). AAC output was transcribed using capital letters and device selections were represented through plus signs.

The transcription and annotation were completed using version 2.4.2 of the Transana video transcription software package (Woods, 2010). After initial transcription and annotation were completed, conversational analysis was used to analyze the video extracts. This form of analysis is descriptive and has the goal of providing an accurate accounting of the interactions in the collection being analyzed. In addition to applying a set of transcription and analytical procedures embraced by conversational analysis practice (Higginbotham & Engelke, 2013; Psathas, 1995; Ten Have, 2007), initial findings are shared in data sessions involving several researchers involved in similar projects. For this study, the extracts shown in Figures 1–3 were initially

Line	Time (in sec)	Speaker	Talk (T), Gaze (G) and Actions (A)
1	0.0	T A	((walks in to dining room from kitchen holding two food containers))
2		J A	((sitting at dining room table, drinking coffee))
3	1.4	T	((stands at table - sets containers down - opens containers and shuts it))
4		T	we have left over sweet potatoes
5		gaze T: Jc	T: Jc
6		J A	((drinking coffee)) ((puts coffee down and looks at containers))
7	3.6	T	((taps one finger on 2nd container))
8		T	mashed potatoes
9		gaze T: Jc	
10	6.9	T	((rotating gestures with hands))
11		T	i have a little ham you know thats chopped up
12		gaze T: Jc	T: Jc
13	8.9	T	:mmm
14		J A	"((head nod))
15		T	uhhm (.) or i have that broccoli soup (.) or i can make you a smoothie
16		gaze T: Jc	
17	17.6	J	((taps once on sweet potato container then twice on mashed potato container))
18		T	:mmm
19		gaze T: Jc	
20		T A	"((taps on sweet potato container))
21	19.0	A	((taps twice on mashed potato container)) ((picks up containers from table))
22		T	>mashed (xxx)< with the ham in it? okay alright let me mix it up
23		gaze T: Jc	
24	20.9	J	"((head nod))
25		T	"::eahh



J and T mutually gaze at the food containers while T is delivering her contribution



T employs gestures for objects that are not on table and J visually attends to her actions



J deploys tapping gestures as a means to construct his contribution

Figure 1. Extract 1.

Line	Time (in sec)	Speaker	Talk (T), Gaze (G) and Actions (A)
1	0.0	J A	((sitting in dining room typing on lightwriter constructing an utterance))
2	0.0	T A	((behind J in kitchen preparing lunch))
3	2.1	J A	((selects button on lightwriter and device emits a low beeping sound))
4	4.8	J A	((second low beeping sound produced by device))
5	6.4	J A	((third low beeping sound produced by device))
6	9.8	J A	((slides lightwriter over to the right hand side of the table closer to the edge of the table)) Waits, right hand touching left part of keyboard. presses key.
7	15.9	J T	CAN YOU CALL DENTIST AND ASK IF THEY RESPONDED TO INDEPENDENT HEALTH
8		A	"((slightly tips head up and to right hand side))
9	20.9	T	ummm (2) yes ill call after we eat
10		A	"((walks from fridge to island in kitchen that is behind J))
11	25.0	T	ooahh
12		J A	((nods head))
13	26.6	T	let me write it down so i dont forget
14		A	"((begins to walk on other side of kitchen island closer to J))
15	31.1	J T	ehhh (2) ahhh vaeh
16		A	"((slightly tips head up and to right hand side))
17		T A	((looking in drawer))
18	35.1	T T	hold on hold on
19	37.4	T	dentist. see if (1.0) they -
20		A	((flipping over piece of paper starts to write))
21	39.4	J T	"CAN YOU CALL DENTIST AND ASK IF THEY RESPONDED TO INDEPENDENT HEALTH
22	44.2	T T	right if they got - if theyve gotten approval yet right?
23	46.8	J T	eahh
24		A	((moves head up))
25	47.3	T T	alright after we eat i will



While T is occupied in the other room, J completes a complete utterance instead of issuing the utterance word-by-word.



J moves his Lightwriter over to the side of the table and reissues his utterance to help T remember his utterance more easily.

Figure 2. Extract 2.

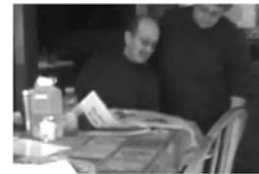
transcribed and analyzed by the first author, iteratively re-transcribed and analyzed by both authors until consensus was reached, and then presented to four other members of the

authors' laboratory. Members of the group included a doctoral student with a PhD in linguistics, a PhD student in linguistics, and two doctoral students with master's degrees

Line	Time (in sec)	Speaker	Talk (T), Gaze (G) and Actions (A)
1	0.0	J	((in dining room, seated at the table, constructing message using Lightwriter))
2		T	((in kitchen behind dining room preparing lunch for J))
3	6.5	J	I SEE IN PAPER PRESIDENT OF RPI MAKES ONE POINT SIX MILLION DOLLARS A YEAR
4	12.6	T	((from other room)) yeah isn't that incredible
5	14.2	J	((looking at newspaper)) eeahh (-) wow
6	18.9	T	((from other room)) who else are the highest paid
7	22.0	T	((walks in to the dining room))
8		J	((looking at newspaper))
9	22.9	T	they said a whole bunch of them make over a million who are they
10		A	"sets bowl down on table" "walks to left side of J and looks at newspaper
11		G Ts Js	Ts Js
12	25.33	J T	eeeahh
13		G Ts Js	Ts Js
14	29.0	J A	((begins typing on lightwriter low beep emitted from device))
15		G Ts Js	Ts Js
16	31.2	T	its a women at RPI
17		A	((looking at newspaper))
18	32.8	J	PRES ### OF ##### SUFFOLK
19		A	((typing on lightwriter))
20		G Ts Js	Ts Js
21	37.7	T	"ssssuffolk universi-
22		G Ts Js	Ts Js
23	40.4	T T	wow i know the woman who runs the health center there
24	43.3	J T	WHICH ### IS ### NOT ## A ##### GREAT #####
25		G Ts Js	Ts Js
26		A	((looking at newspaper)) "((stands up, turns body to the right, looks at device)
27	54.1	T T	i know! thats what i was thinking i mean its-
28		A	((looking at device))"((starts walking away back towards kitchen))
29		G Ts Js	Ts Js Js
30	54.3	J	"SCHOOL" "eeahh
31		A	((typing on device)) ((looks up)) ((looks back down at device))



J constructs a full message using his Lightwriter while T is in the kitchen preparing lunch



J and T both use the newspaper to construct messages and reference their intended meaning



T actively looks at and reads from J's device screen. She comments on his complete utterance before it is fully issued. Allowing the dyad to stay in close temporal proximity.

Figure 3. Extract 3.

in speech–language pathology. On the basis of feedback from the team, discrepancies were resolved for the final transcription.

RESULTS

We purposefully selected three extracts during J. and T.’s mealtime to illustrate the ways multiple modalities including bodies, technologies, and objects were used in time to construct utterances and achieve mutual meaning. The selected extracts exemplified the variety of modalities that the pair used during their social interactions. Use of these modalities varied depending on the physical proximity J. and T. shared with one another. Analysis of these extracts is described in the following text. Table 2 provides a description of the conventions used in the extract transcripts.

Environmental and body-based modalities: Interaction in close physical proximity

In Extract 1, T. and J. are together in the dining room discussing what J. is going to have for lunch. T. walks into the dining room, places two food containers on the table, and indicates what food options are available (Lines 4–8). T. constructs and delivers her utterance by pointing to, opening up, and verbally labeling the food containers. During this time, J. coordinates his gaze to the food containers as T. points and verbally labels them. Next, T. directs her gaze to J. and with a rotating hand gesture indicates that the ham can be mixed in with two potato options (Line 10). T. then offers the last food options verbally as they are back in the kitchen (Lines 11 and 15).

Table 2. Legend for notations used in transcripts

Notation	Definition
(walks in to dining room)	Text in double parentheses is a gloss or description of the nonverbal actions by conversants
∨ or ^	Up and down arrows are used to show when specific actions, talk, or gaze occurs within the ongoing interaction
T _c J _c , T _j J _t	Notes where J. or T. were directing their gaze. The capitalized letter represents the conversant and the small subscript letter represents where they are directing their gaze (e.g., to each other, to a container, an object)
::ooh	Colons indicate an extension of the sound or syllable. More colons indicate a longer stretch/prolongation of the sound or syllable.
(.)	A period in parentheses indicates a time interval of one tenth of a second or less that occurred in the stream of talk.
(xxx)	A series of xs in parentheses indicates that talk was present, however, the transcriber was unable to correctly identify the talk of the specified conversant.
>mashed potatoes<	Talk presented in between > < symbols indicates that speech rate was increased or rushed.
I SEE IN PAPER	Talk presented in capital letters represents talk that was issued by the SGD.
#	Pound signs represent the number of button presses used by the SGD user to construct contributions.

Note. SGD = speech-generating device; the transcriptions presented here combine conversational analysis conventions proposed by Gail Jefferson (see Atkinson et al., 1984; Jefferson, 2004) as well as those presented by Higginbotham and Engelke (2013).

As T. completes her utterance, J. continues to coordinate his gaze on T. and her hand gestures. Within 0.3 s of T.'s utterance completion, J. makes his food choices by tapping twice on the sweet potato container and then twice on the mashed potato container (Line 17). At the end of the interaction, T. and J. mutually confirm J.'s lunch selections (Lines 22–25).

In this extract, both conversants coordinate meaning in-time by mutually using food containers, gestures, gaze, and their voices to construct utterances that are understandable and maintain the typical pace of spoken conversation. The food containers offer an immediate resource for each participant to construct utterances and manage turn exchange within a coordinated and timely manner. T. utilizes the food containers to physically show what options are available and, in turn, J. adopts the food containers as means to state what he would like to have for lunch. When physical resources are not available, T. designed her vocal communication and gestures to represent various lunch options, affording J. the ability to quickly make his lunch choices through vocalization and pointing. This offer-response sequence is an example of a fundamental sequential structure in conversation, the *adjacency pair*, in which the preceding utterance obligates the speaker to provide a specific response, as in this case, whether the food being offered is acceptable. Designing her utterances in this way ensures that T. can respond in-time using the communication modalities available to J.⁷

Throughout this interaction, turn taking was coordinated, nonproblematic, and exhibited few pauses in between participants' actions. T. and J. mutually coordinated their gaze, talk, and actions to deliver utterances

in a timely and organized manner. Despite his impaired voice and body, J. matched T. in the temporal delivery of his contributions.

It is of note that this interactional exchange was successful without an SGD. J. chose not to use his Lightwriter, even though it was on the kitchen table within reach just next to the food containers. The ability to output intelligible utterances via an SGD would be associated with timing delays due to setup, utterance composition, and delivery. Also, J. would have to direct his gaze and actions toward the device and not toward T. and the physical objects in the immediate environment. By utilizing physical objects and body-based resources as modalities for utterance construction, both J. and T. stayed in-time and J. was able to match his actions with those of his partner.

SGD modality: Interactions with no physical proximity

In contrast to the previous extract, Extract 2 illustrates J. using an SGD to compose utterances when T. is working in the kitchen, preparing food. This extract begins with J. composing a full utterance on his Lightwriter. During this time, T. is standing behind him in the kitchen preparing lunch. Before issuing his utterance, J. turns the volume up on his device (evidenced by the three low beeps emitted from his device) and then moves his device to the edge of the table where it is facing the kitchen. Once J. has properly positioned the device, he issues his full request to T. She responds to J.'s utterance and states that she needs to write down his request so that she will not forget to complete the task. During a 5-s pause in talk, T. searches for a paper and pen and J. slightly rotates his head to look behind him while positioning his hand on the device to reissue his utterance if needed. J. then attempts to use his dysarthric speech to remind T. of his request; however, she is still looking for paper to write down the request and asks him to hold on. T. begins to repeat J.'s request aloud but slightly pauses when writing. During this 1-s pause in T.'s speech, J. reissues his

⁷It is important to note that the adjacency pairs are a common interaction structure found throughout instructional therapy discourse, as well as everyday talk with individuals with communication disabilities (Goodwin, 2003; Solomon-Rice & Soto, 2011; Weeks, 1985; Zemel & Koschmann, 2011).

utterance and the extract ends with a confirmatory sequence.

During this interaction, J. and T. are not positioned face-to-face but are separated from each other by approximately 10 ft. With T. attending to food preparation, J. chooses to compose his entire utterance before issuing it as a complete contribution. J. utilizes his Lightwriter to issue complete utterances when T. is not in proximity. J.'s use of this completed utterance delivery strategy is consistent with T.'s attention to her current activity. By not delivering his message until it is fully prepared on the SGD, J. displays sensitivity to the fact that T. needs to attend to two activities at the same time—her ongoing work and his incoming utterance. That is, the prior preparation of the message on the SGD and the timing of J.'s delivery provided T. with an opportunity to attend to both her work and J.'s message.

During the conversation, J. orients to the attentional demands placed on T. First, to account for T.'s position behind him, he increases the volume of his device and moves it so that his utterance is more likely to get T.'s attention. These actions increase the probability of T. understanding J.'s request. J. pauses for approximately 3 s. During this time, J. does not erase his utterance but keeps his hand positioned and ready to reissue his contribution if needed. Next, T. starts writing down J.'s request, simultaneously repeating back J.'s words. T. pauses for approximately 1 s. After this pause, J. repeats his request using his SGD. J. may have reissued this request because his initial request interrupted T. while she was completing another task. J.'s success in managing this interaction is related to how he designed his messages to meet the attentional needs of T.

The interaction timing differences seen between this extract and the previously presented extract may be impacted by the participants' lack of physical proximity and engagement in separate activities. In contrast to Extract 1, the prolonged pause times in this example may reflect attentional demands of food preparation on T., as she attempts to

comprehend the meaning of J.'s utterance. Evidence for T.'s comprehension difficulties is reflected in the time spent to confirm J.'s utterance. Prolonged pauses and extended confirmation sequences were not observed when interactants were in the same room and could reference objects available in the physical space. Even though the dyad had to take an extended amount of time confirming J.'s request, the pair worked together and responded to each other's attentional states in an appropriate manner. In addition, J. was able to complete his interactional goals even with his impaired body, dysarthric speech, and the demands his SGD placed on the interaction.

Combination of modalities: Interaction with changing physical proximity

Extract 3 begins with J. sitting at the dining room table reading the newspaper while T. is behind him in the kitchen preparing lunch. During this interaction, J. and T. converse about a news story that J. is reading in the paper. In this extract, J. and T. ground their utterances by relying on all previously discussed resources: physical objects, voice, gesture, gaze, and SGD output. At the beginning of this extract, J. composes an entire utterance using his Lightwriter, before issuing it to T. (Line 3). Shortly thereafter, T. walks into the dining room, asks J. a question regarding the news story, then moves behind J. and begins to read the newspaper herself (Lines 9–17). At this time, J. switches his Lightwriter to word-by-word output and then constructs his response to T.'s question. While J. is issuing his response, T. reads part of the news story aloud that overlaps with J.'s SGD output. As J. is issuing his next contribution, T. shifts her body and gaze away from the newspaper and toward the Lightwriter display (Line 20). With her body and gaze now aligned to see the Lightwriter display screen, T. responds to J.'s ongoing utterance in time without waiting for the SGD to initiate the text-to-speech output (Line 23).

J. and T. select different communication modalities to compose utterances as their

physical proximity to one another changes. First, J. chooses to use his SGD to construct an entire utterance while T. is in a different room engaged in a separate activity. Similar to Extract 2, when T. was in the kitchen, J. could have used his voice to mediate the interaction but instead chose to compose and issue a grammatically complete utterance using his SGD, perhaps reflecting his awareness that his soft, dysarthric speech may cause problems while trying to establish a topic when his partner is in a different room involved in a separate activity. Once T. enters the room, both participants change their communication modalities, almost in unison. First, both J. and T. utilize the newspaper as shared physical object to compose meaning about a specific news story. Also, J. uses his SGD for face-to-face spoken composition by switching his device to speak individual words as they are completed. J.'s differential use of text-to-speech output suggests that he is sensitive to the timing of spoken productions as well as his vocal limitations. By using a word-by-word output mode, J. was able to keep his partner's attention by issuing words at a relatively rapid pace. His use of a Lightwriter, instead of voice or gesture, to convey the message reveals J.'s awareness that the topic of conversation is relatively abstract and lacks physical concrete objects to reference. The Lightwriter provides a repeatable spoken and semipermanent visual display facilitating comprehension and reducing the probability of misunderstanding. T. confirms the conversational utility of the Lightwriter's visual display by reading the Lightwriter's display and responding to the word J. is typing, before the device delivers the speech output associated with the word. J. and T.'s ability to flexibly coordinate different interaction media allowed them to stay in-time despite J.'s impaired voice and body.

DISCUSSION

The conversational examples presented here are consistent with prior studies of SGD mediated interaction. The extracts presented provide examples of how two individuals

used various communication modalities and interaction media for the purposes of recipient design, grounding, and staying in-time. Across all three extracts presented here, J. and T. used a variety of physical and technology-based resources including voice, gestures, facial expressions, objects, the SGD speech output, and the SGD display screen. The decision of when to use and when not to use these resources was systematic and driven by each partner's sensitivity to attentional states, task demands, and timing expectations (i.e., recipient design). Contributions were designed on the basis of the partners' physical proximity to one another, as well as other activities in which T. may have been involved. J. specifically designed contributions in ways that not only allowed him to adhere to temporal standards of face-to-face interaction but also were cognizant of T.'s split attentional state. All three extracts demonstrate how the participants worked together in a coordinated fashion, despite differences in their communication modalities, to establish and maintain mutual understanding. Finally, all of these extracts were carried out in-time despite the potential for timing delays due to J.'s impaired voice and body. Implications are discussed in terms of the use of multiple resources to convey meaning, the importance of conversational timing, and clinical and device design recommendations.

Use of multiple modalities and resources

Throughout the extracts presented, J. and T. showed that they were effective multimodal communicators using various communication modalities and interaction media for carrying out their conversations. The dyad layered speech, physical gestures, body movements, and SGD use in a sequentially and temporally coordinated fashion to construct meaningful utterances. This is similar to past research revealing augmented speakers to be highly flexible communicators (Beeke, Wilkinson, & Maxim, 2001; Higginbotham, 2009; Murphy, Marková, Collins, & Moodie, 1996). J. and T. jointly managed the demands of their in-person interactions, coordinating

a variety of communication modalities (e.g., voice, gesture, physical proximity, and body position) and media (e.g., Lightwriter, objects, SGD display screen) with one another as they interacted in-time. Despite his impaired voice and body, J. employed vocalizations as well as pointing and tapping, head nodding, and other gestures to achieve meaning in a coordinated manner with his speaking counterpart. Likewise, T. coordinated her talk via multiple communication modalities (e.g., physical orientation, object use, gaze, gesture, speech) in ways that maximized mutual understanding. Research in AAC-mediated conversations has shown that augmented speakers and their vocal partners exhibit a preference for producing coordinated and co-participatory joint actions (Bloch, 2005; Bloch & Wilkinson, 2004; Higginbotham, 2009; Higginbotham & Wilkins, 1999; Hörmeyer & Renner, 2013; Luo, 2009; Wilkinson et al., 2011). The transcripts analyzed here are congruent with the aforementioned research, providing ample examples of T. and J.'s coordinated, co-participatory interactions involving both body-based and technology-mediated interactions.

Systematic use of SGD features and screen

Throughout the extracts examined, it was evident that J. strategically deployed specific SGD features to construct and deliver his interactional contributions. First, J. systematically decides when he should use the SGD. For example, in Extract 1, J.'s Lightwriter is available to use and right in front of him. Even though the device is in close proximity, J. uses other resources instead. Next, J. chose to switch between whole-utterance output and word-by-word output. Switching of device output mode appeared to be driven by T.'s physical location, as well as her current activity. J. also manipulated the position of his SGD, as well as its volume, to enhance message intelligibility, potentially reducing the need for repair. As in our study, Higginbotham et al. (2016) found that augmented speakers elected to use their device based on the task

demands. In both of these studies, SGDs were used to do the referential work that could not be accomplished via other modalities. Conversely, talk related to agreement checks, attention maintenance, stating opinions, and expressing humor were deployed through body-based modalities (e.g., gestures, body position, vocalizations) and environmental resources (e.g., objects).

The SGD display screen also was used by J. and T. to stay in-time and establish common ground. Specifically, T. would orient toward the device screen while filling in components of J.'s ongoing composition and incorporate the displayed information into the ongoing discourse, which is similar to many instances observed in our previous work, as well as other published research (Bloch, 2011; Higginbotham, 1989; Higginbotham & Engelke, 2013; Luo, 2009; Norén et al., 2013; Wilkinson et al., 2011). By having visual access to the SGD screen, the vocal speaker can identify troubles in the utterance before the augmented speaker produces his or her speech-synthesized utterance. When successful, making use of the information on the display screen can mitigate the temporal delays of AAC interaction and potentially decrease the amount of time spent repairing SGD-delivered contributions. However, as discussed by Higginbotham and Engelke (2013), significant problems can arise when the augmented speaker's utterance-in-composition is misinterpreted by speaking counterparts.

Staying in-time

As we have shown, talking *in-time* is a primary feature of in-person interaction. The interactions analyzed show that J. and T. used multiple communication modalities and media to maintain enchronic temporal standards. When media such as an SGD is introduced into conversation, the interactional expectations change depending on the features and constraints of the device itself (Clark, 1996; Clark & Brennan, 1991). There are specific moments when J. and T. decided not to use the available SGD and to rely on other

modalities such as pointing, tapping, vocalizations, and physical objects. When an SGD was used, J. exploited device features such as the volume and output method in an attempt to keep up with the temporal demands of the interaction and to be sensitive to his partner's attentional state. These in-time device modifications made by J. increased his likelihood of successfully grounding his interaction with T. without resorting to a prolonged repair sequence (Clark 1996; Clark & Brennan, 1991; Higginbotham & Wilkins, 1999). In addition, J.'s composition of longer utterances occurred when T. was preoccupied with another task so that she was not waiting for J. to finish his composition. J.'s decision to compose longer messages during T.'s preoccupation with another task functioned communicatively to mitigate timing delays in their conversation. If intentional, this would be another successful tactic used by J.

Clinical and device design implications

Clinicians implementing SGD and other AAC technologies should consider selecting tools and strategies that address the temporal challenges faced by their clients. For example, Higginbotham et al. (2016) discuss three different timing dimensions and recommend various strategies based on those dimensions. First, in *now-time talk*, participant focus is on immediate responses with no timing delay, and AAC technologies that allow the use of body-based and vocal modalities are suggested. Any alternative access methods, such as head or eye tracking, which cannot be extended to use other modalities, may not be conducive for now-time talk. For example, J. decided to use his impaired vocal speech to provide immediate confirmations and denials to stay in time with T. as they discussed a newspaper article. Second, *near-time talk* needs to be accomplished quickly, but with some limited allowance for presentation delay (e.g., 2–10 s). In these cases, single spoken letters, prestored messages, and complete utterance-based systems would be most appropriate. In this study, J. was able to quickly adapt his device features to be suc-

cessful in instances of near-time talk. This was evident when he switched his text-to-speech presentation output to word-by-word delivery instead of whole-utterance delivery. Finally, in *delayed-time talk*, the augmented speaker takes more time (e.g., >10 s) to compose utterances, which is particularly useful when grammatical appropriateness or informational accuracy is important. In these cases, having a partner visually access a device screen can help incrementally build meaning during message composition and reduce the probability of requisite repair strategies. This was apparent when J. constructed an entire message for T. as she was involved in completing other activities. In addition, J. was sure not to erase this entire message before T. confirmed its meaning, as ensuring T. had complete understanding of this utterance was essential.

Techniques informed by conversation analysis can help speech-language pathologists identify troubles that occur in communicative interactions and devise strategies to compensate for those problems, especially problems related to appropriately using multiple modalities, media, and resources as well as interaction timing. For example, conversation analysis has been applied to the study of aphasia (Myrberg, Hydén, & Samuelsson, 2018; Simmons-Mackie, Kingston, & Schultz, 2004), dysarthria (Saldert, Ferm, & Bloch, 2014), and dementia (Spilkin & Bethlehem, 2009) to identify client and communication partner strengths and weaknesses in language use such as turn taking, topic initiation, and repair sequences. By closely examining naturalistic interactions, a clinician may be able to identify common trouble sources in talk and provide appropriate management strategies for specific issues. According to Simmons-Mackie et al. (2004), analyzing naturalistic interaction can help clinicians and researchers create a listing of effective and efficient conversational management strategies.

Limitations

This research studied three episodes of interaction selected from a video corpus involving a husband with ALS and his wife

engaged in their daily interaction routines. From this corpus, we selected three interaction episodes that were relatively nonproblematic with respect to interaction timing and coordination of meaning. The detailed analysis of a single or select few episodes of interaction is a viable research approach in the conversation analysis literature (Schegloff et al., 1974), but by itself, the findings are restricted to these individuals and their communication in the particular communication contexts examined. Generalization of these findings is accomplished through the comparison with other single case studies of similar and dissimilar interactions. We recognize that individuals with different backgrounds, relationships, ages, disabilities, and communication media may interact differently from the ways the presented participants conversed and the research community is strongly encouraged to add to this emerging database of cases. It should be noted, however, that the use of multiple communication modes and communication media can be found throughout the literature focusing on augmented interactions (c.f., Clarke & Bloch, 2013; Norén et al., 2013; Smith & Murry, 2016; Wilkinson, 2013).

Conclusion and future work

The work presented here supports the idea that augmented speakers and their speaking counterparts use a variety of physical and behavioral resources, including an SGD, to

ground meaning and ensure interaction success with respect to the interaction task before them. Despite the barriers imposed by disability and technology, in the interactions analyzed here, J. and T. coordinated their actions and jointly constructed meaning within a generally enchronic time frame. Longer utterances requiring more time were composed when J.'s interlocutor was otherwise occupied, avoiding problems associated with delayed utterance production. These findings support the use of multiple modalities to construct collaborative interactions that consider the affordances and constraints of interaction media and other resources used to engage in in-time conversation. Current and future AAC designs should focus on providing more interactively flexible technologies that better address personal communication style and support temporal-sequential interaction demands, some of which were illustrated in this study. These would include the selective production of spoken letters, single words, phrases, and sentences, ways of displaying the progress of utterance composition to one's interlocutor, and designing devices with low device operational demands to promote active attention to the social interaction. Future research should continue to examine AAC use in naturalistic environments with a variety of other populations (e.g., pediatric) so that we are better able to understand how technology impacts and changes the landscape of social interaction.

REFERENCES

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- Atkinson, J. M., Heritage, J., & Oatley, K. (Eds.). (1984). *Structures of social action*. New York: Cambridge University Press.
- Beeke, S., Maxim, J., & Wilkinson, R. (2007, May). Using conversation analysis to assess and treat people with aphasia. *Seminars in Speech and Language*, 28(2), 136–147.
- Beeke, S., Wilkinson, R., & Maxim, J. (2001). Context as a resource for the construction of turns at talk in aphasia. *Clinical Linguistics & Phonetics*, 15(1-2), 79–83.
- Bloch, S. (2005). Co-constructing meaning in acquired speech disorders: Word and letter repetition in the construction of turns. In *Applying conversation analysis* (pp. 38–55). London: Palgrave Macmillan.
- Bloch, S. (2011). Anticipatory other-completion of augmentative and alternative communication talk: A conversation analysis study. *Disability and Rehabilitation*, 33(3), 261–269.
- Bloch, S., & Wilkinson, R. (2004). The understandability of AAC: A conversation analysis study of acquired dysarthria. *Augmentative and Alternative Communication*, 20(4), 272–282.
- Brennan, S. E. (1998). The grounding problem in conversations with and through computers. In S. R. Fussell & R. J. Kruez (Eds.), *Social and cognitive approaches to*

- interpersonal communication* (pp. 201–225). New York: Psychology Press.
- Clark, H. H. (1996). *Using language*. Cambridge, England: Cambridge University Press.
- Clark, H. H., & Brennan, S. E. (1991). Grounding in communication. *Perspectives on Socially Shared Cognition*, 13, 127–149.
- Clarke, M., & Bloch, S. (2013). AAC practices in everyday interaction. *Augmentative and Alternative Communication*, 29(1), 1–2.
- Damico, J. S., Simmons-Mackie, N., & Wilson, B. (2006). The negotiation of intelligibility in an aphasic dyad. *Clinical Linguistics & Phonetics*, 20(7–8), 599–605.
- Deppermann, A. (2013). Multimodal interaction from a conversation analytic perspective. *Journal of Pragmatics*, 46(1), 1–7.
- Enfield, N. J. (2017). *How we talk: The inner workings of conversation*. New York: Basic Books.
- Goodwin, C. (1979). The interactive construction of a sentence in natural conversation. In G. Psathas (Ed.), *Everyday language: Studies in ethnomethodology* (pp. 97–121). New York: Irvington Publishers.
- Goodwin, C. (2000). Action and embodiment within situated human interaction. *Journal of Pragmatics*, 32(10), 1489–1522.
- Goodwin, C. (2003). Conversational frameworks for the accomplishment of meaning in aphasia. In *Conversation and brain damage* (pp. 90–116). Oxford, England: Oxford University Press.
- Goodwin, C. (2018). *Co-operative action*. New York: Cambridge University Press.
- Hanson, E. K., Beukelman, D. R., & Yorkston, K. M. (2013). Communication support through multimodal supplementation: A scoping review. *Augmentative and Alternative Communication*, 29(4), 310–321.
- Higginbotham, D. J. (1989). The interplay of communication device output mode and interaction style between nonspeaking persons and their speaking partners. *Journal of Speech and Hearing Disorders*, 54(3), 320–333.
- Higginbotham, D. J. (2009). In-person interaction in AAC: New perspectives on utterances, multimodality, timing, and device design. *Perspectives on Augmentative and Alternative Communication*, 18(4), 154–160.
- Higginbotham, D. J., & Caves, K. (2002). AAC performance and usability issues: The effect of AAC technology on the communicative process. *Assistive Technology*, 14(1), 45–57.
- Higginbotham, D. J., & Engelke, C. R. (2013). A primer for doing talk-in-interaction research in augmentative and alternative communication. *Augmentative and Alternative Communication*, 29(1), 3–19.
- Higginbotham, D. J., Fulcher, K., & Seale, J. (2016). Time and timing in interactions involving individuals with ALS, their unimpaired partners and their speech generating devices. In M. Smith & J. Murry (Eds.), *The silent partner: Language, interaction and aided communication* (pp. 199–227). London: J & R Publishers.
- Higginbotham, J., Mathy-Laikko, J., & Yoder, D. (1988). Studying conversations of augmentative communication system users. In L. Bernstein (Ed.), *The vocally impaired: Clinical practice and research* (pp. 265–294). New York, NY: Grune & Stratton.
- Higginbotham, D. J., & Wilkins, D. P. (1999). Slipping through the timestream: Social issues of time and timing in augmented interactions. In D. Kovarsky, J. Duchan, & M. Maxwell (Eds.), *Constructing (in) competence: Disabling evaluations in clinical and social interaction* (pp. 49–82). Mahwah, NJ: Erlbaum.
- Higginbotham, D. J., & Yoder, D. E. (1982). Communication within natural conversational interaction: Implications for severe communicatively impaired persons. *Topics in Language Disorders*, 2(2), 1–19.
- Hörmeier, I., & Renner, G. (2013). Confirming and denying in co-construction processes: A case study of an adult with cerebral palsy and two familiar partners. *Augmentative and Alternative Communication*, 29(3), 259–271.
- Jefferson, G. (2004). Glossary of transcript symbols with an introduction. *Pragmatics and Beyond New Series*, 125, 13–34.
- Jewitt, C. (2008). Multimodality and literacy in school classrooms. *Review of Research in Education*, 32(1), 241–267.
- Johnston, S. S., Reichle, J., Feeley, K. M., & Jones, E. A. (2012). *AAC strategies for individuals with moderate to severe disabilities*. Baltimore: Brookes Publishing Company.
- LeBaron, C. (2005). Considering the social and material surround: Toward microethnographic understandings of nonverbal behavior. In V. Manusov (Ed.), *The sourcebook of nonverbal measures* (pp. 493–506). Mahwah, NJ: Erlbaum.
- Levinson, S. C., & Holler, J. (2014). The origin of human multi-modal communication. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 369(1651), 20130302. doi: 10.1098/rstb.2013.0302
- Levinson, S. C., & Wilkins, D. P. (2006). *Grammars of space: Explorations in cognitive diversity*. New York: Cambridge University Press.
- Luo, F. (2009). *Personal narrative telling by individuals with ALS who use AAC devices*. Unpublished doctoral dissertation, University at Buffalo, Buffalo, NY.
- Meredith, J. (2015). Transcribing screen-capture data: The process of developing a transcription system for multi-modal text-based data. *International Journal of Social Research Methodology*, 19(6), 1–14.
- Müller, E., & Soto, G. (2002). Conversation patterns of three adults using aided speech: Variations across partners. *Augmentative and Alternative Communication*, 18(2), 77–90.
- Murphy, J., Marková, I., Collins, S., & Moodie, E. (1996). AAC systems*: Obstacles to effective use. *International Journal of Language & Communication Disorders*, 31(1), 31–44.

- Myrberg, K., Hydén, L. C., & Samuelsson, C. (2018). Different approaches in aphasia assessments: A comparison between test and everyday conversations. *Aphasiology*, 32(4), 417–435.
- Norén, N., Svensson, E., & Telford, J. (2013). Participants' dynamic orientation to folder navigation when using a VOCA with a touch screen in talk-in-interaction. *Augmentative and Alternative Communication*, 29(1), 20–36.
- Ochs, E., Graesch, A. P., Mittman, A., Bradbury, T., & Repetti, R. (2005). Video ethnography and ethnoarchaeological tracking. In M. Pitt-Catsouphes, E. E. Kossek, & S. Sweet (Eds.), *The work and family handbook: Multi-disciplinary perspectives, methods, and approaches* (pp. 387–409). Mahwah, NJ: Erlbaum.
- Pilesjö, M. S. (2014). Creating meaning through the coordination of gaze direction and arm/hand movement. *Journal of Interactional Research in Communication Disorders*, 5(1), 63–96.
- Psathas, G. (1995). Talk and social structure and studies of work. *Human Studies*, 18(2-3), 139–155.
- Robillard, A. B. (1999). *Meaning of a disability: The lived experience of paralysis*. Philadelphia, PA: Temple University Press.
- Saldert, C., Ferm, U., & Bloch, S. (2014). Semantic trouble sources and their repair in conversations affected by Parkinson's disease. *International Journal of Language & Communication Disorders*, 49(6), 710–721.
- Schegloff, E., Jefferson, G., & Sacks, H. (1974). A simplest systematics for the organization of turn-taking for conversation. *Language*, 50(4), 696–735.
- Seale, J., Bisantz, & Higginbotham, J. (2019). *Interaction symmetry in augmentative and alternative communication*. Manuscript submitted for publication.
- Simmons-Mackie, N., Kingston, D., & Schultz, M. (2004). Speaking for another. *American Journal of Speech-Language Pathology*, 13(2), 114–127.
- Smith, M., & Murry, J. (Eds.). (2016). *The silent partner: Language, interaction and aided communication*. London: J & R Publishers.
- Solomon-Rice, P., & Soto, G. (2011). Co-construction as a facilitative factor in supporting the personal narratives of children who use augmentative and alternative communication. *Communication Disorders Quarterly*, 32(2), 70–82.
- Spilkin, M. L., & Bethlehem, D. (2009). A conversation analysis approach to facilitating communication with memory books. *Advances in Speech Language Pathology*, 5(2), 105–118.
- Streeck, J., Goodwin, C., & LeBaron, C. (2011). *Embodied interaction: Language and body in the material world*. New York: Cambridge University Press.
- Ten Have, P. (2007). *Doing conversation analysis*. London: Sage.
- Weeks, P. A. D. (1985). Error-correction techniques and sequences in instructional settings: Toward a comparative framework. *Human Studies*, 8(3), 195–233.
- Wilkinson, R. (2013). Conversation analytic investigations of dysarthria and hearing impairment: The impact of motor and sensory impairments on social interaction. *Journal of Interactional Research in Communication Disorders*, 4(1), 1–26.
- Wilkinson, R., Bloch, S., & Clarke, M. (2011). On the use of graphic resources in interaction by people with communication disorders. In J. Streeck, C. Goodwin, & C. LeBaron (Eds.), *Embodied interaction: Language and body in the material world* (pp. 152–168). New York: Cambridge University Press.
- Woods, D. (2010). Transana qualitative analysis software for researchers (Version 2.42) [Computer software]. Madison, WI: Transana.
- Zemel, A., & Koschmann, T. (2011). Pursuing a question: Reinitiating IRE sequences as a method of instruction. *Journal of Pragmatics*, 43(2), 475–488.