

The psychometric properties of the communicative competence scale for individuals with Aphasia using speech-generating devices

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ABSTRACT

Background: Persons with aphasia (PWA) use augmentative and alternative communication (AAC) systems to access and create symbol-based messages. The purpose of this study was to (a) investigate the psychometric properties of the newly developed Communicative Competence Scale (CCS), and (b) to determine if any factors, or subcategories, exist within each scale of the scale. The CCS aims to assess the competence of PWA using AAC.

Aims: Respondents were 55 undergraduate and graduate speech-language pathology students. The students were recruited to test the statistical properties of the CCS and Conversational Skills Rating Scale (CSRS). Prior to completing both instruments, respondents watched two videos of a PWA communicating with a speech-generating device. The messages were displayed using a grid display in one video and a scene display in the other.

Main contribution: Concurrent validity was established between the CCS and the CSRS, and a moderate correlation was found. Reliability Coefficients revealed that the CCS and the CSRS had acceptable levels of internal consistency. Factor analysis revealed factor loadings or subordinate categories within the CCS and CSRS that were consistent with previous research.

Conclusions: The CCS was found to be an internally consistent, reliable, and valid measure of perceived communicative competence of PWA using aided AAC. Clinical implications are discussed.

KEYWORDS: Aphasia, augmentative and alternative communication, communicative competence, attitudes, psychometric properties, communication scalescale

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Introduction

Many persons with aphasia (PWA) with little or no functional speech utilize augmentative and alternative communication (AAC) methods and strategies to support their communication (Koul, 2011). As part of a multimodal communication system, AAC can help PWA to exchange information with others and enhance their social participation (Koul, Corwin, & Hayes, 2005). Previous research has indicated that AAC intervention, combined with communication partner training, has the potential to enhance communication in persons with chronic, severe Broca's, and global aphasia (e.g., Brock, Koul, Corwin, & Schlosser, 2017; Dietz et al., 2018; Johnson, Hough, King, Vos, & Jeffs, 2008; Koul, 2011; Koul & Corwin, 2003; Koul & Harding, 1998). In the past two decades, competency with digital communication, including the use of mobile devices, has become an integral part of how individuals interact and connect. Moreover, the general consumer-level technologies are being increasingly adapted to meet the communicative needs of individuals with little-to-no functional speech (Koul, 2011; Shane et al., 2012). Overall, these societal and technological changes may affect the interpersonal interaction and communicative competence of PWA. Specifically, technologies impacting communication include speech-generating devices (SGDs) and applications using general consumer-level technologies (Koul, Petroi, & Schlosser, 2010). SGDs produce synthetic or digitized speech output upon the selection of graphic symbols or text. Currently available SGDs *primarily* provide two interface designs to access and produce novel and programmed messages. Taxonomic grid displays organize information based on a hierarchical classification system. Specifically, grids incorporate graphic symbols, or cartoon line drawings, that are organized taxonomically within superordinate and subordinate folders. In contrast, scene displays utilize a high level of contextual support in their organizational composition. Scene displays are organized schematically or episodically and use personal or non-personal photographs. Previous research indicates that many PWA have been successful in using these displays in experimental contexts across a variety of communicative and non-communicative tasks (Brock et al., 2017; Dietz, Weissling, Griffith, McKelvey, & Macke, 2014; Hux, Buechter, Wallace, & Weissling, 2010; Johnson et al., 2008; Koul & Corwin, 2003; Petroi, Koul, & Corwin, 2014; Wallace & Hux, 2014).

Several studies have documented the communicative competence outcomes for PWA using natural speech or AAC interventions involving aided and unaided approaches (e.g., Beeke et al., 2013; Bloch & Beeke, 2008; Brock et al., 2017; Dietz et al., 2018, 2014; Wallace & Hux, 2014). However, very few studies have investigated AAC stakeholder ratings of communicative competence in PWA (Lasker & Beukelman, 1999; Lasker & Holz, 2016). These stakeholders, including family members, friends, caregivers, and clinical professionals, are responsible for revealing communicative competence. This may involve issues such as not asking "test" questions (e.g., Beeke et al., 2013) or co-constructing messages with PWA (e.g., Goodwin, 1995; Kagan, Black, Duchan, Simmons-Mackie, & Square, 2001; Oelschlaeger & Damico, 1998; Wilkinson, Bryan, Lock, & Sage, 2010). Thus, respondent perceptions may impact the quality and effectiveness of the exchange. We can potentially select AAC devices for PWA that not only improve communicative competence but also influence stakeholders' perception of communicative competence in PWA. This is critical because untrained stakeholders may not recognize the use of AAC modalities (aided and unaided), paralinguistic cues,

and interactional alternatives to standard grammatical structures (e.g., adjectives, nouns, and fixed units such as “I think”) resulting in lack of social ease when communicating with PWA or communication breakdown (Beeke, Wilkinson, & Maxim, 2007; Brock et al., 2017; Hoag, Bedrosian, Johnson, & Molineux, 1994; Schiffrin, 1987). Therefore, the purpose of this study is to develop a scale that investigates how AAC stakeholders rate interactional alternatives (i.e., aided and unaided AAC) employed during structured conversation and the overall communicative competence of PWA.

Currently, there are no published reliable and valid communicative competence scales available to rate the perceived communicative effectiveness of PWA using AAC. Rather, previous studies have developed scale items without measuring the scale’s psychometric properties (e.g., Hustad & Gearhart, 2004; Lasker & Beukelman, 1999). In sum, a scale to measure unaided and aided communicative competence for PWA would be a valuable tool for clinicians and researchers for the following reasons: (a) determine effectiveness of AAC-based treatment strategies for PWA; (b) analyse talk-in-interaction to inform device selection and interface design, and (c) determine the perceived communicative competence of PWA.

Perceived communicative competence and AAC

The communicative competence theory acknowledges the variability of linguistic knowledge among individuals, as well as the cognitive, situational, and sociocultural factors that may affect communicative performance (Canale, 1983; Canale & Swain, 1980; Hymes, 1972; Light & McNaughton, 2014). Light (1989) extended the early work on communicative competence to the population of individuals using AAC. She proposed that communicative competence is an interactive construct requiring four competencies to support overall communication: linguistic (native language and symbol-based languages), operational (system operation), social (e.g., engaging with others), and strategic (e.g., ability to repair communication breakdowns). In subsequent iterations of the model, psychosocial factors including communication partners, motivation, attitude, resilience, and confidence were added (Light & McNaughton, 2014). Of the four areas of competence proposed by Light (1989), social competence may be most critical as it involves both sociolinguistic and sociorelational aspects of communication (Hymes, 1972). In order for AAC users to be socially competent, it is important that both, the AAC users and their communication partners, are provided opportunities to practice sociolinguistic competence in natural contexts.

Sociolinguistic competence in AAC users has been previously measured through the study of talk-in-interaction (Calculator & Dollaghan, 1982; Higginbotham, 1989; Higginbotham & Engelke, 2013). The talk-in-interaction studies within AAC, as well as the unaided and aided dyad studies, have used the conversational analysis framework (see Goodwin & Heritage, 1990) to investigate how PWA and their partners engage in conversation in both naturally occurring contexts and structured communicative interactions (e.g., language testing, biographical content, personal interests) (e.g., Bloch & Beeke, 2008; Bloch & Clarke, 2013; Brock et al., 2017; Wilkinson, 2013). Specifically, talk-in-interaction treatment paradigm is important because it can potentially reveal how PWA engage technology-based AAC systems to initiate conversation, make comments, repair breakdowns, and navigate the system for everyday communication at the microanalysis level (e.

g., underlying problems or adaptations during communication). In contrast, decontextualized language tests isolate language skills (e.g., verb production), resulting in a narrow investigation of communication through natural speech (Beeke, Wilkinson, & Maxim, 2003; Beeke et al., 2007). It is clear that decontextualized language tests may not account for how PWA adapt and use multimodal communication to engage, sustain, repair, and end conversations. Moreover, these tests do not account for the role of communication partners and social groups on message construction. Previous research has demonstrated that the use of aided and unaided AAC strategies and techniques are a collaborative endeavour between the user and the partner, resulting in co-constructed messages in most communicative acts (e.g., Bloch & Beeke, 2008; Bloch & Clarke, 2013; Clarke, Bloch, & Wilkinson, 2013; Higginbotham & Engelke, 2013).

The concept of co-construction of messages and communication partner influence on communication outcomes has a long-standing history in aphasia (Bloch & Beeke, 2008; Kagan, 1998; Kagan et al., 2001). It is important that the communicative partners are trained to identify and reveal competence in PWA because many PWA employ a consistent set of resources to take a turn at talk. For example, many PWA have verb production deficits but will use a combination of natural speech, gesture, graphic symbol, or vocalization to convey the missing verb or word (Beeke et al., 2007; Brock et al., 2017). But this multimodal communication is not without consequences to communicative competence. Previous research has observed that the operational requirements of many AAC systems may exceed the working memory capacity of the user and result in communication performance decrements (Brock et al., 2017; Thistle & Wilkinson, 2013; Wilkinson & Jagaroo, 2004). Thus, successful communication through AAC systems requires training not only for the user but also for the partner.

Talk-in-interaction research is important because it not only reveals how PWA engage technology-based AAC systems. More importantly, it also reveals how communication partners engage with the AAC system, the PWA, and message construction. Previous research demonstrates that aided and unaided AAC is a collaborative endeavour between the user and the partner, resulting in co-constructed messages or asymmetrical contributions from naturally speaking partners (e.g., Bloch & Beeke, 2008; Bloch & Clarke, 2013; Clarke et al., 2013; Higginbotham & Engelke, 2013).

The concept of co-construction of messages and communication partner influence on communication outcomes has a long-standing history in aphasia and AAC research (Bloch & Beeke, 2008; Kagan, 1998; Kagan et al., 2001). It is imperative that partners are trained to identify and reveal competence in PWA because many PWA employ a consistent set of resources to take a turn at talk. For example, many PWA have verb production deficits but will use a combination of natural speech, gesture, graphic symbol, or vocalization to convey the missing verb or word (Beeke et al., 2007; Brock et al., 2017). But this multimodal communication is not without consequences to communicative competence. Previous research has observed that the operational requirements of many AAC systems may exceed the working memory capacity of the user and result in communication performance decrements (Brock et al., 2017; Thistle & Wilkinson, 2013; Wilkinson & Jagaroo, 2004). Thus, successful communication through AAC systems requires training not only the user but also for the partner.

Brock et al. (2017) used a conversational treatment paradigm to compare the effects of a grid display and a scene display across several variables (e.g., conversational turns

and conceptual complexity of utterance) with two PWA during structured conversational interactions with a trained communication partner. Results indicated that the number of conversational turns were higher in the scene display condition than in the grid display condition. Further, both participants had a greater number of complex, multimodal utterances in the scene display condition in comparison to the grid display condition. Finally, the scene display conversations were shorter in duration than the grid displays conversations secondary to the fewer navigational errors made by the participants. This study provided preliminary evidence that the interface displays used in SGDs have an impact on the communicative effectiveness of some PWA.

Lasker and Beukelman (1999) investigated the effects of storytelling mode (i.e., natural speech, AAC notebook, and digitized speech) on communicative competence among the peers of PWA. They developed a five-item scale that measured the following constructs: competence, effectiveness, comfort talking with PWA, willingness to engage in conversation, and comprehension of PWA. Results indicated that peers of PWA prefer digitized speech output to any other storytelling mode. This suggests that technology-based AAC strategies can positively and negatively impact communicative competence.

Richter, Ball, Beukelman, Lasker, and Ullman (2003) investigated the communicative competence ratings of respondents towards an individual with amyotrophic lateral sclerosis using three message formulation strategies (i.e., word-by-word, sentence-by-sentence, and complete narration) in a storytelling task. Results indicated that respondents rated the speaker as a relatively more competent communicator in the narration condition compared to the word-by-word and sentence-by-sentence conditions. Furthermore, the time associated with each strategy had an impact on listener ratings. Respondents preferred the complete narration technique because it took the speaker less time to tell the story compared to the sentence-by-sentence and word-by-word conditions. In a related study, Hustad (2001) investigated the perceived communicative competence and attitude ratings of 68 nondisabled respondents towards four speakers with severe dysarthria using no cues, topic cues, alphabet cues, or combined topic and alphabet cues. The three-item scale measured communicative effectiveness, willingness to communicate with the AAC user, and persistence in attempting to comprehend the AAC user's message. The results indicated that combined topic and alphabet cues in conjunction with natural speech resulted in a greater positive perceived communicative competence rating towards the speakers with dysarthria.

The aforementioned studies clearly indicate how aided and unaided AAC can influence respondent ratings of communication effectiveness for a person with limited expressive speech and/or poor speech intelligibility. Previous data also suggest that message production efficiency improves respondent ratings of communicative competence towards aided speakers (Richter et al., 2003). Since PWA across subtypes present a unique cluster of speech and language characteristics that differentiate them from other groups with severe communication impairment, it is critical that clinicians have a reliable and valid scale to measure perceived communicative competence in PWA.

In sum, the communicative competence of PWA who use AAC is closely tied to their own sociolinguistic and sociorelational skills, partner training, and the aided or unaided strategy employed for communicative purposes (e.g., Bloch & Clarke, 2013; Brock et al., 2017; Lasker & Beukelman, 1999; Light & McNaughton, 2014). One of the ways to enhance sociolinguistic competence of PWA is to train and provide them with the

opportunities to use aided and unaided AAC techniques and strategies in natural communicative contexts. Previous research has indicated that these aided AAC strategies enhance the perception of communicative competence (e.g., Beck, Kingsbury, Neff, & Dennis, 2000; Gorenflo & Gorenflo, 1991, 1997; Gorenflo, Gorenflo, & Santer, 1994; Lasker & Beukelman, 1999). However, no studies to date have created a reliable and valid scale to measure the competence of PWA using AAC. The competence ratings from AAC stakeholders, according to Richter et al. (2003), are valuable for the design of SGDs, of applications providing speech output, and the development of AAC techniques and strategies. These ratings are also valuable from a talk-in-interaction perspective. Specifically, a reliable and valid scale could help professionals identify impairments at the microstructure and macrostructure levels, as well as identify strategies used by PWA when they are unable to communicate through natural speech.

Given the paucity of reliable and valid communicative competence measurement tools for PWA using AAC, the purpose of this study was twofold: (a) investigate the psychometric properties (reliability and validity) of the newly developed Communicative Competence Scale (CCS) using the Conversational Skills Rating Scale (CSRS) (Spitzberg & Adams, 2007) as a benchmark and (b) to determine if any factors, or subcategories, exist within each scale of the scales. The following research questions were addressed:

- (1) Are the CCS and the CSRS reliable and valid measures of communication with PWA as rated by speech-language pathology (SLP) students?
- (2) Are there any factors, or subcategories, within each of the scales that measure a specific construct (e.g., non-verbal communication)?

Methods

Participants

The participants ($N = 55$) were undergraduate and graduate SLP students. These participants were chosen because they had didactic training, direct experience in aphasia, or a combination of both training and experience (see Table 1). Additionally, using trained SLP students is an initial step in establishing the reliability and validity of these scales. The majority of respondents were female ($N = 53$) between the ages of 20 and 27 years. All but one respondent had direct experience with stroke survivors; however, 47 respondents did not have any experience with PWA using AAC techniques and strategies.

Materials

Materials included (a) an SGD with two interface display types, (b) two digital video recordings, (c) the CSRS, and (d) the CCS.

SGD and interface display types

A dedicated DynaVox VMax^{®1} SGD was selected because of its availability to the researchers as well as its functionality that allowed for the presentation of messages using two different displays: taxonomic grid display and scene display. Two interface

Table 1. Participant demographic information.

Item	Scale answer	N (%)
Gender	Male	2 (3.71)
	Female	52 (96.29)
Age	Less than 20	1 (1.90)
	20–23	34 (63.00)
	24–27	10 (20.40)
	28–31	5 (9.30)
	Over 32	3 (5.60)
	Some college	29 (53.70)
Highest level of education	Bachelor's	25 (46.30)
	Yes	54 (98.18)
Have you worked (pre-professional, professional, personal experience) with individuals who have sustained a stroke?	No	1 (1.82)
	0–5 months	37 (68.50)
How much experience working with individuals who have aphasia?	6–11 months	10 (18.50)
	1–3 years	5 (9.30)
	4–5 years	1 (1.90)
	6+ years	2 (1.90)
	0 months	47 (87.00)
How much experience with persons with aphasia and AAC?	1–5 months	5 (9.30)
	6–11 months	1 (1.90)
	1–3 years	1 (1.90)
	Yes	52 (96.29)
Have you heard of Augmentative and Alternative Communication (AAC) for persons with little to no functional speech output?	No	2 (3.71)

Some demographic information includes 54 respondents because one respondent did complete the entire questionnaire.

displays were used because it is important to establish the reliability and validity of any scale across a variety of techniques and strategies used by PWA. Additionally, as indicated in the introduction, different AAC strategies, techniques, and potential barriers can influence respondent ratings of competence (e.g., Light & McNaughton, 2014; Richter et al., 2003). Thus, a reliable and valid scale that measures competence across a variety of AAC techniques, devices, and strategies is warranted for broad, clinical application. Figure 1 provides an example of the scene display. Additional figures and information such as the number of symbols per display, symbols per page, and orthographic text on each display can be found in Brock et al. (2017).

Digital video recordings

Two digital recordings depicted an English-speaking, 61-year-old right-handed man, named FB, who was 10 years post-stroke (left hemisphere lesion). A comprehensive description of the participants in the recordings is provided in Brock et al. (2017). One digital recording included the use of a scene display, while the other included the use of a grid display. FB was wheelchair-bound and selected for this investigation because he had limited speech (fewer than 30 words) with no evidence of dysarthria. The *Western Aphasia Battery-Revised* (Kertesz, 2006) was administered and confirmed his diagnosis of severe, non-fluent aphasia (Aphasia Quotient = 30.30). FB's receptive language was within functional limits given his ability to follow simple one-step commands and conditional directives. His hearing and vision were within functional limits as indicated by his ability



Figure 2. Screenshot.

This video Screenshot includes the stroke survivor using his DynaVox Vmax (2007) with the communication partner. Superimposed in the right hand corner is a second video screenshot that allowed the respondents to see the participant's symbol selection on the SGD. The images are covered for confidentiality and copyright reasons.

Each digital video stimulus included six discussion topics: Lucy and Ricky at breakfast, Lucy and Ethel finding a job, Lucy's first job, Lucy's second job, Ricky and Fred cleaning, and Ricky and Fred cooking. To ensure that both, the grid display video condition and scene display video condition, contained the same six discussion topics, two certified SLPs independently evaluated the digital recordings. A unit-by-unit agreement ratio was calculated (Hegde, 2003), and the agreement index was 100%.

It is important to note that the experiment proper is the second in a line of research investigating the effects of scene and grid displays on communicative competence. All participants knew about the recording and were instructed to only talk about the *I Love Lucy* episode. The communication partner was an unfamiliar, 21 year-old male undergraduate SLP student with limited experience in aphasia. He was provided a 30-min didactic training session regarding conversational strategies typically used to assist PWA (e.g., wait time, slower speaking rate, open-ended questions, interpreting/rephrasing gestures, and vocalizations). The partner then demonstrated his ability to use these strategies during a role playing exercise with the first author. Additionally, the communication partner was provided several open-ended questions to ask the PWA to maintain the conversation. Thus, the conversation was structured to the extent that allowed us to explore the differences between grid and scene displays as PWA engage in conversation with a partner on a predetermined topic (*I Love Lucy*) for a previous study (Brock et al., 2017).

Communicative competence scale

The nine-item CCS was used to assess the communicative behaviours of the PWA using SGDs during a conversational interaction. The scale includes a five-point Likert response

format bound by bipolar descriptors (Strongly Agree to Strongly Disagree). The CCS was developed using content from two previously published scales: Garrett's (2004) Aphasia Group Conversational Competence Rating Scale and Hustad's (2001) experimental statements. Five statements from the Aphasia Group Conversational Competence Rating Scale and two statements from Hustad (2001) were included in the CCS. In addition, the researchers developed two new statements to determine whether the display type facilitated the speaker's communication (see [Appendix 1](#) for the CCS items).

The construction of the CCS was guided by the four domains of communicative competence for AAC users as proposed by Light (1989): linguistic, operational, strategic, and social competencies. Two-scale items (i.e., items 2 and 6) measured linguistic competence under the construct of success and effectiveness. Two-scale items (i.e., items 5 and 8) measured operational competence under the construct of AAC impact on conversational effectiveness. Three-scale items (i.e., items 1, 3, and 7) measured social competence of the PWA under the construct of active conversational partner. Two-scale items (i.e., items 4 and 9) measured strategic competence under the construct of frequency of multiple modality use (e.g., speech and gesture) to get the message across.

Conversational skills rating scale

The 25-item CSRS (Spitzberg & Adams, 2007) was used as a benchmark measure to determine the validity and reliability of the CCS. This scale uses a five-point Likert response format bound by bipolar descriptors (i.e., ranging from inadequate to excellent). The CSRS measures four aspects of communication: (a) attentiveness, (b) composure (e.g., assertive or confident), (c) expressiveness (e.g., gestural animation), and (d) coordination (i.e., interaction management). However, several *similar* factor solutions of the CSRS have been found depending on the purpose of the research and the participants recruited.

Previous studies indicate that the CSRS is internally consistent ($\alpha = .80$) (Brundidge, 2002). Further, the inter-rater reliability correlation coefficient is above $r = .72$ (Spitzberg & Adams, 2007). With respect to concurrent validity, Dawson (1986) found the CSRS to be significantly correlated, $r = .55$, $p < .01$, with the Simulated Social Interaction Test (Curran, 1982), indicating that the CSRS is a valid tool.

Procedure

The respondents watched the videos either individually or in groups of <20 persons. Respondents watched in classrooms or conference rooms on standard projection screens. Respondents were first provided with oral and written descriptions of the speaker, the conversational topic, the interface displays, and the scales (see [Appendix 1–3](#)). Questions regarding the scales' terms were answered during this time. All respondents watched two videos (i.e., scene display and grid display) and filled out two scales per video (i.e., CCS and the CSRS). The presentation order of the videos and the scales was counterbalanced to control for order effects. Respondents provided their CCS and CSRS ratings independently after watching each video condition. More specifically, CCS and CSRS ratings were provided after the conclusion of a video. Then, the second video was watched, and when concluded, the second round of CCS and CSRS ratings were completed.

Data analyses

Respondent ratings for the dependent variables (i.e., CSRS and CCS) were analysed to determine concurrent validity, internal consistency of each scale, and intra-rater reliability. Additionally, factor analysis was applied to each scale to identify any latent constructs.

Procedural integrity

An independent observer collected procedural integrity data for 33.33% of the total respondents to ensure that the procedures were implemented as intended (see Schlosser, 2002). Procedural integrity was calculated by dividing the number of steps followed by the number of steps not followed plus the number of steps followed, multiplied by 100. Procedural integrity was 100%.

Results

Reliability and validity of the CCS and CSRS

The CCS was administered to 55 SLP students to gather reliability and validity data. Concurrent validity of the CCS was calculated by determining the Pearson product-moment correlation coefficient between the CCS and the CSRS. Concurrent validity analysis revealed that the two scales approached moderate correlation ($r = .51, p < .001$) indicating that the CCS and CSRS are valid measures of competence for PWA using SGDs.

Cronbach's (1951) alpha coefficient of reliability was calculated to determine the reliability of each scale. Cronbach's (1951) alpha coefficients of reliability revealed that the CCS ($\alpha = .88$) and the CSRS ($\alpha = .88$) had acceptable levels of internal consistency (see Field, 2009). This indicated that the test items were homogeneous and measured similar constructs of communicative competence.

For intra-observer reliability of the CCS, 14 respondents completed the investigation twice within 2 weeks. The Pearson product-moment correlation coefficient served as the test-retest statistic (Portney & Watkins, 2008). Results revealed that the initial CCS rating of the scene and grid display conditions were significantly correlated ($r = .57, p < .01$) with the second CCS rating of the scene and grid display conditions.

Factor analyses

CCS

When conducting the factor analysis, it was determined that item 9 (see Appendix 3) measured two constructs (i.e., different ways of communicating and different strategies), which caused it to cross-load onto each factor within the CCS. Osborne and Costello (2009) recommend eliminating these items from the analysis. Therefore, we conducted a second factor analysis using a Promax (oblique) rotation for the *eight*-item CCS. The Promax rotation was used because the factor correlation matrix revealed that the scale's two factors were correlated ($r > .32$; see Osborne & Costello, 2009). The Kaiser-Meyer Olkin measure of sampling adequacy suggested the scale was factorable ($KMO = .86$), and the diagonals of the anti-image correlation matrix were all above the acceptable limit of .50 (Field, 2009). Bartlett's test of sphericity was significant, $\chi^2 (36) = 616.09$,

$p < .001$, indicating that correlations between items were sufficiently large for factor analysis. The results of the factor analysis are shown in Table 2. When loadings $< .30$ were suppressed, the analysis yielded a two-factor solution.

Four items loaded onto Factor 1 (Conversational Effectiveness) and accounted for 60.52% of the scale's variance. Typical items loading on this factor included, "In general, this person with aphasia is an effective communicator" and "This person with aphasia was so effective that I would engage in a conversation if I encountered him in the community". Four items loaded onto Factor 2 (Successful Communicative Supports) and accounted for 13.64% of the scale's variance. Typical items loading on this factor were, "What effect did the computer support have on the person with aphasia's communication effectiveness?" and "How much did the person with aphasia participate/engage in the interaction?" The Cronbach's (1951) alpha reliability coefficients for the Conversational Effectiveness factor ($\alpha = .86$) and the Successful Communicative Supports factor ($\alpha = .83$) were acceptable (i.e., $\alpha = .70$; see Nunnally, 1978).

Table 3 provides the descriptive statistics for each CCS item and its associated AAC competency from Light (1989). Respondents indicated that the AAC user participated ($M = 4.74$; $SD = .60$) in each conversation; however, respondents indicated that he "rarely" or "sometimes" took an active role and initiated (e.g., questions and comments) ($M = 2.35$; $SD = 1.05$). Respondents also indicated that the computer enhanced his

Table 2. Factor loadings for factor analysis with promax rotation of the communicative competence scale.

Scale item	Conversational effectiveness	Successful communicative supports
Would Engage in Conversation	.97	
PWA is Effective Communicator	.94	
Overall Effectiveness	.82	
PWA Active Partner	.68	
Computer Enhanced Effectiveness		.85
How Much Participation?		.83
AAC had Affect		.83
Communicative Success	.46	.48*
Eigenvalues	4.89	1.23
% of variance	60.52	11.13
Cronbach's α	.86	.83

Factor loadings below .30 are suppressed for clarity. Some items (*) cross-loaded onto each factor, indicating that these communication factors may be correlated.

Table 3. Descriptive statistics of individual CCS items.

Scale item	AAC competency	Range	Mean (SD)
Effective Communicator	Linguistic	1.00–5.00	3.37(1.13)
Communicative Success	Linguistic	2.00–5.00	3.63(.76)
How Much Participation	Social	2.00–5.00	4.74(.60)
Active Partner	Social	1.00–5.00	2.35(1.05)
Would Engage in Conversation	Social	1.00–5.00	3.24(1.26)
Computer Enhanced Effectiveness	Operational	1.00–5.00	4.03(1.20)
AAC had Affect	Operational	1.00–5.00	3.95(1.24)
Overall Effectiveness	Strategic	1.00–5.00	3.51(1.09)
*Modalities of Communication	Strategic	1.00–5.00	3.50(1.12)

*The original scale included Modalities of Communication (e.g., different ways of communicating); however, it was deleted from the factor analysis because it measured two separate communicative constructs that affected the respondents' ratings.

effectiveness ($M = 4.03$; $SD = 1.20$) and that the AAC system had an effect ($M = 3.95$; $SD = 1.24$) on the overall communication of the user.

CSRS

We conducted a factor analysis using a Promax rotation for the 25-item CSRS. The Promax rotation was used because the factor correlation matrix revealed that the scale's four factors were correlated ($r = -.26$ to $.53$; see Osborne & Costello, 2009). The Kaiser-Meyer Olkin measure of sampling adequacy suggested the scale was factorable ($KMO = .83$), and the diagonals of the anti-image correlation matrix were all above the acceptable limit of $.50$ (Field, 2009). Bartlett's test of sphericity was significant, $\chi^2(300) = 1900.69$, $p < .001$, indicating that correlations between items were sufficiently large for factor analysis. The results of the factor analysis are shown in Table 4. When loadings $< .30$ were suppressed, the analysis yielded a four-factor solution.

Seven items loaded onto Factor 1 (Expressiveness) and accounted for 29.62% of the scale's variance. Typical items loading on this factor included whether or not the PWA initiated topics and expressed an opinion. Seven items loaded onto Factor 2 (Suprasegmentals) and accounted for 21.99% of the scale's variance. Typical items loading on this factor included the use of vocal variety, vocal confidence, and volume. Seven items loaded onto Factor 3 (Paralinguistics) and accounted for 8.14% of the

Table 4. Factor loadings for factor analysis with promax rotation of the conversational skills rating scale.

Scale item	Expressiveness	Suprasegmentals	Paralinguistics	<u>Coordination</u>
1. Vocal Confidence		.54		
2. Articulation-Clarity		.71		
3. Vocal Variety		.53		.46*
4. Volume		.81		
5. Posture		.84		
6. Lean to Partner		.82		
7. Awkward Movements			.48	.41*
8. Facial Expression			.60	
9. Nodding Response			.79	
10. Gesture Use			.49	
11. Smile Laugh			.77	
12. Eye Contact			.64	
13. Humor Use	.64		.57*	
14. Ask Questions	.88			
15. Speak about Partner	.92			
16. Speak about Self	.77			
17. Agreement	.57			
18. Opinion	.66			
19. Initiate Topics	.82			
20. Maintenance	.51			
21. Interruption				.77
22. Time Speaking				.49
23. Speak Rate				.60
24. Nervous		.45*		.54
25. Speak Fluency		.45*		.58
Eigenvalues	7.40	5.50	2.04	1.41
% of variance	29.62	21.99	8.14	5.66
Cronbach's α	.89	.85	.76	.85

Factor loadings below .40 are suppressed for clarity. Some items (*) cross-loaded onto two factors indicating that the item was correlated with each factor.

Table 5. Descriptive statistics of individual CSRS items.

Scale item	Range	Mean (SD)
Speak Rate	1.00–5.00	4.01(1.32)
Speak Fluency	1.00–5.00	3.17(1.10)
Vocal Confidence	1.00–5.00	2.77(1.30)
Articulation	1.00–5.00	3.26(1.17)
Vocal Variety	1.00–5.00	3.76(1.24)
Volume	1.00–5.00	3.67(1.08)
Posture	1.00–5.00	3.69(1.05)
Lean to Partner	1.00–5.00	3.53(1.18)
Nervous	1.00–5.00	3.98(1.09)
Movements	1.00–5.00	3.67(1.11)
Facial Expression	1.00–5.00	3.12(1.35)
Nodding Response	1.00–5.00	4.04(1.00)
Gesture Use	1.00–5.00	3.49(1.39)
Humor Use	1.00–5.00	3.95(1.07)
Smile Laugh	2.00–5.00	4.25(0.77)
Eye Contact	1.00–5.00	4.21(0.99)
Ask Questions	1.00–5.00	3.05(1.60)
Speak about Partner	1.00–5.00	3.27(1.57)
Speak about Self	1.00–5.00	3.11(1.52)
Agreements	1.00–5.00	3.79(1.18)
Opinion	1.00–5.00	3.95(1.26)
Initiate Topics	1.00–5.00	3.39(1.63)
Maintenance Topic	1.00–5.00	3.65(1.14)
Interruption	1.00–5.00	4.05(1.16)
Time Speaking	1.00–5.00	3.65(1.15)

scale's variance. Typical items loading on this factor included the use of facial expressions, gestures, and eye contact. Four items loaded onto Factor 4 (Coordination) and accounted for 5.66% of the scale's variance. Typical items loading on this factor included topic maintenance and fluency. Cronbach's (1951) alpha reliability coefficients for the Expressiveness ($\alpha = .89$), Suprasegmentals ($\alpha = .85$), Paralinguistics ($\alpha = .76$), and Coordination factors ($\alpha = .85$) were acceptable (i.e., $\alpha = .70$; see Nunnally, 1978).

Table 5 provides the descriptive statistics for each CSRS item. Interestingly, the respondents indicated that the AAC user had adequate speaking fluency ($M = 3.17$; $SD = 1.10$) and articulation ($M = 3.26$; $SD = 1.17$) in spite of demonstrating severe, non-fluent aphasia. Moreover, the suprasegmentals and paralinguistics of the AAC user's communication was highlighted as a strength (e.g., nodding, gestures, eye contact, and vocal variety).

Discussion

The primary aim of this study was to obtain psychometric data on the CCS. Results indicated that the CCS and the CSRS are internally consistent measures of communicative competence. Although the ratings were based on a singular topic and some of the interactions between the PWA and the partner involved answering close-ended probe questions, a significant portion of the recorded conversation was open-ended. The trained communication partner utilized several strategies to facilitate continued conversation (e.g., increasing wait time and paraphrasing content or sustaining a topic). Moreover, when interpreting the results of the scales used in this study, it is important to remember that both PWA and their communication partners are responsible for fostering communicative competence (Bloch &

Beeke, 2008; Brock et al., 2017; Kagan et al., 2001; Oelschlaeger & Damico, 1998; Wilkinson et al., 2010). Therefore, the respondents in this study may be rating the conversational skills of both the PWA and the communication partner.

Reliability and factor analyses

CCS

The CCS was developed to measure aspects of linguistic, operational, social, and strategic communicative competencies in PWA. The CCS was moderately correlated with the CSRS, indicating that the CCS was a valid measure. The Cronbach's (1951) alpha reliability coefficient for the CCS indicated that the scale was internally consistent. The intra-rater reliability was also significant indicating that the CCS yielded consistent ratings over time.

With respect to the factor analysis, two factors were extracted from the CCS, accounting for 71.65% of the scale's variance: Conversational Effectiveness and Successful Communicative Supports. The alpha reliabilities from these factors were strong (i.e., $\alpha > .80$), indicating that the CCS items were selected well with the exception of one statement. Item 9 measured communicative modalities, and it cross-loaded onto each of the factors. This indicates that the item was correlated with both factors at a very high level (i.e., $>.32$; Osborne & Costello, 2009). Closer inspection of the item wording, as seen below, revealed that *two constructs* may have been measured simultaneously.

How frequently did the person with aphasia use different ways of communicating (e.g., speaking, writing, AAC system) or different strategies (e.g., rephrase, give instructions to partner) when trying to get his message across?

First, the phrase "different ways of communicating" measures the individual's use of any modality to convey a message. While embedded examples of different ways to communicate were provided (e.g., writing), the list was not exhaustive. Thus, it is likely that the respondents provided their ratings based on the examples, and not on other communicative modalities such as frequently used gestures and vocalizations (e.g., sound effects). Second, this item also referred to "different strategies" that measured how the individual repaired conversational breakdown. Research indicates that these items be deleted from the analysis (Osborne & Costello, 2009). This creates a limitation in that the CCS only has one item measuring strategic competence; however, the CSRS did measure several aspects of strategic competence (i.e., items 7–13) that is discussed below. Future research utilizing the CCS would benefit from an additional scale item to separately measure each construct.

Item 2, measuring communicative success, also cross-loaded onto each CCS factor but was retained in the analysis.

How much of the time was the person with aphasia able to get his message across (communicative success)?

Osborne and Costello (2009) suggest that cross-loading items can be retained if the item is known to be part of the latent construct. This cross-loading was not surprising given the rationale for AAC implementation is to increase conversational effectiveness (McNaughton & Bryen, 2007). Previous research supports this rationale indicating that

AAC techniques and strategies positively influence the respondents' rating of the user's communicative competence (e.g., Gorenflo & Gorenflo, 1991; Hoag & Bedrosian, 1992; Hoag et al., 1994).

The Successful Communication Supports factor is a reliable measure of an aspect of operational competence that may differentiate successful from unsuccessful AAC use. The Conversational Effectiveness factor is a reliable measure of aspects of linguistic competence and social competence. Ratings from the individual items from the Conversational Effectiveness factor suggest that the PWA's active participation and initiation varied from not effective (e.g., "never" initiating or commenting) to effective (e.g., "always" initiating or commenting). This degree of variation presents a unique problem because the results are both consistent and inconsistent with previous research. The results are consistent with previous research indicating that unaided and aided AAC techniques and strategies positively impact communicative competence (e.g., Beeke et al., 2013; Gorenflo & Gorenflo, 1991; Hustad, 2001; Lasker & Beukelman, 1999; Lasker & Holz, 2016; Richter et al., 2003). However, the data are mixed with respect to active participation. That is, some respondents were consistent with previous research, indicating that the user was a passive partner who "never" to "rarely" to an active role (Hoag et al., 1994; Midtlin, Næss, Taxt, & Karlsen, 2015). However, and inconsistent with previous research, some respondents indicated active involvement ("often" to "always") of the AAC user in the video. There are several explanations as to why this occurred, but the most probable explanations are related to (a) the holistic nature of how respondents rated competence with the CCS when compared to the CSRS and (b) the methodological differences employed across studies and the two interface displays used in this study.

First, the CCS measured more macro-level communication and the effects of an SGD on competence (e.g., effectiveness), while the CSRS measured more discrete, micro-level markers (e.g., fluency). Thus, it is possible that respondents holistically rated the AAC user's competence without attending to micro-level details such as how much speaking time was allocated to each individual in the conversation. The CCS mean ratings indicated that the AAC user "rarely" to "sometimes" took an active role commenting and initiating ($M = 2.35$; $SD = 1.05$). In contrast, similar CSRS items measuring micro-level active participation (e.g., time speaking, interruption, initiating, and topic maintenance) were rated as "adequate" to "good" ($M = 3.39$ – 4.05 ; range = 1.00 [inadequate] – 5.00 [excellent]). This difference is important because the data indicate that the AAC user's ability to interrupt ($M = 4.05$) was almost a full point higher than his ability to initiate topics ($M = 3.39$). This suggests that specific aspects of the user's active participation were better than others. Thus, the micro- and macro-levels of communication, as measured through more naturalistic conversation, is critical to understanding the true communicative skills of PWA using AAC because standard clinical testing underestimates this population (Beeke et al., 2003).

The second aspect potentially explaining the inconsistency with previous research includes the impact of interface display on communication. The effect of interface display was not measured in the present study as it was a *scale development study*. However, PWA use a wide variety of AAC techniques and strategies to meet their daily communicative needs, and the respective impact of these tools on the perceived communicative competence must be systematically evaluated using a reliable and valid measure. By verifying the strong psychometric properties of the CCS, this study

is an initial step in that direction. Future research on the effects of interface display and CCS ratings is imperative because of the growing body of scene display literature and its increased use in clinical practice. Previous studies have found that scene displays (a) may enhance the multimodal message complexity of PWA when compared to grid displays (Brock et al., 2017), (b) result in a greater number of conversational turns for PWA (Brock et al., 2017; Hux et al., 2010), and (c) are easier to navigate than grid displays (Brock et al., 2017; Wallace & Hux, 2014).

While this is only a scale development study, it is important to note the potential clinical applications of the CCS. A fruitful line of research with the CCS may focus on the clinical utility of the scale for measuring pre- and post-AAC intervention outcomes. The CCS could allow speech-language pathologists to quickly quantify the effectiveness of their multimodal interventions. Additionally, the CCS could be used for assessment purposes. Specifically, clinicians could use the scale to feature match (i.e., matching the capabilities or features of an AAC system with the cognitive-linguistic skills of the user) by measuring and comparing the effectiveness of different speech-generating devices, interface displays, or message rate enhancement techniques during structured conversations. This may enhance the clinical decision-making process, resulting in AAC technologies and systems that are adopted and successfully used to augment natural speech.

CSRS

This is the first study that used the CSRS to measure the conversational effectiveness of PWA. Consistent with previous research, a four-factor solution was found (see Spitzberg & Adams, 2007). The four-factor solution was robust, accounting for 65.41% of the scale's variance. Additionally, it appears that the scale is sensitive enough to detect some of the non-verbal aspects of communication in PWA. Notably, the Suprasegmental and Paralinguistic factors reflected a residual ability to exchange information when natural speech failed (e.g., nodding, gestures, eye contact, and vocal variety). This is consistent with previous research indicating that multimodal communication may enhance the communicative interaction of some PWA (e.g., Beukelman & Mirenda, 2013; Brock et al., 2017; Purdy & Van Dyke, 2011).

Interestingly, the respondents indicated that the PWA had adequate speaking fluency and articulation ability in spite of a diagnosis of chronic, severe non-fluent aphasia. This is consistent with previous research indicating that conversational- and sentence-level analysis of natural speech and gestural communication more accurately represents certain aspects of communicative competence than standard language batteries (Beeke et al., 2013, 2007). Although we expected that the respondents who were exposed to persons with speech and language impairments would have identified the restricted fluency and articulatory ability, it appears that the use of conversational strategies by the partner in conjunction with AAC may have positively influenced the communicative competence ratings for this particular construct. As discussed in the CCS section above, respondents indicated that the AAC user exhibited adequate time speaking in comparison to his partner. While several explanations of this effect were offered, further research is needed. Yet, professionals may consider programming AAC systems with symbols and messages that are not only easy to locate but are also relevant to a broader audience (e.g., unfamiliar communication partners). Moreover, highly structured

biographical content or routine discussion of a closed set of hobbies may not be what PWA or their partners want to communicate, which may negatively impact how active PWA are during conversation.

There were six items (see [Table 4](#)) that cross-loaded onto two factors indicating some correlation among the items and the factors. These items were kept in the analysis because they may be important to each factor. For example, the awkward movements (item 7) item cross-loaded on to the Coordination factor and the Paralinguistics factor. The coordination factor measures the individual's interaction management, while the Paralinguistics factor measures non-verbal communication. Thus, the awkward movement item may identify disruptions with respect to Coordination and Paralinguistics. Additionally, it is not surprising that items such as humour use (item 13) cross-loaded onto the Expressiveness and Paralinguistics factors because the AAC user was a multi-modal communicator. Humour was used as an expressive unit and as a paralinguistics unit.

Overall, given the reliability and validity of the CCS and CSRS, it may be beneficial to combine the two scales to obtain communication skill at the micro- and macro-levels. The CSRS's factors (e.g., Suprasegmentals and Paralinguistics) analyse communication at the micro-level, while the CCS factors analyse communication at the macro-level (e.g., effectiveness and AAC affects). In this way, the factor structures of the CCS and the CSRS complement one another because they measure a wide range of communication skills that are targeted during intervention. For example, multimodal interventions, including facilitated use of vocalizations, gestures, movement, and laughing, are efficacious ways to target overall communicative competence when natural speech and language do not suffice (Rose, 2013).

Limitations

Although the sample size for this study was adequate for statistical analysis, the intra-observer reliability data were obtained only for a smaller data set ($n = 14$). Additionally, no inter-observer reliability data were obtained. It is recommended that future research should focus on assessing the reliability and validity of the CCS using a large sample. Second, the participants were all enrolled in a communication sciences and disorders training program. It is imperative that future research include a broad range of AAC stakeholders (e.g., caregivers) because these individuals may be the primary communication partners and are valuable contributors to the design of AAC systems (Richter et al., 2003). Third, the participants' ratings also may have been influenced by the role played by the communication partner in eliciting, maintaining, and supporting communication. Thus, when using these scales it is important to remember that the ratings are influenced by multiple factors including, but not limited to, communication supports. Fourth, this study only utilized communicative interaction videos from one person with non-fluent aphasia to assess respondent ratings. It is recommended that future studies focus on assessing communicative competence across aphasia subtypes and severities.

Finally, it is important to note that the CSRS items measuring speaking about the partner and speaking about self were not relevant to this study because of the singular topic used in conversation and the structured nature of the interaction did not allow for that type of communication. However, the purpose of this study was to establish the reliability and

validity of the CCS using the CSRS as a benchmark. If we eliminated those items, it would change the reliability and validity of the CSRS, thereby invalidating the results.

Conclusion

This study investigated the psychometric properties of two scales (CCS and CSRS) on AAC stakeholder ratings of PWA using an SGD. The results indicated that the CCS and CSRS were internally consistent and valid measures to rate the communicative competence of PWA. Caregivers' ratings of AAC use may be beneficial to clinicians. We see these scales providing valuable insight from various AAC stakeholders that may shape device/application selection, intervention plans, and conversational skill development. Future research should focus on investigating the sensitivity of these scales to capture treatment gains.

Notes

1. Manufactured by DynaVox Technologies (2007). 2100 Wharton Street Suite 400, Pittsburgh, PA 15,203, U.S.A.
2. Manufactured by Apple Inc. (2015). 1 Infinite Loop, Cupertino, CA 95,014, U.S.A.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendices

Appendix 1

Oral and Written Directives

You will observe a person with aphasia in a wheelchair engaged in a conversation with a communication partner. The person with aphasia will be using a computer support, called an Augmentative and Alternative Communication (AAC) device that uses pictures to help him interact. In this first video, the person with aphasia will be using a...

- (1) Visual scene display. You will see photographs from the *I Love Lucy* episode in this video (POINT TO PWA AND TO VIDEO IN UPPER CORNER). In this video, you will see the individual with aphasia speaking and gesturing.

OR

- (2) Taxonomic grid display. You will see cartoon like drawings depicting the *I Love Lucy* episode in this video (POINT TO PWA AND TO VIDEO IN UPPER CORNER). In this video, you will see the individual with aphasia speaking and gesturing.

Appendix 2

Oral and Written Direction for the Scales

Communicative Competence Scale

Instructions: You will be watching a video and rating how effective the person with aphasia is during the conversational interaction. In general, a rating of an **“a”** represents a person is **not an effective** communicator, and a rating of an **“e”** represents a **more effective** communicator. Please provide your rating on the form provided.

AND

Conversational Skills Rating Scale

Instructions: You will observe a person with aphasia in a wheelchair engaged in a conversation with a communication partner. The person with aphasia will be using a computer support, called an Augmentative and Alternative Communication (AAC) device that uses pictures to help him interact.

You will be watching a video and rating how effective the person with aphasia is during the conversational interaction. In general, a rating of an **“A”** represents a person is **an inadequate** communicator, and a rating of an **“E”** represents an **excellent** communicator. Please provide your rating on the form.

Final Directions

Please watch the videos in their entirety before filling out the surveys. Please fill out the surveys in the exact order given to you. Please do this activity independently. No talking during the video or while filling out the surveys. Any questions?

Appendix 3

Communicative Competence Scale

- (1) How much did the person with aphasia participate/engage in the interaction?*
- (2) How much of the time was the person with aphasia able to get his message across* (communicative success)?
- (3) How much of the time did the person with aphasia take an active role (initiate) in the interaction by asking questions, generating unsolicited comments, or expressing opinions?*
- (4) How would you rate the person with aphasia's overall communication ability?*
- (5) Was the computer support an important tool for enhancing the person with aphasia's communication effectiveness?
- (6) In general, this person with aphasia is an effective communicator.**
- (7) This person with aphasia was so effective that I would engage in a conversation if I encountered him in the community.**
- (8) What effect did the computer support have on the person with aphasia's communication effectiveness (e.g., getting his message across, relaying information)?*

DELETED FROM ANALYSIS

- (9) How frequently did the person with aphasia use different ways of communicating (e.g., speaking, writing, AAC system) or different strategies (e.g., rephrase, give instructions to partner) when trying to get his message across?*

Note. A * indicates that the scale item was adopted from Garrett (2004). A ** indicates that the scale item was adopted from Hustad (2001)