

SELF-REPORTED AND PARTNER-REPORTED FUNCTIONAL COMMUNICATION AND
THEIR RELATION TO LANGUAGE AND NON-VERBAL COGNITION IN MILD TO MODERATE
APHASIA

by

PAULA J. MESSAMER

B.A., University of California, Los Angeles, 1986

M.A., University of Colorado, Boulder, 1991

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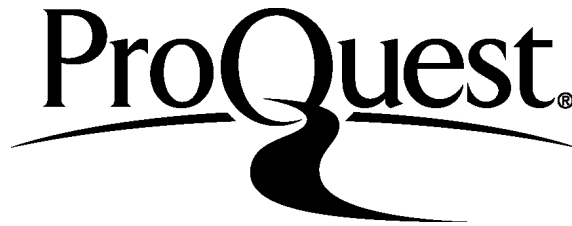
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SELF-REPORTED AND PARTNER-REPORTED FUNCTIONAL COMMUNICATION AND THEIR RELATION TO
LANGUAGE AND NON-VERBAL COGNITION IN MILD TO MODERATE APHASIA

written by Paula J. Messamer
has been approved for the
Department of Speech Language and Hearings Sciences

Gail Ramsberger, Sc.D. (chair)

Pui Fong Kan, Ph.D.

Neeraja Sadagopan, Ph.D.

Clayton Lewis, Ph.D.

Anne Whitney, Ed.D.

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ABSTRACT

Paula J. Messamer (Ph.D. Speech, Language and Hearing Sciences)

Self- and partner-reported functional communication and their relation to language and non-verbal cognition in mild to moderate aphasia

Directed by Gail Ramsberger, Associate Professor and Chair, Department of Speech
Language and Hearing Sciences, University of Colorado at Boulder

Purpose: Non-verbal cognition and language functions were examined in adult stroke survivors with aphasia. The specific purpose of the study was twofold: 1) to examine the relationship between self-reported outcomes from people with aphasia (PwA), measures of non-verbal cognition (Delis-Kaplan Executive Function Systems Test (D-KEFS), Delis, Kaplan, & Kramer, 2001) and measures of language (Western Aphasia Battery-Revised (WAB-R), Kertesz, 2007; Boston Naming Test Second Edition (BNT-2), Kaplan, Goodglass, & Weintraub, 2001) and 2) to examine these same relationships using partner-reported outcomes for that same group of PwA. This study used the Aphasia Communication Outcome Measure (ACOM, Doyle et al., 2013) to gather both self-reported ACOM data and partner-reported ACOM data (ratings of the person with aphasia's communication made by a regular conversation partner).

Method: Seventeen participants with aphasia underwent examination with an extensive test battery including measures of functional communication, non-verbal cognition, and

language impairment. In addition, 16 of their regular communication partners rated functional communication performance.

Results: Self-reported functional communication is strongly related to the number of errors committed on the D-KEFS design fluency test ($r = .81$, $p = .001$). Furthermore, a modified form of the D-KEFS design fluency test (in which the examinee is allowed unlimited time) shows that the proportion of errors contributes significantly to a two-predictor linear regression model. These two predictors account for 66% of the variance in self-reported functional communication ratings. These results suggest that non-verbal cognition for people with mild to moderate aphasia may serve an important role in functional communication. By contrast, self-reported functional communication was uncorrelated with aphasia severity ($r = .04$, $p = .88$), naming performance on either the WAB-R ($r=.059$, $p=.823$) or the BNT-2 ($r=.097$, $p=.713$), and category fluency ($r=.086$, $p=.741$).

Partner-reported functional communication was highly correlated to the naming subtest on Western Aphasia Battery-Revised (WAB-R) scores ($r=.71$, $p=.02$) and to performance on the Boston Naming Test (BNT-2; $r=.56$, $p=.026$). Partner-reported functional communication was also strongly predicted based on the number of animals named during the category fluency task on the WAB-R ($r=.782$, $p=.000$). A linear regression model including WAB-R category fluency accounted for 61.1% of the variance in partner-reported ratings. A second linear regression adding naming as a predictor was not significant ($F_{\text{change}} = 2.18$, $p=.163$). By contrast, none of the non-verbal cognition measures were useful predictors of partner-reported functional communication. These results suggest that aphasia severity serves an important role in partner ratings of functional

communication whereas non-verbal cognition does not.

Taken together, these results suggest that PwA and their partners rely on different aspects of communication when judging functional communication.

Further work to explore the use of patient-reported outcome (PRO) measures and to identify factors that contribute to self-reported functional communication is needed. The discussion addresses the appropriateness of using PRO measures in aphasia and the use of surrogate reports.

Keywords: Aphasia, patient-reported outcomes, partner-reported outcomes, functional communication, non-verbal cognition, language impairment

DEDICATION

This dissertation is dedicated to my husband, Frank Eparvier. Your unwavering support and encouragement has meant so much to me. Without it, I would never have succeeded at this endeavor. Let's go have some fun.

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CHAPTER 1:

INTRODUCTION

Aphasia is an acquired language disorder resulting from brain damage. Aphasia can occur following stroke, brain injury, tumor, degenerative disease, etc. Approximately 100,000 new cases of aphasia occur annually in the U.S. (National Institute on Deafness and Other Communication Disorders, 2008) and more than 1 million Americans are living with aphasia (National Aphasia Association, 2016). The communication deficits that occur from aphasia affect speaking, comprehension, reading, and/or writing.

In addition to compromised language abilities, people with aphasia (PwA) frequently present with cognitive deficits affecting attention (Erickson, Goldinger, & LaPointe, 1996; Korda & Douglas, 1997; LaPointe & Erickson, 1991; Laures, Odell, & Coe, 2003; Murray, Holland, & Beeson, 1998), working memory (Caspari, Parkinson, LaPointe, & Katz, 1998; Christensen & Wright, 2010; Murray, 2012; Wright, Downey, Gravier, Love, & Shapiro, 2007) and executive function (Fridriksson, Nettles, David, Morrow, & Montgomery, 2006), which may also contribute to their problems with communication.

Although PwA can be active, productive members of their families and communities, there are significant personal and societal costs associated with acquired neurogenic changes in communication. These include loss of productivity (Ownsworth & Shum, 2008), reduced functional independence (Simmons-Mackie, Threats, & Kagan, 2005) and changes in self-identity (Simmons-Mackie & Elman, 2011). Most people who acquire aphasia never

return to work (Morris, Franklin, & Menger, 2011). People who were once voracious readers may be unable to read even simple texts. People who enjoyed public speaking or active conversations may be unable to contribute to conversations (at least at the level of interaction they once enjoyed).

Given the personal and societal impacts of aphasia, great emphasis is being placed on outcome measures that reflect improvements in everyday function and quality of life. According to the patient-centered care model, patients should play an active role in evaluating the quality and effectiveness of the care they receive and in deciding goals for treatment (Davis, Schoenbaum, & Audet, 2005). That is, the individual with aphasia should be regarded as the ultimate judge of his/her own quality of life because patient experience is considered a more sensitive and specific measure of important therapeutic effects, and self-report may reveal disability and disease related life losses much more accurately than conventional assessments of impairment (e.g. ability to walk, performance on language tests).

It follows that collecting data on the patient's views of their own outcomes is an increasingly important part of the health care delivery process (American Speech Hearing Association, 2013; Irwin, 2012; Rao, 2015;) and the use of patient-reported outcome (PRO) measures is key to understanding the impact of aphasia from the perspective of the person with aphasia (Chue, Rose, & Swinburn, 2010). Patient-reported outcomes (PROs) are outcomes reported directly by the patient concerning their overall functioning and sense of wellbeing (Threats, 2012; U.S. Food and Drug Administration, 2016).

Prior research has shown that communicative functioning is only partially explained by the level of language impairment. Furthermore, evidence suggests that, in addition to

language, there may be explanatory value in also using level of cognitive impairment as a predictor of communicative function. This study looks at whether measures of cognition can be used to predict self-reported functional communication.

In addition, because post-stroke deficits and aphasia may prevent some people from providing their own self-reports, it is common to rely on surrogate reports from regular communication partners (e.g. family, friends, and caregivers). This study, therefore, looks at whether partner-reported functional communication is 1) correlated with self-reported functional communication and 2) whether partner-reported functional communication is associated with the same language and cognition predictors as self-reported functional communication.

Chapter II provides a review of the literature. The aims of the literature review are:

- 1) To provide background about the relationship of impairment-based measures of aphasia, cognition and functional communication measures.
- 2) To describe the use and value of PRO measures in general and in the context of stroke and aphasia.
- 3) To address issues specific to the use of PRO measures in aphasia
- 4) To address issues specific to the use of surrogate PRO measures in aphasia

The remaining chapters present a research study. The aims of this research study are:

- 1) To replicate previous findings showing that self-reported and partner-reported functional communication are strongly related.
- 2) To explore the relationship between self-reported functional communication and

measures of cognition.

- 3) To explore the relationship between partner-reported functional communication and measures of language and cognition.

CHAPTER 2:

BACKGROUND AND SIGNIFICANCE

LINGUISTIC IMPAIRMENTS IN APHASIA

Aphasia is an acquired neurogenic language disorder which results from injury to the areas of the brain involved in language. Aphasia is not a single disorder, but instead is a family of disorders that involve varying degrees of impairment across language modalities (American Speech-Language-Hearing Association, 2016).

The signs and symptoms of aphasia vary widely across individuals depending on the location and extent of their brain damage (Kagan, Black, Duchan, Simmons-Mackie, & Square, 2001). Language impairments include disturbances of receptive and expressive abilities affecting spoken language output, spoken language comprehension, written expression and reading comprehension (ASHA, 2016).

Impairments of verbal expression include an impaired ability to express thoughts using a smooth, uninterrupted flow and rate of speech; difficulty finding words, difficulty naming objects; speaking in single words, speaking in short fragmented phrases, omitting short words like “the”, “of”, and “was”; an inability to repeat what someone else has said; substituting sounds within words; substituting one word for another (e.g. “yes” for “no”); making up new words; stringing together real or made-up words into non-informative sentences.

Impairments of auditory comprehension include difficulty understanding spoken utterances; providing unreliable answer to "yes/no" questions; failing to understand complex grammar (e.g., The farmer was chased by the cow.); requiring extra time to understand spoken messages and finding it very hard to follow fast speech (e.g., radio or television news); misinterpreting subtleties of language (e.g., takes the literal meaning of figurative speech such as "It's raining cats and dogs."); and a lack of awareness of language deficits.

Impairments of writing (agraphia) include difficulty writing or copying letters, words, and sentences; writing only single words; substituting incorrect letters or words; spelling or writing nonsense syllables or words; writing run-on sentences that don't make sense; and writing sentences with incorrect grammar.

Impairments of reading (alexia) include difficulty comprehending written material; difficulty recognizing words by sight; inability to sound-out words; substituting associated words for a word; difficulty reading non-content words (e.g., function words such as *to*, *from*, *the*).

The signs and symptoms displayed by a given individual vary based on situation, partner, and topic. For example, a given individual seemingly may have no difficulties when chatting with familiar partners but show significant slowing or word finding problems when conversation topics are more complex or unfamiliar.

MEASURING LINGUISTIC IMPAIRMENTS

Assessment of aphasia is completed in a number of ways and using a range of assessment measures. In some cases, an entire standardized test battery is administered. In other cases, a clinician may give selected subtests from standardized test batteries in order

to provide subjective descriptions of a person's functioning. In other cases, nonstandardized tools developed by the clinician are used to probe aspects of speech, language, and cognition (ASHA, 2016).

The decision to use standardized or nonstandardized assessment procedures is determined by the clinician based upon a variety of factors, including the needs of the person with aphasia, the complexity of impairment, payer rules, facility policy, and other considerations. When time and billing constraints limit the time allowed for assessment, screening tests such as the Bedside Evaluation Screening Test (BEST-2; West, Sands, & Ross-Swain 1998) are often used. Screenings serve to identify patients who should be fully evaluated to determine if there is a disorder but do not provide sufficient data to fully characterize it.

In research, aphasia is typically assessed using a standardized test battery shown to have strong psychometric properties such as high inter- and intra-rater reliability. These assessments diagnose and grade relative strengths and weaknesses across the language and cognitive areas affected by aphasia. Examples of such assessment are the Western Aphasia Battery-Revised (WAB-R, Kertesz, 2007), the Boston Diagnostic Aphasia Examination (BDAE; Kaplan, 1983), and the Porch Index of Communicative Ability (PICA; Porch, 1971).

The WAB-R was selected as the measure of language for this research study because, in addition to estimating overall aphasia severity (WAB-Aphasia Quotient or AQ), it also provides differential diagnosis of aphasia type and provides a profile of general strengths and weaknesses in a subset of areas including fluency, auditory comprehension, and naming. Spontaneous speech is assessed via responses to personal questions and the

patient's description of a line drawing. Spontaneous speech is rated on two 10-point scales: information content and fluency, which includes grammatical competence and presence of paraphasias. Comprehension is assessed based on responses to yes/no questions (that may be answered in either verbal or nonverbal fashion), by physical responses to spoken words (touch the pen); and by physical responses to sequential commands (e.g. pick up the pen and then turn over the book). Repetition is assessed using 15 progressively longer items that are scored as correct, partially correct (due to presence of phonemic errors) or as complete errors. The naming score is comprised of object naming (without cuing or, if necessary, with tactile and/or phonemic cuing), category fluency (number of animals named in 60 seconds), sentence completion, and responsive speech.

COGNITIVE IMPAIRMENTS IN APHASIA

Separate from language deficits, PwA also show impairments on tests of cognition including attention (Erickson, Goldinger, & LaPointe, 1996; Korda & Douglas, 1997; LaPointe & Erickson, 1991; Laures et al., 2003; Murray, Holland, & Beeson, 1998; Murray, 2012; Robin & Rizzo, 1989), working memory (Caspari, Parkinson, LaPointe, & Katz, 1998; Christensen & Wright, 2010; Wright, Downey, Gravier, Love, & Shapiro, 2007), executive function (Fridriksson, Nettles, Davis, Morrow, & Montgomery, 2006) and processing speed (Gerritsen, Berg, Deelman, Visser-Keizer, & Jong, 2003; Neto & Santos, 2012).

MEASURING COGNITION IMPAIRMENTS IN APHASIA

Because of the language deficits, assessment measures intended for non-aphasic populations may be too linguistically complex for PwA. For this reason, researchers have employed tasks designed to assess cognition while minimizing or reducing language

demands. Examples include the Wisconsin Card Sorting Test (Baldo, Dronkers, Wilkins, Ludy, Raskin, & Kim, 2005; Grant & Berg, 1993; Fridricksson et al., 2006; Hinckley & Carr, 2001; Lambon Ralph, Snell, Fillingham, Conroy, Sage, 2010; Purdy, 2002;), the Tower of Hanoi and Tower of London tests (Purdy, 2002), the Ravens Colored Progressive Matrices (Hinckley & Carr, 2001; Raven, 1962), Pyramids and Palm Trees (Lambon Ralph et al., 2010), the Test of Everyday Attention (Robertson, Ward, Ridgeway, & Nimmo-Smith, 1996), the Rey-Osterreith Complex Figure (Keil & Kazniak, 2002), and the Porteus Mazes (Murray, 2012; Porteus, 1959; Purdy, 2002).

Evidence suggests that cognition and language impairments operate independently of one another (Helm-Estabrooks, 2002; Hinckley & Nash, 2007). That is, PwA sometimes have impairments on cognitive tasks that are not consistently related to aphasia severity.

In addition, there is a high degree of variability in cognitive performance across individuals (Hinckley & Nash, 2007). For example, Murray (2012) found that as a group PwA performed significantly worse than a neurologically unimpaired control group on cognitive measures but that within the group there was large variability in the presence, types, and severity of individual's attention and other cognitive deficits.

Furthermore, evidence suggests that that poorer cognitive status leads to poorer treatment outcomes. Lambon Ralph et al. (2010) showed that higher performance on tests of language and cognitive ability before treatment was associated with larger gains from anomia therapy. Fillingham, Sage, and Lambon Ralph (2005a, 2005b; 2006) showed that pre-treatment measures of executive function (Wisconsin Card Sort Task, WCST; Grant & Berg, 1993) and self-monitoring skills predicted participants' response to treatment. Similarly, Seniów, Litwin, & Leśniak (2009) showed that visuo-spatial working memory

was positively associated improvement in naming and comprehension (although no relationship was found between language therapy outcome and abstract thinking ability).

The Delis-Kaplan Executive Function Systems test (D-KEFS; Delis, Kaplan, & Kramer, 2001) is designed for the assessment of executive functions (Homack, Lee, & Riccio, 2005). The subtests assess a variety of areas including flexibility of thinking, inhibition, problem solving, planning, impulse control, concept formation, abstract thinking, and creativity. The D-KEFS was selected as the measures of cognition for this study because it included a number of tasks that had minimal language demands and it was normed on a large representative sample of neurologically unimpaired people (ages 8 to 89). After reviewing the 9 subtests in the full D-KEFS testing battery, 4 were selected for inclusion in this research study: Verbal Fluency, Design Fluency, Card Sorting, and Twenty Questions (TQT). The remaining subtests were omitted due to even high linguistic demands than Verbal Fluency and TQT (Word Context; Color-Word Interference, Proverb Test), physical demands (Tower Test) or time restrictions (Trail Making Test).

MEASURING FUNCTIONAL COMMUNICATION IN APHASIA

Impairment measures (such as those described in the prior two sections) help to characterize deficits but functional communication is only partially determined by the impairments of aphasia. Functional communication also depends upon factors such as communication partners, motor skills, communication needs and context. This means that impairment measures alone may not provide valid information about an individual's day-to-day function.

Functional communication is defined as the ‘ability to receive or to convey a message, regardless of the mode, to communicate effectively and independently in a given [natural] environment’ (Frattali, Thompson, Holland, Wohl, & Ferketic, 1995, p. 12). Functional communication assessment methods have included direct measurement of communication behaviors, indirect reports by trained and untrained observers, and reports from PwA (self-reports). Direct measures of functional communication that maintain a natural environment are difficult to achieve. Ramsberger (2005) reported on a measure of conversational success in which she coded how much information a partner was able to glean from a conversation with the PwA about the plotline from a television show (“I Love Lucy”). While this is certainly an example of functional communication, it does not cover the broad spectrum of behaviors that constitute functional communication in its entirety. Indirect measures of functional communication are more common and include estimates of functional communication provided by therapists, caregivers, and family members. These measures also sometimes rely on retrospective reports of communicative behaviors.

Clinician-provided estimates of functional communication include the Communicative Activities of Daily Living-2 (CADL-2) (Holland, Frattali, & Fromm, 1998), American Speech Language Hearing Association Assessment of Functional Communication Skills for Adults (ASHA-FACS) (Frattali, Thompson, Holland, Wohl, & Ferketic, 1995), and the Therapy Outcome Measure (TOM) (John & Enderby, 2000). To complete the Communication Activities of Daily Living -2 (CADL-2; Holland, Frattali, & Fromm, 1998), an observer assess seven categories of verbal and non-verbal communication during role-play of familiar situations (e.g., shopping or making a telephone call). Categories include: social

interaction, divergent communication, contextual communication; sequential relationships, nonverbal communication, reading, writing and using numbers, and humor/metaphor/absurdity.

To complete the Functional Communication Profile (FCP; Sarno, 1969) the clinician assesses functional capacity through observations of the patient's behavior while interacting with the clinician. Communication categories include movement, speaking, understanding, reading, and other (e.g., writing and calculations).

Studies have shown that poorer performance on tests of language level (Holland, 1982; Irwin, Wertz & Avent, 2002; Ross, 1999) and cognition (Fridriksson et al., 2006) are correlated with poorer functional communication when rated by trained observers/therapists. Fridricksson and his colleagues (2006) showed that most participants performed below normal limits on non-verbal executive function tests (Color Trails Test and WCST) and there was a significant relationship between cognition and functional communication (measured using the SLP-rated ASHA-FACS). Decreased cognitive ability might coincide with decreased functional communication ability in PwA.

PATIENT REPORTED OUTCOME MEASURES

As discussed in the introduction, patient reported outcomes (PROs) are key to understanding the impact of aphasia from the perspective of the person with aphasia because they give PwA more power to express how aphasia affects them. PRO measures are especially important if they produce different information than would evident based on either impairment based assessments or other-reported (partner-reported, care-giver reported, or therapist-reported) functional communication.

Insurance providers and governmental agencies are requiring patient-reported outcome (PRO) measures as evidence of treatment benefits (Barrett, 2009; Irwin, 2012, Doyle et al., 2013). Medicare and other insurance agencies are compelling the use of PRO measures to collect data on patient function during the course of therapy services as a means of documenting change in patient condition and outcomes (Irwin, 2012; MCTRJCA, 2012; Pub. L. 112-96; Snyder & Aaronson, 2009) and the Department of Health and Human Services has prioritized patient-reported outcomes in research and clinical care (De Riesthal & Ross, 2015). PRO measures are now being used to justify reimbursement for therapy services, demonstrate treatment effectiveness, justify the continuance of services, provide patient education, and make decisions regarding how to best allocate resources (Threats, 2012).

BARRIERS TO THE USE OF PRO MEASURES IN APHASIA

Despite the push, the integration of PRO measures into research and clinical practice faces significant challenges. There are concerns about the way that PRO measures may impact service delivery (negative impacts on billing and service provision, challenging SLPs to demonstrate the value of their services, time and effort to collect PRO data further limiting treatment time), and concerns about their usefulness (too broad to capture the types of changes seen over short courses of therapy, PRO measures don't tell therapists what treatment methods to use). In the specific case of aphasia, there are ongoing concerns about their appropriateness (not clear that patients can understand the test or that they can give valid and reliable feedback) and their correspondence with impairment measures that have been used as the "gold standard" in the field for decades.

TYPES OF PRO MEASURES IN APHASIA

There are two broad types of PRO measures: Generic and Disease specific (Cella, Hahn., Jensen, Butt, Nowinski, & Rothrock. 2015; Patrick & Deyo, 1989). Generic PRO measures are often used when the goal is to look at quality of life or function across a wide variety of health issues. Disease specific PRO measures are used when there is a specific subset of patients who share a particular diagnosis or are receiving common treatment. That is, disease specific measures better enable differentiation of groups at the level of specific symptoms or patient concerns. Generic measures often capture a different category of outcomes than condition-specific PRO measures. For example, a Generic measure may assess domains of general function, well being, or quality of life, whereas a condition-specific PRO may measure symptoms expected given a specific diagnosis (such as stroke or aphasia). In the case of stroke, disease specific PROs have addressed areas such as mobility, self-care, communication, cognition, and mood. When the focus is on a specific symptom or set of symptoms that are unique to the condition, condition-specific instrument are preferred.

Generic PRO measures can be applied to individuals without specific health conditions, and they can differentiate groups on indices of overall health and well-being. Generic PRO measures have the advantage of allowing for comparisons across patient groups and populations but are likely to be less responsive than condition-specific measures to focal changes that are related to a specific condition and may be targeted in treatment (e.g. aphasia). That is, generic PRO measures may fail to capture important condition-specific concerns.

To be clinically useful, PRO measures must be sensitive to change. Sensitivity to change is the ability to detect a small, but meaningful, differences and is necessary when monitoring patients and implementing clinical interventions. Evidence suggests that condition-specific PRO measures can be more sensitive to change than generic PRO measures. Generic PRO measures may be less sensitive because they contain multi-trait scales that may not be relevant to the target population being assessed. Certainly, condition specific scales can lack sensitivity if they assess a broad range of factors when only one of those factors is being targeted in treatment. For example, it is problematic to assess general change on a stroke impact assessment when treatment has targeted a specific area such as mobility or speech. To address this concern, it is common to focus on a specific subtest. However, because there are often so few items in subtests, this again raises concerns about sensitivity. For example, measures developed to emphasize specific content areas would be expected to show greater post-treatment change in those content areas. In other words, the greater sensitivity to change in condition-specific PRO measures may be attributed to the strong content validity inherent in condition-specific measures.

STROKE SPECIFIC PRO MEASURES

There are a number of assessments available for assessing the effect of stroke on quality of life or participation in activities of daily living. These include the Stroke-Specific Quality of Life (SS-QOL; Williams, Weinberger, Harris, Clark & Biller 1999), the Burden of Stroke Scale (BOSS, Doyle et al., 2004). These contain very brief subsections (7 to 10 items) addressing verbal expression, verbal comprehension, reading and writing.

APHASIA SPECIFIC PRO MEASURES

There are also a number of aphasia specific PRO measures. These include the Communicative Effectiveness Index (CETI; Lomas, Pickard, Bester, Elbard, Finlayson, & Zoghaib, 1989), the Self-Reported Functional Communication: Communication Outcome After Stroke (COAST; Long, Hesketh, & Bowen, 2009), Communication Disability Profile (CDP; Swinburn & Byng, 2006; Chue, Rose, & Swinburn, 2010), the Stroke and Aphasia Quality of Life Scale (SAQOL-39; Hilari, Byng, Lamping, & Smith, 2003) and the Aphasia Communication Outcome Measure (ACOM; Hula et al., 2015).

FINDINGS FROM STUDIES USING PRO MEASURES

Only a few studies have looked at the relationship of *patient-reported* functional communication and impairment-level performance. Doyle and his colleagues found a correlation of 0.65 ($r^2 = .423$, $n=83$) between the Western Aphasia Battery Aphasia Quotient score and the ACOM (Hula et al., 2015). Although significant, this means that only 42% of the variance in the PRO measure was explained using aphasia severity.

To date, no studies have correlated *patient-reported* functional communication with cognition measures. Therefore, this study examines whether adding-verbal cognition measures produces a more powerful model than when using aphasia severity alone. It is also possible that the effects of cognitive dysfunction on daily activities may interact with or amplify limitations due to their language disorder (Keil & Kasniak, 2002).

WHY ACOM?

The ACOM was selected for a number of reasons: 1) it was condition specific for aphasia 2) it had undergone significant verification and validation using Item Response

Theory (IRT) methods as described below, 3) it is specific enough that it should be sensitive to communication issues that are targeted in therapy, 4) it has strong relevance (it asks about things that are important and relevant to PwA and their partners) and changes on the ACOM would reflect improvements in everyday function and quality of life and 5) it has strong test-retest reliability (.86; Hula, Kellough, & Doyle, 2015)

The ACOM was developed across time based on IRT principles (Doyle, McNeil, Le, Hula, Ventura 2008). First, an initial set of 673 items was gathered from 33 existing functional communication instruments. These items were reviewed with stroke survivors, partners, and SLPs to explore their content relevance and representativeness. Multiple studies have resulted in a 59 item version (Doyle, Hula, Hula, Stone, Waumbaugh, Ross, & Schumacher, 2013; Hula et al., 2015). At the time that the data in this study were collected, the reduction to 59 items was not yet complete. Therefore this study used a combination of the 101 items from the Doyle et al. (2012) survey and the 59 items from the Doyle et al. (2014- pre-publication version). All analyses, however, are based on the data from the 59-items in the most recent version of the ACOM.

The reasons for choosing the ACOM are well summarized by Hula et al. (2015):

“The ACOM represents an advance over previously available patient-reported measures for aphasia because it is based on a coherent and empirically supported measurement model, provides highly precise score estimates across all levels of functioning, and its development and validation are being pursued within a modern psychometric framework that will offer users a high degree of flexibility in choosing between test burden and measurement precision”. (pg. 917).

PROXY REPORT AS A SUBSTITUTE FOR SELF-REPORT

A major concern about using patient-reported outcome measures is whether, because of common stroke-related neuropsychological deficits, PwA can provide valid self-assessments. Barrett (2009) cites specific deficits such as failure to adjust for the effect on self-report of spatial neglect, deficits of magnitude estimation, pathologic alteration of self-awareness, and alteration in distributed cortical systems supporting emotional semantics and abstraction (pg. 17). Beyond these, others have cited concerns about the PwA's ability to understand the questions and validly and reliably communicate their own perceptions (Doyle et al., 2013)

Concerns like these have lead many PRO studies to exclude people PwA altogether. Unfortunately, this approach represents a large deviation from the spirit of self-reported PRO measures. Cella et al. (2012) states "Failing to include these populations can result in potentially misleading interpretations of results. Thus, attempting to include them in PRO assessment efforts is crucial; using all possible mechanisms for obtaining self-reports is a high priority, but accomplishing this may be out of the question for some populations." (pg. 18). The exclusion of PwA also attenuates generalizability of research results (Pickard et al, 2004).

One way to include a larger number of patients in research is to use proxy respondents to obtain PRO information for patients who are unable to respond. Proxies are typically significant others (e.g., parents, spouses or other family members, close friends) or formal caregivers (physicians, nurses, aides, teachers). Using proxies can provide a number of potential benefits. The use of proxies not only allows inclusion of a

broader and more representative range of patients in the entire measurement effort, but it can also help minimize missing data and increase the feasibility of longitudinal assessment.

The usefulness of proxy responses as *substitutes* for patient responses depends on the validity and reliability of proxy responses compared with those attributes for patient responses. Agreement between the proxy and patient is typically assessed at either the subscale level, using intraclass correlation coefficients (ICC), or the item level, using the kappa statistic. In addition, group comparisons are used to detect the size and direction of systematic bias.

Some large studies have found positive correlations between self-reported and proxy-reported measures of outcomes (e.g. health-related quality of life, functional communication) in chronic disease (Sneeuw, Sprangers, & Aaronson, 2002) stroke (Duncan et al., 2002) and aphasia (Williams et al., 2006; Bakheit, Carrington, Griffiths & Searle, 2005).

Findings suggest that agreement is higher between proxy and patient ratings when rating more directly observable domains (e.g., physical function vs. energy) (Doyle et al., 2013). Stroke-specific studies that have included participants with aphasia have reported intraclass correlation coefficients ranging from 0.50 to 0.70 for language and communication scales.

Oczkowski & O'Donnell (2010) completed a systematic review of research on the reliability of proxy respondents for patients with stroke covering 13 studies (2618 participants). Their review compared patient and proxy reported outcomes for activities of daily living (ADL) and/or quality of life (QoL) and found that in the chronic stage, patient and proxy agreement was strongest when stroke was severe and when the questions

pertained to observable domains. Using the three categories for inter-rater correlations (ICC or k-statistic) results of poor ($\leq .40$), moderate (.41-.60), substantial (.61-.80) or excellent ($>.80$), they concluded that reliability was substantial to excellent for ADL outcome measures and moderate to substantial for QoL outcome measures.

While patient and proxy rating are correlated, there is evidence of bias in surrogate ratings. Frost, Reeve, Liepa, Stauffer, & Hays (2007) and Irwin, Wertz, & Avent (2002) reported that proxies consistently rate functional outcomes more negatively than patients. An exception to this is pain about which proxies tend to under-report (Andresen, Vahle, Lollar, 2001)

Doyle et al. (2013) correlated ACOM scores across a large sample ($n = 133$) of people with severe to mild aphasia. They showed a moderate correlation between self- and surrogate- reports on the ACOM with an overall correlation of .69 (W. Hula, personal communication; December 4, 2015). Although significant, it is interesting that 52% of the variance in the self-reported ACOM is still unaccounted for when predicted using the partner's ratings and implies that there may be other relevant factors driving ACOM scores. Based on the data, Doyle and his colleagues (2013) concluded "Correlations between self- and surrogate reports were moderate-to-strong, but there were significant disagreements in a substantial number of individual cases." (pg. 957) and "Despite minimal bias and relatively strong association, surrogate reports of communicative functioning in aphasia are not reliable substitutes for self-reports by persons with aphasia" (pg. 957).

To summarize, while a number of studies have found moderate to strong correlations between patient and proxy reported outcomes, there are enough instances in which the disagreements are large that researchers cannot recommend using surrogate ratings in

place of patient ratings. Frost et al. (2007) warned:

“Investigators need to be cautious in trying substitute proxy reports for patient self-report data because of inherent differences between the two types of respondents. The more observable the function, the greater the agreement between a proxy and a patient’s report; better concordance between proxies and patients tends to occur for the physical domains than for psychosocial domains. Proxies tend to report more disability and depression about the patients than patients report about themselves. In contrast, proxies tend to attribute higher levels of cognitive ability to the patients than do patients when rating their own cognitive ability.” (pg. S100).

PROXY REPORT AS A COMPLEMENT TO SELF-REPORT

Rather than viewing proxy assessments as replacements for self-reports, another strategy is to view them as providing complementary information. That is, proxy reports constitute a valid perspective in their own right, regardless of their correspondence with patients’ ratings (Doyle et al., 2013) and in these cases, patient-other agreement may not necessarily be desirable.

If, for example, the patient fails to recognize deficits and problems in functioning, then patient and partner ratings should deviate. Subtler though are the potential differences between the lived experience of the person with aphasia and a partner. Even with significant correlations between self-reported and proxy-reported outcome measures, there is no guarantee that the underlying factors determining the ratings of patients and partners are the same. That is, it is possible that the person with aphasia and the partner

give the same rating on a specific functional communication item similarly (e.g. asking questions of their doctor) but they are judging the performance based on different criteria.

Support for this idea comes from Fucetola & Connor (2015) who showed that family/partners rate the effectiveness of communication primarily based on expressive language despite the fact that other aspects of aphasia (e.g. listening comprehension) are as important for everyday communication. If surrogate raters rely on different information to judge functional communication, then using partner-ratings would be inappropriate. Based on the existing evidence, partner ACOM scores are more likely to correlate with observable components of language (such as naming and fluency) and less likely to correlate with less-observable components (such as auditory comprehension).

SUMMARY AND HYPOTHESES

In summary, the effects of aphasia have been measured in a number of different ways. Impairment measures have the advantage that they characterize specific deficits but only partly correlate to functional communication. Functional communication measures have the advantage of assessing real-world performance that is likely to have relevance to the patient and family. Functional communication has often been measured using the opinion of others, be it therapist, caregivers, or family. With the push to include the patient in assessing their own outcomes, there is a need to understand how patient-reported functional communication relates to impairment measures and other-reported measures. If it can be shown that self-reported measures are highly consistent with 1) impairment measures and/or 2) other-reported measures then these measures can be treated as equivalent. If they are not correlated then this implies that self-reported measures do, in

fact, provide a uniquely valid perspective about the impact of aphasia on the individual.

Based on the literature review, we developed the following hypotheses:

1) Related to Self-Reported Functional Communication

- a) Self reported functional communication would be correlated with aphasia severity.
- b) Self-reported functional communication would be correlated with cognition.
- c) A linear regression model predicting self-reported functional communication using both aphasia severity and cognition would account for significantly more variance than a model using aphasia severity alone.

2) Related to Partner-Reported Functional Communication

- a) Partner-reported functional communication would be correlated with self-reported functional communication.
- b) Partner-reported functional communication would be correlated with aphasia severity and cognition.
- c) A linear regression model predicting partner-reported functional communication using both aphasia severity and cognition would account for significantly more variance than a model using aphasia severity alone.

CHAPTER 3:

METHODS AND PROCEDURE

This chapter describes the methods used for data collection and analyses including a discussion of the subjects, assessment measures, and experimental procedures.

PARTICIPANTS

Seventeen community-dwelling adults (10 males) with chronic aphasia (greater than 6-months post-onset) completed the study. In addition, 16 of their regular communication partners rated functional communication performance. Participants with aphasia were prescreened (in-person or by telephone) for mild-moderate non-fluent aphasia or anomic aphasia with relatively strong auditory verbal comprehension and evidence of word finding difficulty. Volunteers with fluent aphasia, severe apraxia of speech and severe dysarthria were excluded. Participants were required to be monolingual English speakers. Participants were required to have sufficient stamina to complete 4 hours of testing in a single day. Each PwA was required to identify an English-speaking partner with whom he/she had frequent contact both prior to and after aphasia onset and who was willing to participate in the study.

Participants were recruited through multiple channels. Some were recruited using flyers posted at the University of Colorado, Speech, Language and Hearing Sciences Department Clinic and others were recruited through a bulletin board posting to the ASHA

Neurophysiology and Neurogenic Speech and Language Disorders Special Interest Group (SIG 2). Speech Language Pathologists who identified potential participants were sent a copy of the flyer and were asked to provide it to potential participants. These potential participants were then required to initiate any further contact. In addition to participants from Boulder/Denver, participants were recruited in Minneapolis, MN and Baltimore, MD.

The Institutional Review Board of the University of Colorado approved the study, and signed informed consent was obtained from each participant after passing the pre-screening. Consent forms were mailed to the PwA's home address to allow ample time for review prior to the first session. Those with aphasia were encouraged to have a family member or friend review the form with them. Consent was obtained at the beginning of the first session and critical points were reviewed in person verbally and highlighted on the form. Critical points included the total time commitment, the types of activities they would be doing, the ability to withdraw at any time and for any reason, the compensation amount and the partial compensation amount if they terminated their participation. When the participant did not hold his/her legal power of attorney, both the participant and the person who holds the power of attorney signed the consent form. Participants with aphasia were compensated \$200 while communication partners were compensated \$25.

A total of 27 people were prescreened and a total of 22 people entered into the study. Four of the five nonentrants were not enrolled because they appeared to have fluent aphasia or no longer have aphasia. One was cleared for participation but had other health issues that prevented scheduling. Of the 22 people who entered the study, 5 people failed to complete it after being consented. Participants were discharged for the following reasons: Participant 5 had a stroke between days 1 and 2 of testing; Participant 10 scored

26/100 on the WAB-AQ (cut-off was 50 or higher) and was dismissed from the study; Participant 18 arrived sick on day 2 and was unable to complete the study; Participant 20 asked to be dismissed from the study after completing the first half of the ACOM, the WAB-R and the timed BNT-2. Participant 21 decided she did not want to participate after completing 1-hour of tasks. Participants who failed to complete the study were paid \$10 per hour for each hour completed or \$60 whichever was smaller. This lesser amount was intended to only partially compensate the participant because their data, since it was incomplete, could not be used.

DEMOGRAPHICS

The demographic and clinical characteristics of the group are summarized in Table 1. The seventeen PwA who completed the study ranged in age from 30 to 72 ($M = 53.24$, and $SD = 11.27$). All completed high school and more than half held 4-year or advanced degrees.

WESTERN APHASIA BATTERY-REVISED.

All participants with aphasia included in the final data set presented with mild-to-moderate aphasia as measured by the WAB-AQ (range 54.3-96.2; $x = 76.9$, $s.d. = 10.70$) and relatively good auditory comprehension as indicated by WAB-R auditory comprehension subtest scores (range 7.2 – 10.00; $x = 8.61$, $s.d. .91$). See Table 2 for complete WAB-R data summary.

Despite the prescreening, two participants (6 and 9) received sufficiently high WAB-AQ scores to be categorized as non-aphasic (a score in excess of 93.7 is considered “normal”; Kertesz, 1982). Because their ACOM self-reports indicated ongoing

communication challenges (ACOM scores = 191, 176 out of 236 respectively, we modified our original selection criteria and retained these 2 participants in the analysis. Note that this is consistent with the inclusion criteria used by Doyle and colleagues who had a WAB-AQ range min-max of 10.2 – 100 (Hula, personal communication, January 27, 2015).

Partner/family raters consisted of spouses or romantic partners (44%), siblings (19%), adult children (13%), or parents (25%). Participant 3's partner had poor familiarity (she worked at the front desk of the living facility), did not know the participant prior to the onset of aphasia, and never saw him engage in activities outside the living facility. Because of this lack of familiarity, she was unable to comment on many of the items on the ACOM. For these reasons, her data were excluded from the study.

Table 1.

Participant characteristics: Mean, standard deviation (s.d.), and range for 17 persons with aphasia (PwA) with Partner Gender and Relationship to PwA. (Note: "." Indicates missing participant data. See text for explanation).

PwA				Partner		
Participant	Gender	Age	WAB-AQ	Gender	Reside Together	Relationship
1	F	66	74.7	F	No	Daughter
2	M	53	81.0	F	Yes	Spouse
3	M	55	69.3	.	.	.
4	M	57	85.2	F	Yes	Spouse
5	.	.	.	.	.	.
6	M	45	94.8	F	No	Mother
7	F	55	76.7	F	Yes	Mother
8	M	30	86.9	F	No	Mother
9	F	58	96.2	F	No	Daughter
10	.	.	.	.	.	.
11	F	30	76	M	Yes	Spouse
12	M	42	79.2	F	Yes	Spouse
13	F	52	79.5	M	No	Brother
14	M	63	73.4	M	No	Brother
15	F	54	72.8	F	No	Mother
16	F	56	78.6	F	No	Sister
17	M	72	54.3	F	Yes	Spouse
18	.	.	.	.	.	.
19	M	54	60.4	F	Yes	Spouse
20	.	.	.	.	.	.
21	.	.	.	.	.	.
22	M	63	68.9	F	Yes	Spouse
Mean	M = 59%	53.24	76.9	M = 18%		
s.d.		11.27	10.7			

Table 2.

WAB-AQ and subtest scores for each participant with aphasia.

29	Participant	WAB-AQ	Spont. Speech	Fluency	Auditory Comp.	Sequential Commands	Repetition	Naming	Animal Fluency
	1	74.7	11	6	9.3	71	9.8	6.8	5
	2	81.0	14	6	8.8	62	8.7	9	13
	3	69.3	13	6	7.65	42	5.8	8.2	11
	4	85.2	15	6	9.6	75	8.8	9.2	12
	6	94.8	19	9	9.9	89	9.2	9.3	13
	7	76.7	17	8	8.25	50	5.7	7.4	20
	8	86.9	18	9	8.45	67	8.0	9	13
	9	96.2	19	9	10	80	9.5	9.6	16
	11	76.0	13	5	8.30	54	8.0	8.7	10
	12	79.2	14	6	8	40	8.2	9.4	19
	13	79.5	12	4	9.45	72	7.8	9.5	15
	14	73.4	12	4	9.20	64	7.8	7.7	4
	15	72.8	13	5	7.45	50	7.8	8.1	8
	16	78.6	14	5	7.80	40	6.4	8.1	9
	17	54.3	9	4	7.65	42	6.9	3.6	1
	19	60.4	11	4	7.20	28	4.6	7.4	7
	22	68.9	8	4	9.45	78	5.0	8.0	7
	Mean	76.9	13.65	5.88	8.61	59.06	7.53	8.18	10.76
	s.d.	10.7	3.20	1.83	.91	17.35	1.56	1.45	5.18

ASSESSMENTS

A series of functional communication, non-verbal cognition, and language impairment tests were administered to all participants (Appendix A). This section describes each assessment and its purpose. A full explanation of modified instructions is provided in the appendix (Appendix D).

APHASIA COMMUNICATION OUTCOME MEASURE

The Aphasia Communication Outcome Measure (ACOM; Doyle, et al., 2013) was used to assess self-reported and partner-reported functional communication ability. The ACOM consists of 59-items (Appendix B). The questionnaire asks the respondent to rate how effectively they (or their partner with aphasia) engage in certain common, everyday behaviors, tasks, activities, and life situations that involved understanding and or producing spoken, written, and or non-verbal messages, signs, and symbols (Doyle, McNeil, Le, Hula, & Ventura, 2008, p. 720). Some example questions are “how effectively do you start a new topic in conversation?”; “how effectively do you make yourself understood when speaking with family and friends?” and “how effectively do you correct mistakes you make when you talk?”. Effectiveness is defined as “accomplishing what you want to, without help, and without it taking too much time or effort” (Hula et al., 2015, p 910).

ACOM items are rated on a 4-point (ordinal) scale. The respondent may also indicate that they do not engage in a specific behavior (e.g. writing checks) with a follow-up question about whether or not it is due to their aphasia. Responses were converted into T-Score values using software provided by Hula (Hula et al., 2015). T-Score are normalized to have a population mean of 10 and a standard deviation of 3.

BOSTON NAMING TEST (SECOND EDITION)

The Boston Naming Test second edition (BNT-2; Kaplan, Goodglass, & Weintraub, 2001) is a visual confrontation-naming test that assesses naming ability. The BNT-2 was selected because it is a more extensive assessment of word finding difficulty than is provided by the WAB-R. The BNT-2 consists of 60 black and white line drawings of objects. Items on the BNT-2 are ordered according to decreasing frequency and familiarity. (Brookshire & Nicholas, 1995).

This study used a modified version of the BNT-2. Unlike the standard administration, no cuing was provided following errors or significant response delays (i.e. no semantic or phonemic cuing was given). In addition, the BNT-2 stimuli were presented via computer using PowerPoint™ software. The drawings were shown one slide at a time and the participant was asked to name each item. To achieve a correct response, the correct answer must have been the first word(s) spoken, with no phonemic paraphasic errors (e.g. “strethoscope” for stethoscope would be incorrect). The percent correct score is the sum of the correct responses divided by the total number of items (60).

D-KEFS DESIGN FLUENCY TEST

The DKEFS design fluency test assesses attention, processing speed, working memory, initiation, perseveration, cognitive flexibility, and nonverbal abstraction (Zinn, Bosworth, Hoenig, & Swartzwelder, 2007). Participants must generate new designs while abiding by the rules and avoiding impulsive or perseverative responses (Mikola, 2010).

Design fluency is especially useful in the assessment of PwA because language is not required to perform well on the test. Therefore, poor performance on Design Fluency

cannot be explained by language, memory, or motor deficits (Ruff, Evans, & Marshall, 1986). Normative data for this test is available for ages from 8 to 89.

The Design Fluency test is comprised of three conditions: basic, filter, and switch (Figure 1). The task is to draw as many unique designs as possible in 60-seconds. The response sheet is printed with an array of 35 squares. Inside each square is a dot pattern. The same dot pattern appears in each square. In the basic condition (condition 1), the squares on the response sheet contain five filled (i.e., black) dots. The examinee is instructed to draw unique designs by connecting the dots with four straight lines. Credit is not given if a design is repeated across squares. In the filter condition (condition 2) each square contains five empty dots and five filled dots. The examinee is instructed to connect only the empty dots using four straight lines (while ignoring the filled dots). Credit is not given if a design is repeated or if a design includes a filled dot. This is called the filter condition because the task requires the examinee to “filter” out (inhibit) relevant responses from condition 1. In the switch condition (condition 3) each square contains five empty dots and five filled dots (arranged differently than in the filter condition) and the examinee is instructed to alternate between connecting empty dots and filled dots. Credit is not given if a design is repeated or if a design fails to include filled and empty dots in an alternating order. This is called the switch condition because the task requires the examinee to flexibly switch between the filled and empty dots. Possible errors include set-loss errors (the design contains greater or fewer than four lines or does not follow the rules for that condition) and repetition errors.

According to Delis-Kaplan (Delis, Kaplan, & Kramer, 2001b), condition 1 provides a basic test of design fluency, condition 2 measures both design fluency and response

inhibition and condition 3 measures both design fluency and cognitive flexibility.

In addition to completing the standard version of the design fluency test, participants completed an untimed version in which they were allowed to take as much time as they wanted to complete the task and were allowed to decide when they were finished. Some participants filled all 35 squares in each condition while others stopped on their own. Because the task was the same in the standard and untimed versions the order was counterbalanced across subjects. The task was completed a single day with test administrations being at least two-hours apart. The untimed version of the test provides additional information about errors and inhibition of impulsive or perseverative responses.

There are two basic errors that can be committed during the design fluency test: set loss designs and repeated designs. Set loss designs are errors in which the design has too many or too few lines. In condition 1, a set loss design has more or less than 4 lines connecting the dots. In condition 2, a set loss design has more or less than 4 lines connecting the dots or it can include a solid dot. In condition 3, a set loss design has more or less than 4 lines or it fails to switch between solid and open dots. Repeated designs are errors in which the same design was already produced on the current response page. Note that many repeated designs occur because, although the examinee uses a different stroke sequence, the same design is ultimately produced. This often occurs when closed designs (forming a square or rectangle) are begun are started at different initial dots.

D-KEFS VERBAL FLUENCY TEST.

Verbal fluency refers to a person's ability to generate items from a given cue (Baldo et al., 2001). Category fluency is item generation based on semantic cues (e.g. animals,

musical instruments). Letter fluency is item generation based on phonemic cues (e.g. words beginning with the letter F or H).

While similar to the category fluency task in the WAB-R, the D-KEFS verbal fluency test is more complete. There were three conditions in the verbal fluency task: letter fluency (F, A, S in set 1; B, H, R in set 2), category fluency (animal's and boys name in set 1; items of clothing and girls names in set 2) and category switch fluency (alternating between fruits and furniture in set 1 and vegetables and musical instruments in set 2). The order of these conditions was fixed as was the order of the sets (that is, F, A, S was always done first). The timed versus untimed conditions were counterbalanced across participants.

Verbal fluency rates were based on the number of correct items produced in one minute. Items were counted as correct if they met the constraints of the condition and were not repetitions. Letter fluency scores were based on the average number of items generated across the three letter conditions. Category scores were the average number of items generated in the two categories. Switch scores are calculated in two ways: Switch Fluency is the total number of items named from either category (irrespective of whether adjacent items are from alternate categories) and Switch Totals is the number of times the participant switches between categories as items are named.

D-KEFS TWENTY QUESTIONS TEST

The D-KEFS Twenty Question Task (TQT) is a problem-solving task that assesses both language and cognition. Problem solving requires conceptualizing, planning, execution and modifying strategies based on feedback (Marshall, Harvey, Freed, & Phillips, 1996). The TQT taxes abstract reasoning ability, ability to shift cognitive set, and working memory

(Delis et al., 2001).

For this test, the participant is presented with a stimulus page depicting common objects in 8-column by 5-row array. The 30 common objects belong to various categories and subcategories differing in terms of the number of objects in each. For example, the stimulus pictures include 15 non-living things, 8 things found in a kitchen, and 2 appliances (Appendix C).

The participant is instructed to ask the fewest number of yes/no questions in order to identify an unknown target object depicted on the stimulus page. The most effective problem-solving strategy on this task is the participant's asking yes/no questions that eliminate the maximum number of objects regardless of whether the examiner's answer is yes or no. For example, the initial question "Is it a living thing?" eliminates half of the objects (15 out of 30) regardless of whether the examiner answers yes or no; thus, this question reflects a high level of abstract thinking. In contrast, if a participant asks a highly concrete initial question (e.g. "Is it a stove?" or "Is it an appliance?") only a few objects would be eliminated by the examiner's answer.

To efficiently solve the TQT, the examinee must (a) perceive the various categories and subcategories represented by the 30 objects, (b) formulate abstract, yes/no questions that eliminate the maximum number of objects regardless of the examiner's answer (c) effectively use feedback when formulating questions (c) incorporate the examiner's feedback in order to formulate more efficient yes/no questions (d) use working memory to track information that has already been discovered (in order to avoid asking questions that do not eliminate new objects), and (e) switch from a conceptual to a specific-naming strategy when a unique category is identified.

D-KEFS CARD SORT TEST

The D-KEFS Card Sort Task (CST; Delis et al., 2001) assesses concept generation, concept identification, and concept execution as well perseveration (Beatty & Monson, 1990).

The D-KEFS Card Sorting task consists of 16 different sorting concepts across two conditions: Free Sort and Sort Recognition. In free sorting examinee is required to sort six cards into two groups, three cards per group, according to eight possible sorting rules (three verbal and five nonverbal), and to describe the sorting rule after each sort made. In recognition sorting the examiner sorts the cards into two groups and then asks the examinee to identify the sorting rule or concept that was used to sort the cards (Shunk, Davis, and Dean, 2006).

To perform well on the CST, the examinee must (a) perceive the various card-set groupings (b) formulate description of the groupings (e.g. these are all found in the air and these are all found on the ground) (c) effectively shift thinking to identify new groupings and d) avoid repetitions of groupings.

TORRANCE TEST OF CREATIVE THINKING

TTCT is a well-known and widely used test of creativity (Torrance, 1968). It assesses four principal cognitive processes of creativity: (a) fluency or number of relevant responses; (b) flexibility as referred to a variety of categories or shifts in responses; (c) originality (considering novelty responses, not familiar and unusual, but relevant) and (d) elaboration (the number of details used to extend a response) (Almeida, Prieto, Ferrando, Oliveira, & Ferrandiz, 2008).

For this study we used two subtests: Product Improvement and Unusual Uses. For Product Improvements, the examinee list ways to change a stuffed animal toy so that a child would have more fun playing with it. For Unusual Uses, the examinee list interesting and unusual uses of a common object. The scoring for each task is based on proprietary scoring methods. No credit is given for repeated solutions/ideas. For example, credit is given once for the idea to clothe the toy but not for listing individual clothing items.

To perform well on the TTCT, the examinee must (a) generate unique, creative suggestions (b) effectively shift thinking to generate new ideas (c) articulate or use gesture to convey the idea to the examiner.

PROCEDURE

Testing was done across 2 days with 4 hours of evaluation and testing each day (maximum of 8 hours total testing time). No more than 1 week lapsed between the first and second test day. Testing was conducted in a quiet room with only the examiner and participant present. All of the sessions were video recorded.

Each testing day, consisted of a 2-hour testing session in the morning, a 1.5-2 hour break, followed by a 2-hour testing session in the afternoon. The total time commitment was 8 hours but many completed it in fewer hours. Testing was conducted in a quiet room with only the examiner and participant present. All of the sessions were video recorded.

The first 2-hour period used either timed or untimed condition (counterbalanced) and the second 2-hour period will use the opposite condition. This approach was chosen because repeated tests within a short period of time may result in criticisms that

performance differences are due to learning/familiarity but, since there is large variability in performance across days, it ensures that timed and untimed tests versions are completed within a single day.

Tests were administered in blocks. Testing order of the blocks was counterbalanced using a Latin Square Design with replacement for lost participants. Blocks A and B were completed on one day and Blocks C and D were completed on another day. Block A consisted of the untimed versions of the Boston Naming Test, the D-KEFS Verbal Fluency test, the D-KEFS Design Fluency test, the Alphabet Fluency Test. Block B consisted of the timed versions of these tests. Block C consisted of the untimed versions of the D-KEFS Sorting test, the D-KEFS Twenty Questions test, and 4 tests from the Torrance Test of Creative Thinking (Appendix F).

A long break (1.5-2 hours) was given between blocks to allow time for the impact of time pressure to abate between blocks. For example, if the timed and untimed tasks were interleaved, then the impact of pressure is likely to bleed over onto conditions that do not require timed performance. When the timed condition follows an untimed condition, an equivalent length break is provided for rest and serves as a general control for total testing time.

APHASIA COMMUNICATION OUTCOME MEASURE.

For participant with aphasia, ACOM data was collected using an interviewer-assisted administration format as described in Doyle et al. (2013). Items were displayed on a computer screen in large font along with the stem “How effectively do you...” The examiner read each item aloud and also permitted the respondent to read it. Responses were provided orally or by pointing to their choice on a visual scale. The computer screen

also displayed a vertical bar representing the response categories with text labels. In cases where there was any uncertainty about the validity of the response, the examiner verbally repeated the item and the response back to the participant and also pointed to the chosen response on the screen. For partner questionnaires, the item stems were modified to “How effectively does your partner...”. Partner testing was unsupervised and employed an online survey form or a paper version per the preference of the respondent.

To collect the ACOM data, the examiner sat alongside the client and read each question aloud. The client could provide their response orally or by pointing to their choice on a visual scale.

For partners, ACOM data was collected using a computer based questionnaire or, for one participant, a printed version of the survey.

BOSTON NAMING TEST (SECOND EDITION)

The BNT-2 was administered twice under timed and untimed conditions. In the timed condition, each stimulus was presented for 3 seconds then the software automatically progressed to the next image. In the untimed condition, each stimulus was presented until the participant provided a name or indicated that they did not know the name. Because participants often respond using rising intonation (e.g. Flower?), were told that they needed to be clear that they were done or they would be asked “Is that your final answer?”.

Items were scored as correct even if they were named after 3-second presentation time.

D-KEFS DESIGN FLUENCY TEST

The design fluency test consists of three conditions: basic, filter, and switch (described in the Assessment section above). The three conditions were administered in this fixed order. Participants used their “post morbid” hand to draw.

For each of the three conditions, participants were first shown a practice pages with 3 squares, each of which contained an array of dots identical to the array on the test page. The instructions for each condition were given orally. Participants were instructed to make a different design in each square by connecting the dots with straight lines. They were told to use only 4 straight lines. Participants were allowed to lift the pen from the page. Participants were encouraged to practice before each condition and were given feedback about their practice designs. In cases where the design was incorrect, the examiner explained by the design was incorrect and recommended another practice attempt. All participants produced at least one correct design during practice.

Each participant completed the design fluency task twice: timed (standard administration: 60 seconds) and untimed (unlimited time). The order was counterbalanced

across participants and test administrations were at least two-hours apart on the same day. In the timed condition, when time expired, the participant was NOT allowed to finish a design in progress (loud ringing noise interrupted task). In the untimed condition, participants self-terminated or stopped once all 35 of the arrays on the response page had been completed.

During the timed condition an iPad displaying a countdown timer with a red clock face with a sweeping hand was placed in a prominent position in front of the participant. When the 1-minute time ended, a ringing sound played and the examiner stopped the participant immediately. During the untimed condition, an iPad displaying an analog clock was placed in the same position in front of the participant but no reference was made to time. The examiner started the task and then spent the duration of the task looking at paperwork or other materials until the participant indicated they were done or completed all 35 squares. If a participant asked for clarification during the timed condition, the examiner suspended the timer until the question was answered. The most common questions were about what to do when the examinee realized that he/she has committed an error. Participants were told to cross out any errors and continue with the task.

Designs were coded as correct if they used 4 straight lines, were unique (this included designs in which one lines did not touch another at an endpoint.) and met other constraints based on condition (explained below). In the timed condition, the participant was NOT allowed to finish any design in progress when the time expired (loud ringing noise interrupted task). In the untimed condition, participants self terminated or stopped once all 35 of the arrays on the response page had been completed.

D-KEFS VERBAL FLUENCY TEST.

There were three conditions in the verbal fluency task: letter fluency (F,A,S in set 1; B H R in set 2), category fluency (animal's and boys name in set 1; items of clothing and girls names in set 2) and category switch fluency (alternating between fruits and furniture in set 1 and vegetables and musical instruments in set 2). The order of these conditions was fixed as were the order of the sets (that is, F-A-S was always done first). The timed versus untimed conditions were counterbalanced across participants.

In order to avoid increasing the complexity of the instructions and increasing working-memory load, participants were allowed to use names of people, places and numbers during the letter fluency task (these constraints are used in standard administrations of this task). Despite this difference, very few participants violated the rule and, when they did, they generated people's names.

Instructions were given orally. Just before starting, the target letter was written down and shown to the participant then removed from view when the task began. In the timed condition, participants were given 60 seconds to generate items. An iPad showing a clock with a red sweeping count-down indicator was placed directly in front of the participant and the examiner began the task with a "Ready, Set, Go!" while starting the timer. In the untimed condition an iPad with a clock was placed in the same position but participants were told to work at his/her own pace. The examiner listened and wrote down each item generated and encouraged the participant to continue working as long as s/he wanted.

To avoid complexity and working-memory load, participants were allowed to use names of people, places and numbers during the letter fluency task (these constraints are

used in standard administrations of this task). Despite this difference, very few participants violated the rule and, when they did, they generated people's names.

Scoring was completed following the scoring methodology described in the D-KEFS Examiners Manual (Delis, Kaplan, & Kramer, 2001c). Verbal fluency rates were based on the number of correct items produced in one minute. Items were counted as correct if they met the constraints of the condition and were not repetitions. Letter fluency scores were based on the average number of items generated across the three letter conditions. Category scores were the average number of items generated in the two categories. Switch scores are based on the number of correct items generated in the condition regardless of whether or not the participant accurately followed the switching rule.

D-KEFS TWENTY QUESTIONS TEST.

The D-KEFS Twenty Questions test was administered twice, once with no time limits and once with time pressure. In the time pressured condition a count-up timer was placed in front of the participant and he/she was instructed to ask questions as quickly as possible. The clock was started and the timer started as the examiner said "Ready, Set, Go!". The presentation order for the two versions was counterbalanced across participants.

Each administration consists of 4 trials. The first test administration was always completed with the items "banana", "spoon", "owl" and "helicopter". The second test used the items "airplane", "rose", "stove" and "corn". Across all four trials, there is the need to avoid interference from prior items.

For the purpose of this study, three scores from the TQT were derived from the data: 1) the total number of questions required to identify the target item, 2) the abstraction of the

first question in each trial (abstraction refers to the number of items eliminated by a question regardless of whether the response is yes or no), and 3) the total weighted achievement (this scoring corrects for fortuitous guessing).

D-KEFS CARD SORT TEST

The D-KEFS Card Sort test was administered twice, once with no time limits and once with time limits (4 minutes per card set- up to eight sorts per set). In the time limited condition a count-down timer was placed in front of the participant and he/she was instructed to ask questions as quickly as possible. The clock was started and the timer started as the examiner said "Ready, Set, Go!". The presentation order for the two versions was counterbalanced across participants.

Participants are shown how to sort the cards using a sample card set. The sample sorts include one based on perceptual features (cards grouped by color: yellow and blue) and one based on the words appearing on the cards (Boy versus Girls names). To confirm that they were able to read the words on the cards, participants were asked to read the words on the cards aloud before the sorting task began.

For the sort recognition task, the participant was told to look away as the cards were placed into two groups. They were asked to describe how the cards were the same in each group. In the timed condition, viewing time was limited to 30 seconds. Explanation/description time was allowed to continue past the 30 seconds time limit.

TORRANCE TEST OF CREATIVE THINKING

The TTCT has two parallel forms (A and B). The presentation order for the two versions was counterbalanced across participants. Each subtest (Product Improvement and Unusual

Uses) was administered twice, once with no time limits and once with time limits (4 minutes per card set- up to eight sorts per set).

For the Product Improvement task, the participant was allowed to hold, manipulate, and gesture with the stuffed toy. When gesture was used, the examiner worked with the participant to agree on the meaning. For example, if the participant moved the animal across the table, then the examiner might ask “Make it walk”? and wait for the participant to confirm or redirect.

For the Unusual Uses task, the examiner acknowledged ideas and asked questions to clarify uses. For example, if the participant said “painting”, the examiner might ask “You would paint it?” and wait for the participant to clarify.

CHAPTER 4:

RESULTS

DESCRIPTIVE STATISTICS

SELF-RATED AND PARTNER-RATED APHASIA COMMUNICATION OUTCOME MEASURE

As Table 3 shows, the mean ACOM T-Score for the PwA group was 53.18 and the standard deviation was 7.3. Participant 2's ACOM rating score was an outlier (score = 36.30) however analyses of the data without his score did not change the pattern of results. The mean ACOM T-Score for the Partners group was 49.44 and the standard deviation was 9.53. There were no outliers in the partner ACOM scores.

Partner-reported scores were on average more positive than PwA-reported scores. The average difference between PwA and Partner scores was 3.24 (s.d. =10.60). However, 38% of the PwA (6/16) rated themselves higher than did their partner on the ACOM.

Table 3.

PwA and Partner ACOM scores with group means and standard deviations.

Participant	WAB-AQ	PwA ACOM	Partner ACOM	Diff (Partner – PwA)
1	74.8	54.29	34.75	19.54
2	81.0	36.30	45.62	-9.32
3	69.3	61.37	.	
4	85.2	49.04	62.43	-13.39
6	94.8	56.35	50.23	6.12
7	76.7	48.31	56.98	-8.67
8	86.9	57.34	48.64	8.7
9	96.2	62.58	53.42	9.16
11	76.0	54.03	50.24	3.79
12	79.2	51.67	60.69	-9.02
13	79.5	60.74	67.20	-6.46
14	73.4	39.76	43.60	-3.84
15	72.8	47.06	41.36	5.7
16	78.6	55.63	47.93	7.7
17	54.3	54.05	31.70	22.35
19	60.4	60.58	51.73	8.85
22	68.9	55.03	44.46	10.57
mean	76.94	53.18	49.43	3.24
s.d.	10.70	7.30	9.53	10.60

Note: Missing ratings (“does not apply” or “I don’t know”) were omitted from the calculation.

BOSTON NAMING TEST

The percent correct for the two conditions is shown in Table 4. Timed responses (Mean =.56, s.d. =.22) were significantly less accurate than untimed responses (Mean =.46, s.d. = .22); Paired t-test (16)= 5.44, p=.000.

Table 4.

Percent correct naming on Boston Naming Test (BNT-2) for Untimed and Timed Conditions.

Participant	WAB-AQ	BNT-2	Timed BNT-2
1	74.8	.58	.30
2	81.0	.47	.40
3	69.3	.48	.42
4	85.2	.73	.57
6	94.8	.83	.78
7	76.7	.53	.32
8	86.9	.72	.53
9	96.2	.92	.92
11	76.0	.63	.42
12	79.2	.82	.72
13	79.5	.62	.55
14	73.4	.57	.50
15	72.8	.52	.42
16	78.6	.52	.35
17	54.3	.05	.02
19	60.4	.30	.27
22	68.9	.27	.25
Mean	76.94	.56	.45
s.d.	10.70	.22	.22

D-KEFS DESIGN FLUENCY- STANDARD ADMINISTRATION

Table 5 shows that the number of correct designs produced by our sample summed across the 3 conditions ranged from 8 to 29 (mean = 17.82 and s.d. = 6.00). The number of attempted designs ranged from 11 to 44 (mean = 24.59, s.d. = 7.77).

The number of repeated designs produced by our sample summed across the 3 conditions ranged from 0 to 13 (mean = 3.06 and s.d. = 3.79) and set loss design ranged from 0 to 11 (mean = 3.82 and s.d. = 3.05). Adding the errors together, this resulted in proportion of errors ranging from .08 to .55 (mean = .27 and s.d. = .15).

Table 5.

D-KEFS Design Fluency data for Standard Administration. Scores are summed across the 3 conditions.

Participant	WAB-AQ	D-KEFS Design Fluency (Standard Admin)				
		Attempted Designs	Correct Designs	Repeated Designs	Set Loss Designs	Proportion of Errors
1	74.7	27	22	2	4	.22
2	81.0	44	23	13	8	.48
3	69.3	18	16	0	2	.11
4	85.2	20	14	5	1	.30
6	94.8	19	16	0	3	.16
7	76.7	34	18	5	11	.47
8	86.9	32	29	3	0	.09
9	96.2	16	11	1	4	.31
11	76.0	30	27	0	3	.10
12	79.2	23	17	0	6	.26
13	79.5	27	23	2	2	.15
14	73.4	25	19	3	3	.24
15	72.8	20	10	2	9	.55
16	78.6	25	23	1	1	.08
17	54.3	20	12	4	4	.40
19	60.4	11	8	0	3	.27
22	68.9	27	15	11	1	.44
Mean	76.9	24.59	17.82	3.06	3.82	0.27
s.d.	10.7	7.77	6.00	3.78	3.05	0.15

Note: Because a single design can be both a Set Loss Design and a Repeated Design, the sum of Correct + Repeated + Set Loss may be larger than Attempted.

D-KEFS DESIGN FLUENCY- UNTIMED ADMINISTRATION

When given unlimited time, our participants produced an average of 45.1 correct designs across the three conditions (s.d. = 17.6) (Table 6). The number of attempted designs ranged from 18 to 103 (mean = 61.7, s.d. = 25.6).

The number of repeated designs produced by our sample summed across the 3 conditions ranged from 0 to 34 (mean = 7.9 and s.d. = 11.5) and set loss design ranged from 0 to 52 (mean = 8.1 and s.d. = 12.25). Adding the errors

together, this resulted in proportion of errors ranging from .02 to .67 (mean = .22 and s.d. = .196).

Participants 15, and 22 had markedly higher number of repetition errors while Participant 7 had many more set loss errors than the other participants. Participant 2 produced large numbers of repetition and set loss errors. Generally, participants who produced fewer designs were also more accurate.

Table 6.

D-KEFS Design Fluency data for Untimed Administration. Scores are summed across the 3 conditions.

Participant	WAB-AQ	D-KEFS Design Fluency (Standard Admin)				
		Attempted Designs	Correct Designs	Repeated Designs	Set Loss Designs	Proportion of Errors
1	74.7	36	32	0	4	.11
2	81.0	98	52	34	12	.47
3	69.3	18	16	0	2	.11
4	85.2	73	58	6	9	.21
6	94.8	45	45	0	0	.00
7	76.7	81	27	2	52	.67
8	86.9	80	69	8	3	.14
9	96.2	55	50	3	2	.09
11	76.0	54	53	0	1	.02
12	79.2	94	83	7	4	.12
13	79.5	70	60	5	5	.14
14	73.4	45	43	2	0	.04
15	72.8	103	56	32	5	.36
16	78.6	29	27	1	1	.07
17	54.3	40	24	4	12	.40
19	60.4	45	32	2	11	.29
22	68.9	83	40	28	15	.52
Mean	76.9	61.7	45.1	7.9	8.1	.22
s.d.	10.7	25.6	17.6	11.5	12.25	.196

Note: Because a single design can be both a Set Loss Design and a Repeated Design, the sum of Correct + Repeated + Set Loss may be larger than Attempted. The maximum number of attempted designs was limited to 105 (35 designs per response sheet).

D-KEFS VERBAL FLUENCY

Table 7 shows the data for the D-KEFS Verbal Fluency task. Averaged across participants the Letter Fluency (the number of words beginning with a specific letter) across 3 trials ranged from 1 to 43 (mean = 14.00 s.d. = 9.35). Category Fluency (the number of words from a specific category) across 3 trials ranged from 4 to 36 (mean = 17.35 s.d. = 9.68). In the switching condition, the

total number of items named (single trial) ranged from 1 to 12 (mean = 6.18 and s.d. = 2.98) and the total number of switches ranged from 0 to 12 (mean = 4.7 and s.d. = 3.48).

Table 7.

D-KEFS Verbal Fluency data

Participant	WAB-AQ	D-KEFS Verbal Fluency				
		Word Fluency Ratio	Letter Fluency Total	Category Fluency Total	Switch Fluency Total	Switches Total
1	74.7	.26	7.00	13.00	5.00	1.00
2	81.0	.34	17.00	22.00	7.00	6.00
3	69.3	.55	9.00	5.00	3.00	1.00
4	85.2	.34	13.00	17.00	8.00	7.00
6	94.8	.28	14.00	24.00	8.00	7.00
7	76.7	.27	17.00	31.00	6.00	4.00
8	86.9	.39	18.00	19.00	9.00	8.00
9	96.2	.44	43.00	36.00	7.00	6.00
11	76.0	.31	16.00	24.00	7.00	6.00
12	79.2	.34	20.00	26.00	11.00	10.00
13	79.5	.36	19.00	23.00	12.00	12.00
14	73.4	.40	7.00	7.00	5.00	4.00
15	72.8	.25	8.00	16.00	2.00	.00
16	78.6	.39	16.00	17.00	6.00	3.00
17	54.3	.14	1.00	4.00	3.00	2.00
19	60.4	.60	9.00	4.00	5.00	3.00
22	68.9	.28	4.00	7.00	1.00	.00
Mean	76.9	.35	14.00	17.35	6.18	4.7
s.d.	10.7	.11	9.35	9.68	2.98	3.48

D-KEFS TWENTY QUESTIONS TEST.

Data for the D-KEFS Twenty Questions Test are presented in Table 8. All data represent the total across 4 trials. Participant 14 was unable to achieve tasks set. The total number of questions averaged 33.38 questions (s.d. = 19.84) with a

range of 16 to 80 (the maximum). The weighted abstractions scores for the first question averaged 21.63 (s.d. = 14.47) with a range of 0 to 53. Totaled across 4 trials, weighted achievement scores averaged 13.69 (s.d. = 5.87) with a range of 0 to 20.

Table 8.

D-KEFS Twenty Questions Test data for Standard Administration.

Participant	WAB-AQ	Twenty Questions Test		
		Total Questions	Weighted Abstraction	Weighted Achievement
1	74.7	35	11	14
2	81.0	49	14	9
3	69.3	30	4	15
4	85.2	18	32	20
6	94.8	21	25	18
7	76.7	19	36	15
8	86.9	25	32	16
9	96.2	25	53	18
11	76.0	16	32	17
12	79.2	25	32	16
13	79.5	34	14	13
14	73.4	.	.	.
15	72.8	80	0	0
16	78.6	28	22	15
17	54.3	26	16	16
19	60.4	80	0	0
22	68.9	23	23	17
Mean	76.9	33.38	21.63	13.69
s.d.	10.7	19.84	14.47	5.87

Note: Participant 14 was unable to complete any trials of the TQT

D-KEFS CARD SORT TEST

The D-KEFS Card Sort data was not analyzed because many participants required a lot of assistance to achieve task set and/or to accurately explain the card groupings and the intervention by the examiner had an undue influence on the results.

TORRANCE TEST OF CREATIVE THINKING

The Torrance Test of Creative Thinking was also not analyzed because participants had difficulties achieving and maintaining task set. For example, participant 2 began the Product Improvement task but, with time, morphed the task into a story-tell about the stuffed toy. For many participants the task morphed into a listing task in which they itemized specific examples of an idea (e.g. “ you could give it a hat, gloves, a tie, pants...”).

HYPOTHESES RELATED TO SELF-REPORTED FUNCTIONAL COMMUNICATION

HYPOTHESIS 1A: SELF REPORTED FUNCTIONAL COMMUNICATION WOULD BE CORRELATED WITH APHASIA SEVERITY.

The relationship between WAB-AQ scores and patient-reported functional communication was not significant ($F(1,15) = .022$; $p = .884$). In addition, there were no significant relationships between self-reported ACOM scores and any WAB-R subtest measures or the BNT-2 (Table 9).

Table 9.

Pearson correlations for Self-reported ACOM scores and WAB-R (with subtests) and BNT-2 measures (n = 17).

	Self-reported ACOM	P values
Western Aphasia Battery (WAB-AQ)	r = .038	p = .884
Spontaneous Speech	r = .076	p = .770
Fluency	r = .162	p = .534
Auditory Comprehension	r = -.016	p = .952
Sequential Commands	r = -.009	p = .973
Repetition	r = -.195	p = .453
Naming	r = .059	p = .823
Category Fluency	r = .086	p = .741
Boston Naming Test (BNT-2)	r = .097	p = .713

Figure 2 (left panel) shows a scatter plot of self-reported ACOM ratings in relation to category fluency scores. Category fluency is a subtest of the WAB-R and represents the total number animals named in 60 seconds (excluding repetitions).

Figure 3 (left panel) shows a scatter plot of self-reported ACOM ratings in relation to naming scores. Naming is a subtest of the WAB-R. Note that while Participant 17's Naming subtest was an outlier (score = 3.6), an analysis of the data without his score did not change the pattern of results. (The specific scatterplots shown in Figures 2 and 3 chosen because they are relevant for comparison to results presented below).

HYPOTHESIS 1B: SELF-REPORTED FUNCTIONAL COMMUNICATION WOULD BE CORRELATED WITH COGNITION

A Pearson correlation coefficient matrix was generated to inquire about the association between self-rated functional communication and impairment-based measures of non-

verbal cognition. Self-reported functional communication (ACOM T-scores) was significantly correlated with design fluency errors (timed) (Table 10).

Table 10.

Correlation matrix for Self-rated ACOM and cognition scores.

		1.	2.	3.	4.	5.	6.
1. Self-Rated ACOM TSCORE	Pearson's r Sig. (2-tailed)	1					
2. Design Fluency Errors- Timed	Pearson's r Sig. (2-tailed)	-.700** .002	1				
3. Design Fluency Prop. Errors- Untimed	Pearson's r Sig. (2-tailed)	-.343 .178	.823** 0	1			
4. TQT Total Abstraction	Pearson's r Sig. (2-tailed)	.080 .769	-.031 .910	-.139 .608	1		
5. TQT Total Questions	Pearson's r Sig. (2-tailed)	-.144 .594	.162 .550	.218 .416	-.719** 2	1	
6. TQT Weighted Achievement	Pearson's r Sig. (2-tailed)	.187 .488	-.214 .425	-.291 .274	.718 2	-.981 0	1

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Self-rated functional communication was predicted based on errors committed on the design fluency test ($r = .71$, $p = .002$) but not based on any of the TQT measures (Table 10).

Figure 4 (left panel) shows a scatter plot of self-reported ACOM ratings in relation to design fluency errors. Design Fluency Errors is the total number of set loss and repetition errors in the timed condition (60 seconds).

Figure 5 shows a scatter plot of self-reported ACOM ratings in relation to the proportion of errors on the untimed version of the design fluency task. Proportion of errors is the

ratio of total errors (set loss and repetition) divided by the total number of designs in the untimed condition. There is also a negative relationship between the proportion of errors committed on the untimed version of the design fluency test and ACOM self-ratings.

HYPOTHESIS 1C: A LINEAR REGRESSION MODEL PREDICTING SELF-REPORTED FUNCTIONAL COMMUNICATION USING BOTH APHASIA SEVERITY AND COGNITION WOULD ACCOUNT FOR SIGNIFICANTLY MORE VARIANCE THAN A MODEL USING APHASIA SEVERITY ALONE.

A multiple linear regression was calculated to predict ACOM self-ratings based on Total Errors and Proportion of Errors from the Design Fluency task. Although the correlation of self-reported functional communication and proportion of errors committed on the design fluency test was not significant ($r = .343$, $p = .178$), proportion of errors was a useful predictor when added to a linear regression that also included design fluency errors. A significant linear regression equation was found $F(2,15) = 13.53$, $p = .001$ with an r^2 of .66 (adjusted $r^2 = .61$). That is, more than 60% of the variance in ACOM scores could be accounted for with information about the number and proportion of design fluency errors.

To better visualize the relationship between the level of functional communication and non-verbal cognition we grouped participants into categories based on ACOM Ratings and Cognition Scores (Table 11). To accomplish this, a total score on the ACOM was used as a grouping factor where participants who received below average T-scores comprised a more severe group ($n = 5$), participants who received average scores (ACOM T-Score ratings 50-60) comprised an average group ($n = 5$) and those who were rated higher (ACOM T-Score ratings >60) made up the less severe group ($n = 4$). To create groups based on High, Normal, and Low cognitive performance, each participant's scaled scores for the design

fluency test were reviewed. If one or more of the scaled scores was 1 standard deviation higher than the normative sample (13 or higher) then that participants was grouped into the Hi Cog group. If none of the scaled scores was 1 standard deviation higher or lower than the normative sample then that participants was grouped into the Normal Cog group. Finally, if any of the scaled scores 1 or more standard deviation lower (scores 7 or lower) than the normative sample then that participant was grouped into the Low Cog group.

Table 11 shows that of 8 of the 9 participants with High Cognition also had higher than average ACOM scores (89%) while 3 of the 5 participants with Low Cognition also had lower than average ACOM scores (60%).

Table 11.

Breakdown of participants according to cognition level and ACOM scores (cells indicate the number of participants in each group).

	Hi ACOM (>60)	Average ACOM (50-60)	Low ACOM (<50)
Hi Cog (At least one scaled scores > 1 s.d. above norm)	3	5	1
Norm Cog (All scaled scores between +/- 1 s.d.)	1	1	1
Low Cog (At least one scaled score 1 s.d. below norm)	0	2	3

HYPOTHESES RELATED TO PARTNER -REPORTED FUNCTIONAL COMMUNICATION

HYPOTHESIS 2A: PARTNER-REPORTED FUNCTIONAL COMMUNICATION WOULD BE CORRELATED WITH SELF-REPORTED FUNCTIONAL COMMUNICATION.

There was no correlation between PwA-reported and Partner-reported ACOM scores ($F(1,15) = .723, p = .41, r = .222, r^2 = .049$ (adjusted $r^2 = -.019$)). Figure 6 shows that the correlation may be stronger when ACOM scores are lower because there is larger variability as the ACOM scores rise.

INTERRATER AGREEMENT (KAPPA) BETWEEN SELF-RATED AND PARTNER-RATED ACOM SCORES.

To further characterize the inter-rater agreement between PwA-Partner pairs a Cohen's kappa analysis was computed for each pair (Fleiss & Cohen, 1973). Cohen's kappa is the

proportion of agreement corrected for chance agreement between two raters. Kappa scores range from -1 to +1 with negative values indicating a poorer than chance agreement, zero values indicating chance agreement, and positive values indicating better than chance agreement (Viera & Garrett, 2005). Table 12 shows that the kappa scores in our sample ranged from .013 (slight agreement) to .391 (fair agreement). On average, agreement was low with a mean of .141 and s.d. of .135. P-values <.05 were obtained in seven out of sixteen pairs; this indicates that the agreement in item-level ACOM ratings was significantly better than would be expected by chance.

Table 12.

Cohen's kappa scores for each PwA-Partner pair.

Participant	WAB-AQ	Kappa	p
1	74.7	0.032	0.587
2	81.0	0.203	.0007
4	85.2	0.076	0.207
6	94.8	0.295	.0000
7	76.7	0.050	0.541
8	86.9	0.165	0.040
9	96.2	0.081	0.034
11	76.0	0.391	.0000
12	79.2	0.265	.0001
13	79.5	0.181	0.040
14	73.4	-0.147	0.074
15	72.8	0.16	0.024
16	78.6	0.316	.0000
17	54.3	0.095	0.116
19	60.4	0.013	0.860
22	68.9	0.077	0.264

HYPOTHESIS 2B: PARTNER-REPORTED FUNCTIONAL COMMUNICATION WOULD BE CORRELATED WITH APHASIA SEVERITY AND COGNITION.

PARTNER-RATED ACOM SCORE CORRELATIONS TO LANGUAGE.

There was a near-significant relationship between WAB-AQ scores and partner-reported functional communication ($F(1,14) = 3.97; p = .07$). Further analysis revealed partner-reported functional communication was highly related to 2 subtests of the WAB-R and to the Boston Naming Test (Table 13). Note that there are high correlations among subtest measures and the BNT-2.

Alone, WAB-R category fluency accounted for 61.1 percent of the variance (adjusted $r^2 = .584$); $F(1,14) = 22.033, p = 0$. (Figure 2, right)

Although Naming was also highly correlated with partner ACOM scores, adding it as a second predictor to the model did not produce a significantly large change in explained variance to adopt the 2-predictor model ($F \text{ change} = 2.18, p = .163$) (Figure 3, right). This may be due to the intercorrelation between Naming and WAB-R category fluency ($r = .69, p = .02$) (Figure 3, right).

Table 13.

Correlation matrix for Partner-reported ACOM scores and language measures.

		1.	2.	3.	4.	5.
1. Partner ACOM	Pearson's r	1				
	Sig. (2-tailed)				.	
	N	16				
2. WAB-AQ	Pearson's r	.470	1			
	Sig. (2-tailed)	.066				
	N	16	17			
3. Naming (WAB-R Subtest)	Pearson's r	.711**	.790**	1		
	Sig. (2-tailed)	.002	.000			
	N	16	17	17		
4. BNT-2	Pearson's r	.555*	.906**	.803**	1	
	Sig. (2-tailed)	.026	.000	.000		
	N	16	17	17	17	
5. Category Fluency (WAB-R)	Pearson's r	.782**	.639**	.690**	.660**	1
	Sig. (2-tailed)	.000	.006	.002	.004	
	N	16	17	17	17	17

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

PARTNER-RATED ACOM SCORE CORRELATIONS TO COGNITION.

A Pearson Correlation Coefficient matrix was generated to inquire about the association between partner-rated functional communication and impairment-based measures non-verbal cognition. Partner-reported communicative effectiveness (ACOM T-scores) was not correlated with non-verbal cognition (Table 14). The sample size for each correlation analysis was 17 except for those that included the D-KEFS Twenty Questions Test, which was 16, because the video data was lost.

Table 14.

Correlation matrix for Partner-reported ACOM scores and cognitive measures.

		1.	2.	3.	4.	5.	6.
1. Partner ACOM	Pearson's r	1					
	Sig.				.		
	N	16					
2. Design Fluency Errors (Timed)	Pearson's r	-.171	1				
	Sig.	.526					
	N	16	17				
3. Design Fluency Proportion of Errors (Untimed)	Pearson's r	-.135	.823**	1			
	Sig.	.617	.000				
	N	16	17	17			
4. TQT Total Abstraction	Pearson's r	.388	-.031	-.139	1		
	Sig.	.154	.910	.608			
	N	15	16	16	16		
5. TQT Total Questions	Pearson's r	-.217	.162	.218	-.719	1	
	Sig.	.438	.550	.416	.002		
	N	15	16	16	16	16	
6. TQT Total Weighted Achievement	Pearson's r	.194	-.214	-.291	-.718	-.981	1
	Sig.	.488	.425	.274	.002	.000	
	N	15	16	16	16	.16	16

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

In contrast to the self- ratings, scatterplots of the partner ACOM ratings show that partner ACOM scores could not be predicted based on the number (Figure 4, right) or proportion of errors (Figure 5, right) on the design fluency test.

Unlike self-reported functional communication, ACOM partner-ratings could not be predicted based on the Design Fluency task: a simple linear regression was calculated to predict ACOM self-ratings based on Total Errors and Proportion of Errors on the design fluency task. A non-significant regression equation was found ($F(2,13) = .197$, $p = .823$), with an r^2 of .029.

HYPOTHESIS 2C: A LINEAR REGRESSION MODEL PREDICTING PARTNER-REPORTED FUNCTIONAL COMMUNICATION USING BOTH APHASIA SEVERITY AND COGNITION WOULD ACCOUNT FOR SIGNIFICANTLY MORE VARIANCE THAN A MODEL USING APHASIA SEVERITY ALONE.

A stepwise linear regression was calculated to predict ACOM partner-ratings using all of the WAB-R subtests and the BNT-2. From this, a two-factor model including WAB-R Category Fluency and WAB-R Fluency accounted for 74.7 percent of the variance (adjusted $r^2 = .697$); $F(2,13) = 18.235$, $p = .000$. The remainder of the WAB-R subtests were excluded from the model: WAB-AQ, Spontaneous Speech, Auditory Comprehension, Sequential Commands, Repetition, and BNT-2. There was no correlation between partner ACOM scores and Fluency however Fluency becomes a reliable predictor once the error associated with Category Fluency/Naming is removed.

The verbal fluency test on the D-KEFS is similar to the WAB-R category fluency subtest and explains the same variance. However, condition 3 of the D-KEFS Verbal Fluency test assesses an additional factor: category switching. Category switching refers to the number of times the participant can move back and forth between two categories (e.g. vegetables and items of clothing). A linear regression adding Switching (the number of category switches performed in 60 seconds) as a third predictor resulted in a significant model: $F(3,12) = 17.581$, $p = .000$. The addition of Switching as a predictor increased the explained variance to .815 (adjusted $r^2 = .768$). Note: a linear regression replacing WAB-R category fluency with DKEFS Category Fluency was also significant: $F(3,12) = 7.782$, $p = .004$. The explained variance was .595 (adjusted $r^2 = .566$).

SUMMARY OF RESULTS

Self and Partner-reported ACOM scores were not correlated. Self-reported functional communication was unrelated to measures of language impairment but was strongly related to several measures of non-verbal cognition. In contrast, partner-reported functional communication was unrelated to measures of non-verbal cognition but was strongly related to several measures of language impairment.

CHAPTER 5:

DISCUSSION

HYPOTHESES RELATED TO SELF-REPORTED FUNCTIONAL COMMUNICATION

HYPOTHESIS 1A. SELF REPORTED FUNCTIONAL COMMUNICATION WOULD BE CORRELATED WITH APHASIA SEVERITY.

On average, our participants had higher than average WAB-AQ scores but the ACOM scores of the PwA and partners were not significantly different from the reference T-Score mean of 10 (Hula et al., 2015). This indicates that while our participants had higher than average WAB-R scores (Mean = 76.94), the ACOM scores cluster around the ACOM population mean. Similarly, results from the BNT-2 showed that participants, as a group, demonstrated impaired performance relative to age-matched neurologically intact normals (Tombaugh et al., 1997; Goodglass and Kaplan, 1980).

We found no correlation between aphasia severity and self-rated ACOM scores. In light of prior research showing a correlation between self-reported measures and aphasia severity, our lack of correlation is surprising.

There are several possible explanations of these results. First, it is possible that we did not show a correlation between WAB-R scores and ACOM scores because, by selecting participants who had lower aphasia severities and higher auditory comprehension, we limited the variability in the WAB-R scores. Perhaps, given this restricted range, the

predictive power of the language measures simply could not be detected.

Second, it is possible that the relationship between ACOM and WAB-R is different when aphasia is less severe. Our study included people with WAB-AQ scores greater than 50 while Doyle et al.'s study included WAB-AQs ranging from 10 to 100 (Figure 7). Figure 7 shows more variability for WAB-AQ scores greater than 50 and raises the question of whether the relationship of WAB-AQ to ACOM differs when aphasia is less severe. A similar pattern of data is reported in Laska, Bartfai, Hellblom, Murray, & Kahan (2007). The scatterplot of the data shows that the data is best fit by a curve rather than a line but co-author Will Hula attributes the change in slope to a ceiling effect on the WAB-R. That is, when aphasia is mild, WAB-R scores top-out thereby creating poorer fit.

To further pursue the hypothesis that the relationship between aphasia severity and ACOM scores is different when aphasia is less severe, we requested a follow-up analysis of this data to include only those people with WAB-AQ scores between 55 and 100. This resulted in a sample of 71 with a mean = 83.3 and s.d. of 13.1 (W. Hula, personal communication; January 27, 2015). The correlation was .67 ($r^2 = .449$). In other words, these data show that 45% of the variance in the ACOM can be predicted using WAB-AQ; leaving 55% of the variance unexplained. Hula et al. (2015) acknowledges that the explanatory value of aphasia severity is limited: "given that aphasia severity accounted for only approximately half of the variance in ACOM scores, it will be necessary to investigate other potential determinants of self-reported communicative functioning in aphasia." (pg. 917).

HYPOTHESIS 1B. SELF-REPORTED FUNCTIONAL COMMUNICATION WOULD BE CORRELATED WITH COGNITION.

Based on prior evidence that functional communication is not solely driven by aphasia severity, we tested the hypothesis that variance in ACOM scores could be predicted based on non-verbal cognition. Our data show that self-rated functional communication is highly related to performance on the Design Fluency test. Because we sampled people with less severe aphasia, we are unable to tell whether cognition is a useful predictor over the entire range of aphasia severities or cognition is useful only when language deficits are less severe. It is possible that when aphasia severity is greater it has a proportionally larger effect on functional communication.

DESIGN FLUENCY AS A PREDICTOR

The D-KEFS offers norms for individuals from ages 8 to 89 using a scaled mean of 10 and standard deviation of 3. On the standard administration, our participants produced significantly fewer correct designs than the normative sample with age-scaled scores for the number of correct designs ranging from 3 to 10 (mean = 7.35 and s.d. = 2.12, $t(16) = -5.149$, $p = .000$). Although not significant, the age-scaled scores for the number of attempted designs were also lower (Range 3-16; mean = 8.53, s.d. = 2.94, $t(16) = -2.063$, $p = .056$). Thus, although our sample attempted fewer designs, it did not significantly differ from the normative sample. It is possible that the tendency to produce fewer designs reflects diminished processing speed or motor-speed deficits due to using a non-preferred hand when drawing the designs.

Our finding that PwA who commit more design fluency errors report that their functional communication is poorer than those who do not commit such errors is new. No prior studies using the ACOM have examined non-verbal cognition as a predictor.

To do well on the standard (timed) version of the Design Fluency task one must work quickly while maintaining task set and avoiding repetitions. Interestingly, category fluency (a subtest of the WAB-R) did not correlate with ACOM scores despite claims that category fluency also requires speed, self-monitoring, and task-set maintenance. The design fluency task differs from category fluency in terms of the language load, the persistence of the evoking stimulus (dots on the page), and memory load (designs can be reviewed). These differences should be explored further.

This study also employed a new version of the design fluency test that allowed unlimited time to produce designs. The untimed version captured more information about repetitions and set-loss errors. Keil and Kazniak (2002) have suggested that design fluency errors reflect poorer self-monitoring skills and an inability to track and comply with environmental constraints. The fact that the people who commit more errors on the Design Fluency task are also reporting poorer functional communication implies that they are aware of their deficits but unable to avoid their errors. This implies a distinction between self-awareness and self-control such that our participants realize that they make mistakes but cannot prevent them.

TWENTY QUESTIONS TEST AS A PREDICTOR

As a group, participants performed normally on the twenty questions test when compared to age-matched norms. On average, our participants asked about the same number of questions across the four trials as the normative sample but with a larger

variability ($t(15) = .109$, $p = .91$). Scaled-scores for total number of questions had a mean = 8.69 and s.d. = 3.32.

Related to the abstractness of the first questions, our participants eliminated slightly fewer objects with their first question than the normative sample. Age-scaled abstraction scores ranging from 4 to 16 but the difference was not statistically different from the scaled mean of 10 (mean = 8.69, s.d. = 3.32, $t(15) = -1.581$, $p = .135$).

Similarly, total weighted achievement scores were not significantly different from the normative sample. Scaled-scores for weighted achievement (untimed mean = 10.50, s.d. = 4.46, $t(15) = .449$, $p = .66$) were very close to the scaled mean of 10.

Interestingly, unlike another study involving people with traumatic brain injury (Marshall, Karow, Morelli, Iden, & Dixon, 2003), our participants did not improve in the TQT across trials. Few people switched question strategies across the trials in order to improve efficiency (e.g. if they used a color strategy they rarely switched to another strategy on later trials even if a different strategy was more efficient).

TQT was not useful as a predictor of self-reported functional communication as none of the TQT measures loaded in the linear regression. The TQT test may not have been useful for a number of reasons. First, the task is a familiar childhood game and perhaps our participants relied on prior experience when doing the task. This would mean that the test is more an assessment of memory than novel problem solving and would explain age-normal performance. Second, it is possible that the TQT simply does not assess the aspects of cognition that are most affected in this population.

HYPOTHESIS 1C. A LINEAR REGRESSION MODEL PREDICTING SELF-REPORTED FUNCTIONAL COMMUNICATION USING BOTH APHASIA SEVERITY AND COGNITION WOULD ACCOUNT FOR SIGNIFICANTLY MORE VARIANCE THAN A MODEL USING APHASIA SEVERITY ALONE.

Our original expectation was that a linear regression to predict partner-reported ACOM scores would find predictive value in both aphasia severity and cognition measures. However, none of the language measures were reliable predictors of self-reported ACOM scores.

We identified a two factor linear regression model that accounted for 66% of the variance in self-reported ACOM scores. The predictive values of two cognition subtests, Total Errors and Proportion of Errors from the Design Fluency task supports the claim that functional communication is driven, at least in part, by cognitive status.

HYPOTHESES RELATED TO PARTNER-REPORTED FUNCTIONAL COMMUNICATION

HYPOTHESIS 2A. PARTNER-REPORTED FUNCTIONAL COMMUNICATION WOULD BE CORRELATED WITH SELF-REPORTED FUNCTIONAL COMMUNICATION.

We found no correlation between self- and partner-reported ACOM scores. This was unexpected given prior research showing agreement between patient and proxy reported outcomes. Our selection of participants with relatively less severe aphasia may be impacting the correlation. This is supported by Segal & Schall (1994) who found that correlation of scores was substantially weaker when a group of less severely impaired survivors was considered separately.

Our findings suggest that the patient's experience of aphasia may be different than what can be surmised by a communication partner. That is, partners may be interpreting

the ACOM items differently or basing their judgments on different aspects of behavior. This raises some significant questions about the usefulness of PRO measures when they cannot be obtained directly from the PwA. For example, a partner may not appreciate the differences between what the person with aphasia wants/intends to communicate and what he/she actually conveys. These findings imply that using proxy-reported ratings as a replacement for patient ratings at the level of the individual patient may be problematic. However, it may still be useful to use both patient and partner ratings of functional communication to form a more complete impression of the overall recovery environment (Hesketh, Long, & Bowen, 2011).

HYPOTHESIS 2B. PARTNER-REPORTED FUNCTIONAL COMMUNICATION WOULD BE CORRELATED WITH APHASIA SEVERITY AND NON-VERBAL COGNITION.

This study found a significant correlation between partner-reported functional communication and aphasia severity but not with non-verbal cognition. Partners appear to be judging functional communication, at least in part, based on how readily their partner can find the words he/she needs. This suggests that the partners of PwA may be unaware of receptive language problems and cognition issues that their partners experience in everyday activities. The finding that observable language performance (especially category fluency and naming) is highly predictive of partner ratings is consistent with findings from other studies that highly observable behaviors tend to drive partner ratings (Visser-Keizer, Jong, Deelman, Berg, & Gerritsen, 2002).

The perspective of the PwA includes internal information about intention, motivation, and self-awareness. An outsider's information is based on interactions with the PwA and observations of their behavior. An outsiders perspective will be determined

by their own worldview and understanding of aphasia. Clinicians are trained to evaluate behavior in terms of language and cognition. So, an SLP is more likely to spot issues related to inattention, short-term memory deficits, executive function deficits, etc. In contrast, many partners and caregivers of PwA receive little or no information about the impacts of stroke and/or aphasia beyond brief definitions. It follows that a partner might attribute behaviors to language deficits that, in fact, are better explained in terms of cognition deficits. This is not to say that all partners lack an understanding. However, the interplay between cognition and language is not easily separable and, given the lack of education and training required to isolate them, it is easy to understand why partners might not identify cognition issues in the PwA.

HYPOTHESIS 2C. A LINEAR REGRESSION MODEL PREDICTING PARTNER-REPORTED FUNCTIONAL COMMUNICATION USING BOTH APHASIA SEVERITY AND COGNITION WOULD ACCOUNT FOR SIGNIFICANTLY MORE VARIANCE THAN A MODEL USING APHASIA SEVERITY ALONE.

As with self-reported ACOM scores, our original expectation was that partner-reported ACOM scores would be predicted based on both aphasia severity and cognition. However, none of the cognition measures were reliable predictors of partner-reported ACOM scores.

We identified a three factor linear regression model that accounted for 82% of the variance in partner-reported ACOM scores. The predictive values of three language subtests, WAB-R Category Fluency, WAB-R Fluency, and D-KEFS Switching lends support to the claims that partners rely more heavily on observable features of speech and language when assessing functional communication.

IMPLICATIONS

The ACOM proved to be a valuable tool to obtain valid and efficient information about functional communication directly from the person with aphasia. The present study suggests that functional communication ratings by patients and partners are based on different underlying variables. In our sample of people with less severe aphasia, PwA appear to be sensitive to deficits related to non-verbal performance such as attention, self-monitoring, task-set maintenance, and speed. In contrast, partners appear to be sensitive to observable deficits of language such as naming and fluency.

Our findings raise some interesting questions about the value of partner ratings when assessing functional communication in aphasia. Functional communication is about the interaction between the PwA and others. That is, there is always at least one other person involved. The ACOM asks the partner to provide their own opinion of the “effectiveness” of interactions (that they participate in or observe) rather than act as a surrogate in which they guess how the PwA would rate him/herself. Our finding that partner-ratings do not correlate with self-ratings affirms the stance that partner reports constitute a valid perspective in their own right, regardless of their correspondence with patients’ ratings. Furthermore, our results provide some insights into the factors that contribute to the differing perspectives.

Extended to clinical contexts, these results suggest that cognition is an important factor determining how PwA perceive the effectiveness of their own everyday interactions and further stresses the importance of addressing cognition in the evaluation and management of persons with aphasia. Clinically, these findings imply that PwA and partners may judge treatment quality differently based on which behaviors are changed by treatment.

Partners may rate functional communication higher if treatment improves observable language behaviors (e.g word finding errors and delays) while a PwA may rate functional communication higher if the ability to self-monitor, inhibit errors, and cognitive flexibly improved. Furthermore, these data imply that treatment to improve standardized linguistic testing scores (such as the WAB-R) might not result in changes that client's regard as functionally relevant.

Expanding from these results, our data suggest that, for people with mild to moderate aphasia, successful treatment of cognitive deficits might produce larger gains in self-reported functional communication than treatments that target language impairments alone. Perhaps there is a level of language that, once achieved, is sufficient to support functional communication and the focus of treatment should shift to factors impacting cognition. We must however acknowledge that while ACOM self-ratings are correlated with cognition, a causal relationship cannot be inferred from the present data.

STUDY LIMITATIONS

The results of this investigation must be considered within the context of the following limitations. First, the study sample size is small. It would be very informative to further analyze whether certain functional communication tasks are more related to cognition but, given the sample size, this analysis could not be completed. Second are concerns about the recruiting pool. Our participants were recruited using contacts with SLP providers. This means that the participants were either receiving ongoing rehabilitation services or had received services. The fact that participants were receiving services implies that they were able to drive, navigate public transportation services, or had a partner/caregiver who

assisted them. In addition, these people were either able to fund ongoing treatment or had access to free aphasia resources in their communities. These people are potentially different from individuals with aphasia who have not received extensive therapy services and therefore our results may not be generalizable to individuals whose language and physical status, financial, or social supports preclude their participation in community activities. Finally, by specifically recruiting people with less severe aphasia including relatively intact auditory comprehension, these data might not apply to others.

GENERAL CONCLUSIONS

PRO measures give the patient a direct voice to say how they are affected by aphasia. This study correlated impairment-based measures of language and cognition with self and partner-reported functional communication.

Our general findings were:

- When people with mild to moderate aphasia rated their own functional communication, these ratings correlated with non-verbal cognition and not with aphasia severity.
- The ratings of family members or caregivers did not align with patient ratings.
- Partner-ratings did not correlate with the same impairment measures as the patient-reported outcomes. Instead, aphasia severity was highly predictive while non-verbal cognition was not.

Our findings suggest one of two things: 1) that self-reported functional communication is more closely related to non-verbal cognition than it is to language level or 2) that by restricting the range of WAB-R scores we, in effect, controlled for the effect of

language that would be otherwise present and both aphasia severity and cognition are factors in ACOM self ratings. More data with a larger range of WAB-AQ scores would differentiate between these two explanations.

This study suggests that self-reported measures and partner-reported measures are not interchangeable but each provides a uniquely valid perspective about the impact of aphasia on the individual.

By correlating impairment-based measures of language and cognition with self and partner-reported functional communication, we showed that partners appear to judge functional communication, at least in part, based on how readily the PwA can find the words he/she needs. This finding is not, in and of itself, surprising. What is surprising is that PwA do not appear to be using word-finding difficulty and verbal fluency when judging their own communicative effectiveness. This study also found that while self-reported communicative effectiveness could be predicted based on non-verbal cognition, partner-reported communicative effectiveness could not. It appears that individuals with aphasia assess their own communicative effectiveness in terms of less observable behaviors that are more related to cognitive function than aphasia severity. The implication is that the two groups may be using very different criteria to judge communicative effectiveness. The fact that patient-reports correlate to cognition deficits that partners fail to recognize is a significant finding and raises serious questions about the use of surrogate raters when collecting PRO data.

Further research is warranted to explore the relationship of functional communication with language and cognition. The differences in explanatory power between category fluency and design fluency across the two subject groups are especially interesting. Given

that category fluency has been used as both a test of aphasia and as a test of executive function but it failed to capture any variance in self-reported functional communication demands further investigation.

Future studies should also examine the interplay of language and cognition on treatment effects and how they generalize to changes in functional communication.

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FIGURES

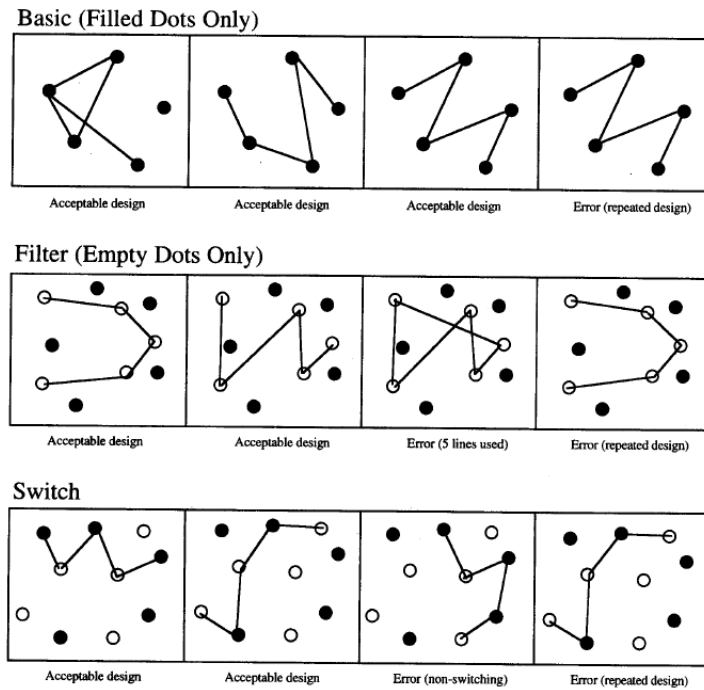


Fig. 2. Examples of the stimuli used in the three conditions of the design fluency task, including examples of both acceptable and unacceptable designs.

Figure 1. Example of D-KEFS Design Fluency task (from Baldo, Shimamura, Delis, Kramer, & Kaplan, 2001).

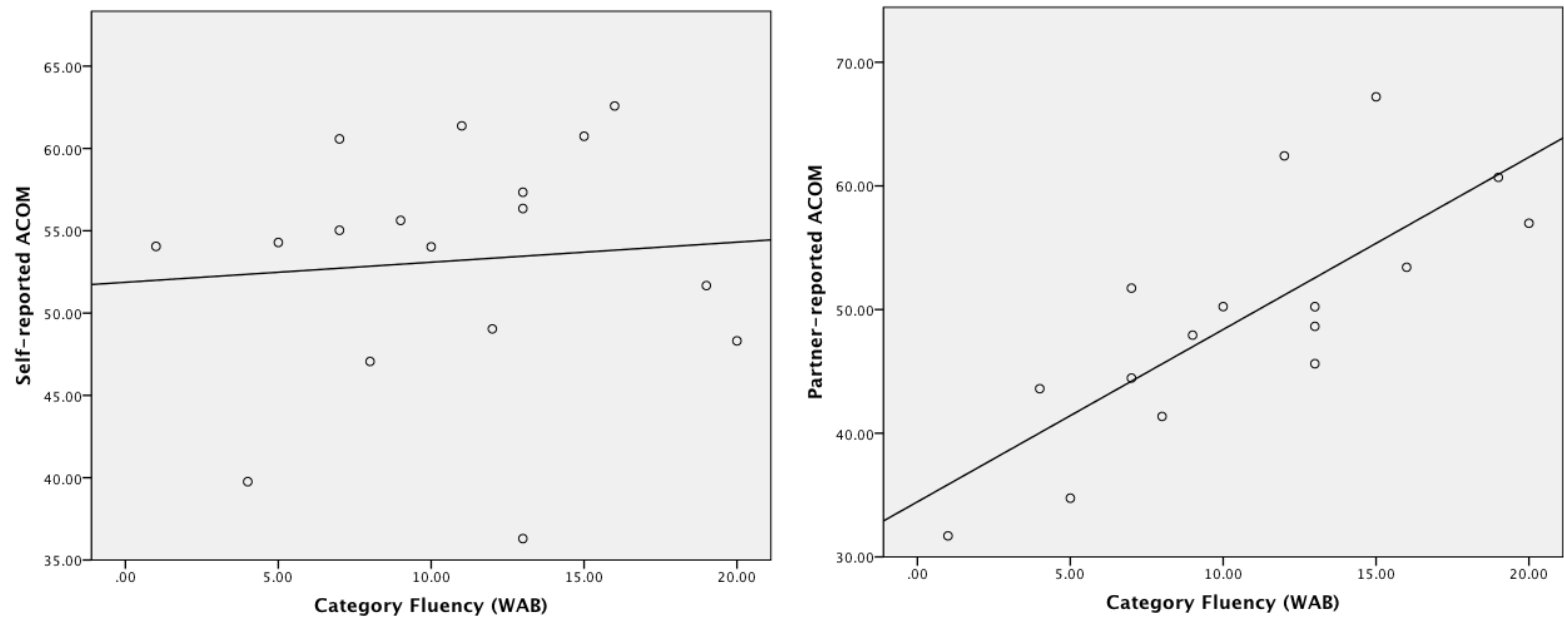


Figure 2. Scatter plots of ACOM self-ratings (left) and ACOM partner-ratings (right) as a function of WAB-R category fluency score. Self-reported functional communication was NOT predicted based on WAB-R category fluency scores ($r = .086$, $p = .741$) while partner-reported functional communication was predicted based on WAB-R category fluency scores ($r = .782$, $p = .000$)

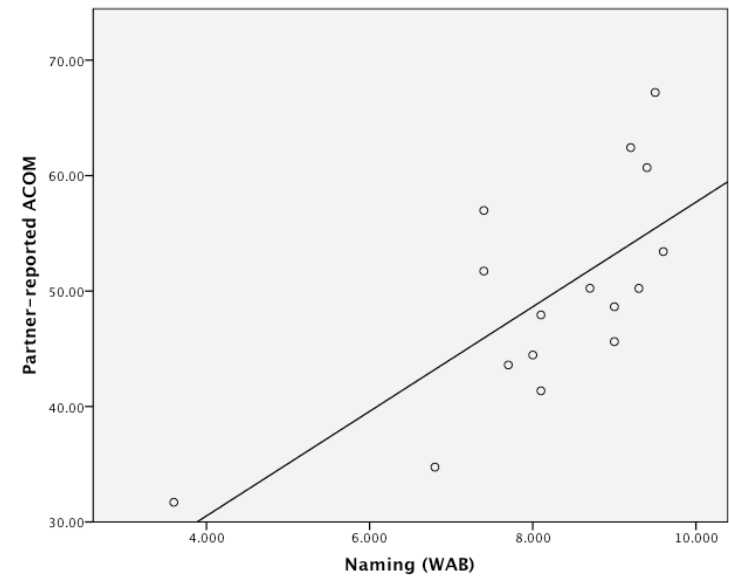
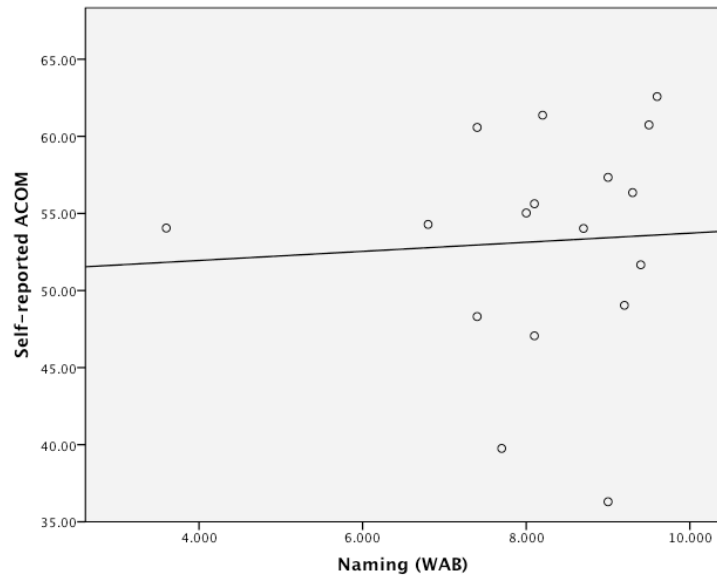


Figure 3. Scatter plots of ACOM self-ratings (left) and ACOM partner-ratings (right) as a function of WAB-R naming score. Self-reported functional communication was NOT predicted based on WAB-R naming scores ($r = .059$, $p = .823$) while partner-reported functional communication was predicted based on WAB-R naming scores ($r = .711$, $p = .002$)

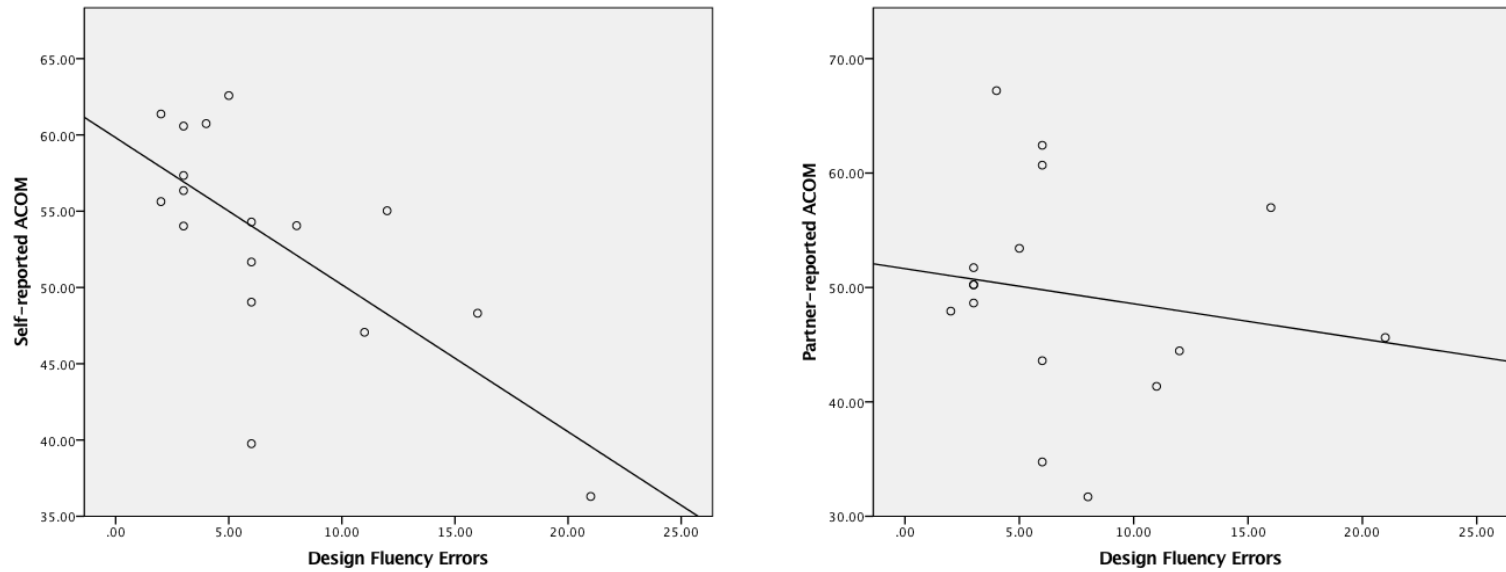


Figure 4. Scatter plot of self-reported ACOM ratings in relation to the number of errors on the D-KEFS Design Fluency Test. Self-reported functional communication was predicted based on design fluency errors ($r = -.700$ $p = .002$) while partner-reported functional communication was NOT predicted based on design fluency errors ($r = -.171$, $p = .526$).

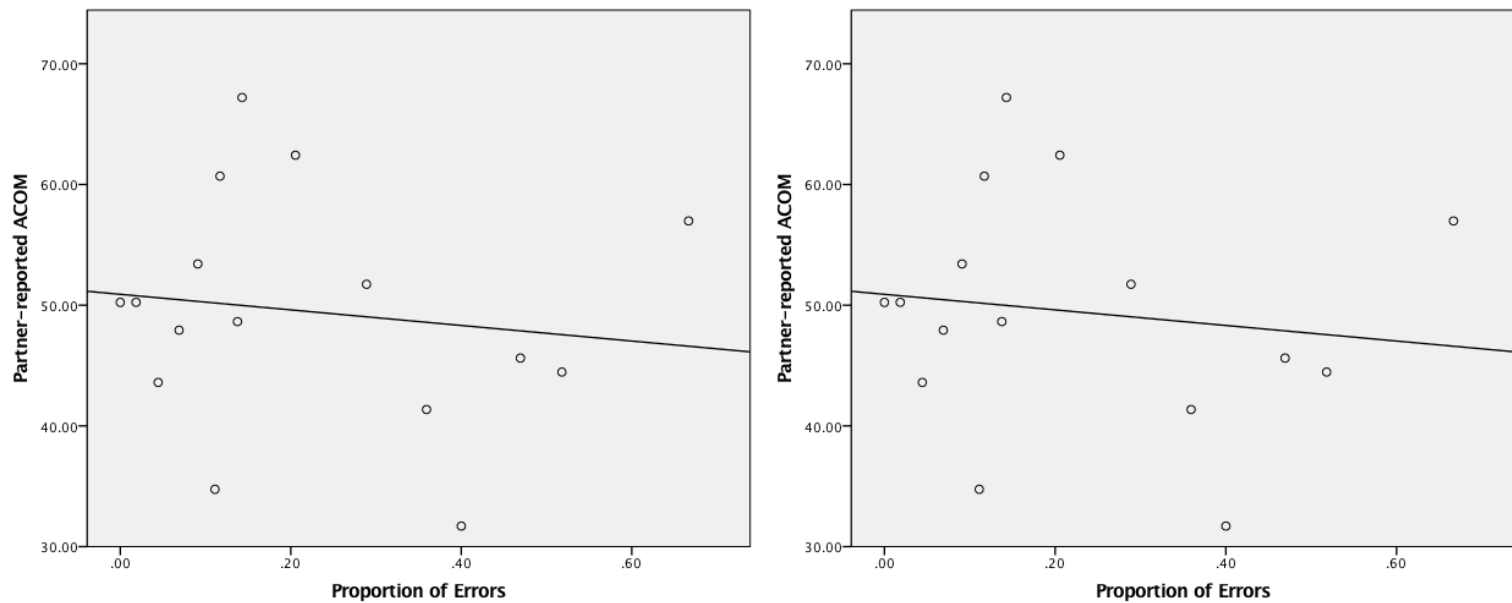


Figure 5. Scatter plot of self-reported ACOM ratings in relation to the proportion of errors on the untimed administration of the D-KEFS Design Fluency Test. Self-reported functional communication was NOT predicted based on proportion of errors on the design fluency task ($r = -.343$ $p = .178$) but proportion of errors was useful in the two factor linear regression. Partner-reported functional communication was NOT predicted based on proportion of errors on the design fluency task ($r = -.135$, $p = .617$).

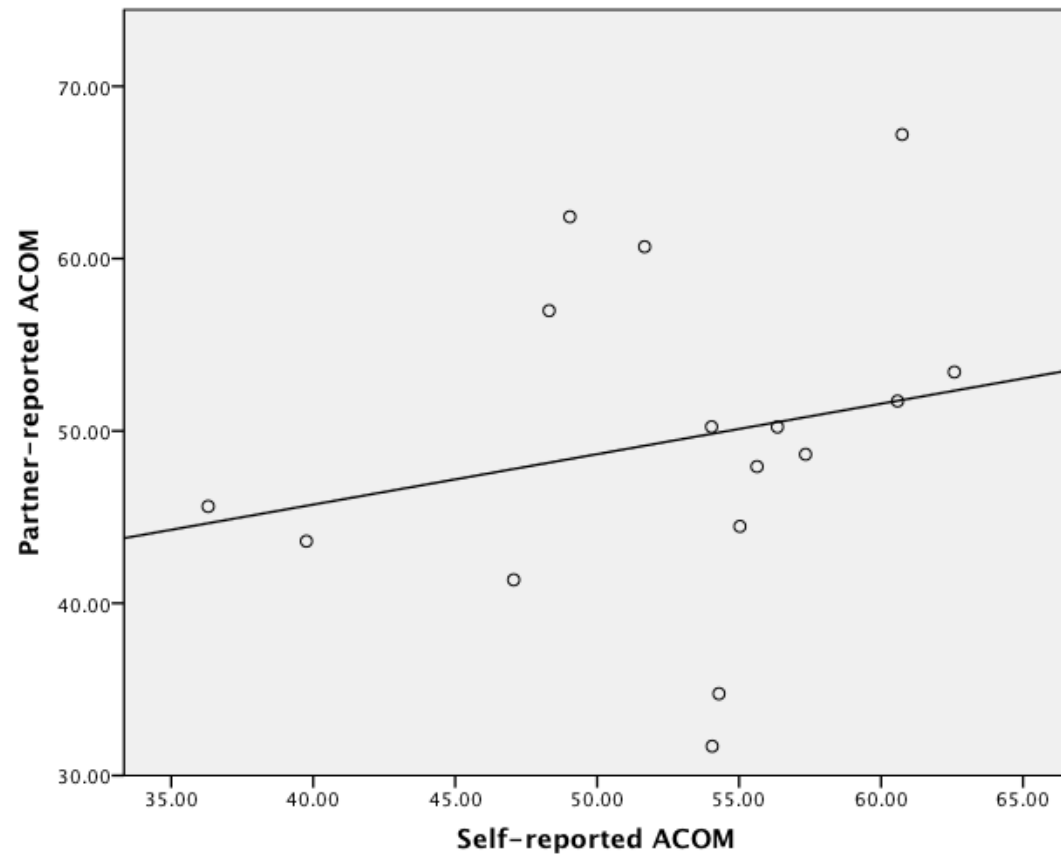


Figure 6. Scatter plot of self-reported ACOM versus partner-reported ACOM scores ($r = .222$, $p = .41$).

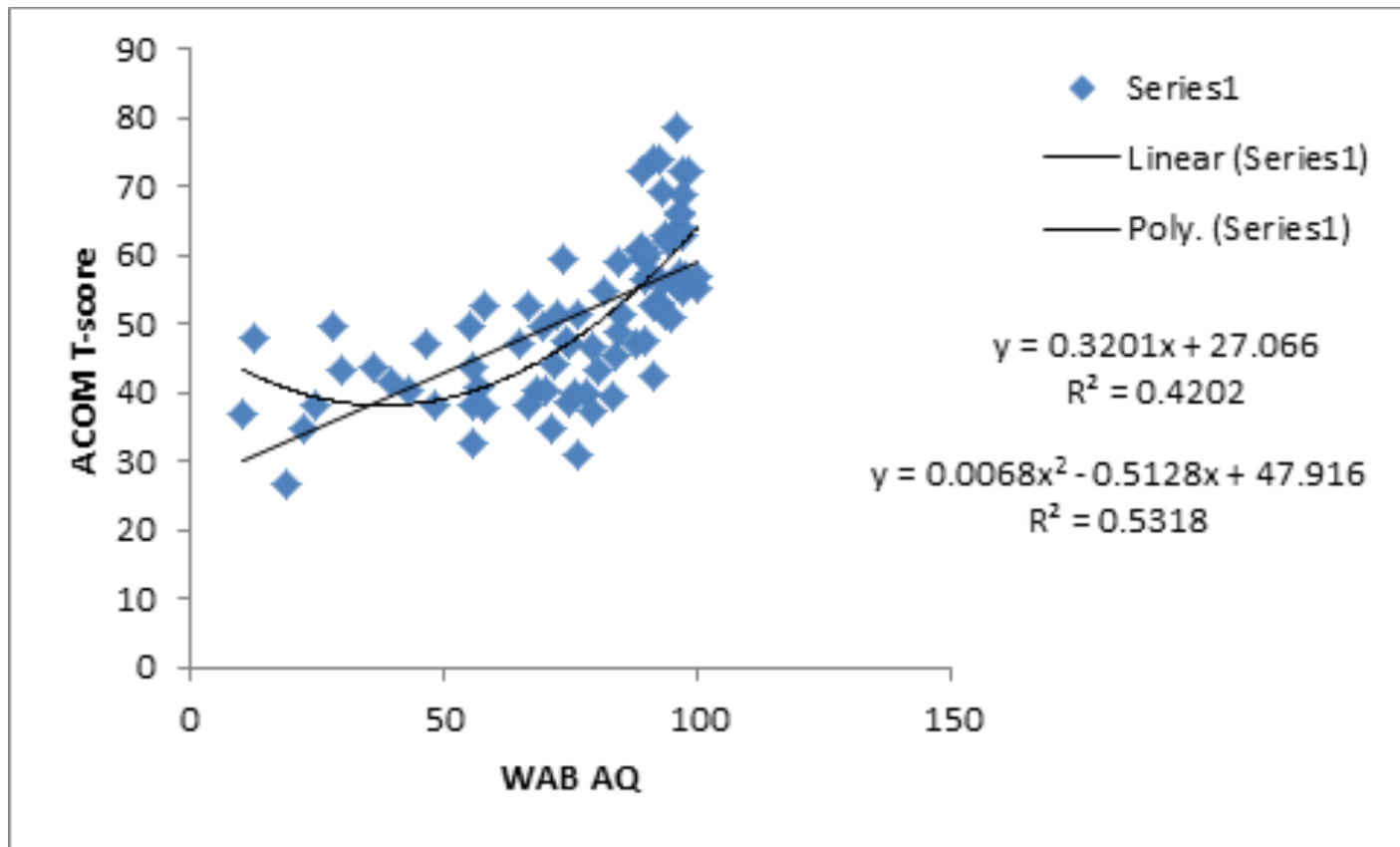


Figure 7. Scatter plot of WAB-AQ to ACOM T-Scores. Figure provided by Will Hula (personal communication, January 17, 2015).

APPENDIX A:

SAMPLE PROCEDURE

Day 1

Activity/Test

1. Review and complete consent form procedures
2. Demographics Questionnaire
3. Vision screening
4. Apraxia Battery for Adults
5. 144 item ACOM first-half

Assessment Block A

1. Boston Naming Test (Untimed)
2. Delis-Kaplan Verbal Fluency (Untimed)
3. Delis-Kaplan Design Fluency (Untimed)

Assessment Block B

1. Boston Naming Test (Timed)
2. Delis-Kaplan Verbal Fluency (Timed)
3. Delis-Kaplan Design Fluency (Timed)

Day 2

Activity/Test

1. 144 item ACOM second-half
2. Western Aphasia Battery- Revised

Assessment Block C

1. Delis-Kaplan Sorting Test (Timed)
2. Delis-Kaplan Twenty Questions (Timed)
3. Torrance Test of Creative Thinking- Product Improvement (Timed)
4. Torrance Test of Creative Thinking- Unusual Uses (Timed)

Assessment Block D

1. Delis-Kaplan Sorting Test (Untimed)
2. Delis-Kaplan Twenty Questions (Untimed)
3. Torrance Test of Creative Thinking- Product Improvement (Untimed)
4. Torrance Test of Creative Thinking- Unusual Uses (Untimed)

APPENDIX B:

ACOM QUESTIONS

How effectively do you....	How effectively does your partner....
1. talk to your closest family member or friend	1. talk to his/her closest family member or friend
2. say the names of food items	2. say the names of food items
3. say the names of body parts	3. say the names of body parts
4. talk about current/previous work	4. talk about current/previous work
5. ask for information from store employees	5. ask for information from store employees
6. discuss family matters with your spouse and children	6. discuss family matters with his/her spouse and children
7. say your address	7. say his/her address
8. leave a message on an answering machine	8. leave a message on an answering machine
9. say the names of clothing items	9. say the names of clothing items
10. talk about your future plans with family or friends	10. talk about his/her future plans with family or friends
11. tell a story	11. tell a story
12. introduce yourself	12. introduce himself/herself
13. have a conversation with strangers	13. have a conversation with strangers
14. say your name	14. say his/her name
15. talk about your day with family or friends	15. talk about his/her day with family or friends
16. say the names of common objects (e.g., bed, lamp, pencil)	16. say the names of common objects (e.g., bed, lamp, pencil)
17. explain your health concerns to your doctor	17. explain his/her health concerns to his/her doctor
18. talk about your health concerns with family members	18. talk about his/her health concerns with family members
19. call family members by name	19. call family members by name
20. find the words you want to say during conversation	20. find the words he/she wants to say during conversation

21. explain how to get somewhere	21. explain how to get somewhere
22. tell a joke	22. tell a joke
23. make yourself understood when you speak with strangers	23. make himself/herself understood when he/she speak with strangers
24. fill out simple forms	24. fill out simple forms
25. keep a conversation going	25. keep a conversation going
26. tell people about yourself	26. tell people about himself/herself
27. explain how to do something	27. explain how to do something
28. correct yourself when people do not understand you	28. correct himself/herself when people do not understand him/her
29. make yourself understood when you speak with family or friends	29. make himself/herself understood when he/she speaks with family or friends
30. follow conversation about familiar topics	30. follow conversation about familiar topics
31. start a conversation with other people	31. start a conversation with other people
32. talk about movies that you have seen	32. talk about movies that he/she has seen
33. understand your closest family member or friend when they talk to you	33. understand his/her closest family member or friend when they talk to him/her
34. follow simple spoken requests (e.g., pass the salt)	34. follow simple spoken requests (e.g., pass the salt)
35. start a new topic in conversation	35. start a new topic in conversation
36. share opinions	36. share opinions
37. make your wants and needs known	37. make his/her wants and needs known
38. talk with a group of people	38. talk with a group of people
39. write your phone number	39. write his/her phone number
40. fill out complex forms	40. fill out complex forms
41. correct mistakes you make when you talk	41. correct mistakes he/she makes when he/she talks
42. write a simple "to do" list	42. write a simple "to do" list
43. understand your bank/credit card statements	43. understand his/her bank/credit card statements
44. tell people why you can't talk very well	44. tell people why he/she can't talk very well
45. read signs in a store to find what you need	45. read signs in a store to find what he/she needs
46. write your address	46. write his/her address
47. understand magazine/newspaper articles	47. understand magazine/newspaper articles
48. understand newspaper headlines	48. understand newspaper headlines
49. read street name signs	49. read street name signs

50.	answer yes/no questions	50.	answer yes/no questions
51.	read product labels	51.	read product labels
52.	follow therapy instructions	52.	follow therapy instructions
53.	understand medicine labels	53.	understand medicine labels
54.	write messages in greeting cards	54.	write messages in greeting cards
55.	follow a story someone tells	55.	follow a story someone tells
56.	read traffic signs	56.	read traffic signs
57.	read food labels	57.	read food labels
58.	understand humor in pictures (e.g., comics, photographs)	58.	understand humor in pictures (e.g., comics, photographs)
59.	write a personal letter	59.	write a personal letter

APPENDIX C:

D-KEFS TWENTY QUESTIONS ITEM GROUPINGS

D-KEFS Categorical Hierarchy			
Category	Sub-category	Sub-category	Object
Living Things	Plants	Fruits	Apple
			Banana
			Oranges
		Vegetables	Carrot
			Corn
		Common	Tree
			Rose
	Animals	Mammals	Dog
			Cow
			Elephant
		Birds	Ducks
			Eagle
			Owl
		Fish	Goldfish
			Shark
Non-Living Things	Kitchen Items	Silverware	Knife
			Fork
			Spoon
		Dishes	Bowl
			Cup
			Plate
		Appliances	Refrigerator
			Stove
	Transportation	Ground	Cars
			Bus
			Train
		Air	Airplane
			Helicopter
		Water	Boat
			Submarine

APPENDIX D:

MODIFIED INSTRUCTIONS

OVERVIEW

Modified instructions were created for the Boston Naming Test, the Delis-Kaplan Executive Functions Systems Test (D-KEFS; Delis, Kaplan, & Kramer, 2001), and the Torrance Test of Creative Thinking (TTCT). These modified instructions are intended to increase or decrease the emphasis on speed of response.

For all speeded tasks, a computer showing a stopwatch and the remaining time were prominently displayed. See <http://www.online-stopwatch.com/countdown-clock/full-screen/>.



To avoid to potential criticism that the timer is creating visual distraction rather than time pressure, a clock with the time was displayed when non-timed tasks are being completed.

<http://www.online-stopwatch.com/large-online-clock/>



Boston Naming Test (BNT-2) Modified Instructions

- ⇒ In order to control presentation speed, the BNT items are being shown on a computer screen using a PowerPoint presentation.
- ⇒ **Unspeeded**
- ⇒ Block A/C: I'm going to show you a series of pictures on this computer. Your task is to tell me the name for each picture. Take as much time as you need to answer.
- ⇒ Block B/D: Now I'm going to show you the same pictures again. This time, you can take all the time you need to answer.
- ⇒ **Time Pressure Condition**
- ⇒ Block A/C: I'm going to show you a series of pictures using this computer. The computer will show each picture for exactly 3 seconds and then it will move on automatically. Your task is to name each item as quickly as you can. Once the picture changes, you should move onto the next picture even if you haven't named the previous picture.
- ⇒ Block B/D: Now I am going to show you the same pictures again. This time, the computer will show each picture for exactly 3 seconds and then it will move on automatically. Your task is to name each item as quickly as you can. Once the picture

changes, you should move onto the next picture even if you haven't named the previous picture.

Western Aphasia Battery- Revised (WAB-R) Modified Instructions

The Western Aphasia Battery was given using the standardized procedure only; no speeded presentation method was be used.

D-KEFS Alternate Instructions

Verbal Fluency

⇒ **Condition 1: Letter Fluency- Unpressured Instructions:**

⇒ Block A/C: I'm going to say a letter of the alphabet. When I begin, I want you to tell me as many words as you can that begin with that letter. None of the words can be names of people, or places, or numbers. For example, If I gave you the letter T, you could say toy, tooth, and so forth but you should not say Tom because that is a person's name, you should not say Texas because that is the name of a place, and you should not say twelve because that is a number. Also, do not give me the same word with different endings. For example, if you say take, you should not also say takes or taking. Do you have any questions? Take as much time as you need. The first letter is _____ < Allow at least 60 seconds or longer if participant is still generating items- score only those from first 60 seconds>

⇒ Block B/D: We are going to do this task again using some new letters. As before, I'm going to say a letter of the alphabet. For example, if you say take, you should not also say takes or taking. Do you have any questions? Take as much time as you need. The first letter is _____ < Allow at least 60 seconds or longer if participant is still generating items- score only those from first 60 seconds>

⇒ **Condition 1: Letter Fluency- Time Pressured Instructions:**

⇒ Block A/C: I'm going to say a letter of the alphabet. When I begin, I want you to tell me as many words as you can that begin with that letter. None of the words can be names of people, or places, or numbers. For example, If I gave you the letter T, you could say toy, tooth, and so forth but you should not say Tom because that is a person's name, you should not say Texas because that is the name of a place, and you should not say twelve because that is a number. Also, do not give me the same word with different endings. For example, if you say take, you should not also say takes or taking. Do you have any questions? **I am measuring the number of words you can generate in 60 seconds so it is important that you work very fast.** Do you have any questions? The first letter is _____ <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 60 seconds>

⇒ Block B/D: We are going to do this task again using some new letters. As before, I'm going to say a letter of the alphabet. For example, if you say take, you should not also say takes or taking. Do you have any questions? **I am measuring the number of words you can generate in 60 seconds so it is important that you work very fast.** Do you have any questions? The first letter is _____ <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 60 seconds>

⇒ **Condition 2: Category Fluency- Original Instructions:**

⇒ Block A/C: Now we are going to do something a little different. This time, I want you to tell me as many animals/items of clothing as you can. It doesn't matter what letter they start with. Do you have any questions? Begin when you are ready < Allow at least 60 seconds or longer if participant is still generating items- score only those from first 60 seconds>

⇒ 2nd Task: Now tell me as many boys/girls names as you can. Ready? Begin when you are ready < Allow at least 60 seconds or longer if participant is still generating items- score only those from first 60 seconds>

⇒ Block B/D: This time we are going to do this again with a new category. This time, I want you to tell me as many animals/items of clothing as you can. Do you have any questions? Ready? Begin when you are ready < Allow at least 60 seconds or longer if participant is still generating items- score only those from first 60 seconds>

⇒ 2nd Task: Now tell me as many boys/girls names as you can. Ready? Begin when you are ready < Allow at least 60 seconds or longer if participant is still generating items- score only those from first 60 seconds>

⇒ **Condition 2: Category Fluency- Time Pressured Instructions:**

⇒ Block A/C: Now we are going to do something a little different. This time, I want you to tell me as many animals/items of clothing as you can. It doesn't matter what letter they start with. I am measuring the number of words you can generate in 60 seconds so it is important that you work very fast. Do you have any questions? When I say Go, tell me as many animals/items of clothing as you can. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 60 seconds>

⇒ 2nd Task: Now tell me as many boys/girls names as you can. I am still measuring the number of words you can generate in 60 seconds so work very fast. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 60 seconds>

⇒ Block B/D: This time we are going to do this again with a new category. This time, I want you to tell me as many animals/items of clothing as you can. . I am measuring the number of words you can generate in 60 seconds so it is important that you work very fast. Do you have any questions? When I say Go, tell me as many animals/items of clothing as you can. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 60 seconds>

⇒ 2nd Task: Now tell me as many boys/girls names as you can. I am still measuring the number of words you can generate in 60 seconds so work very fast. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 60 seconds>

⇒ **Condition 3: Category Switching- Unpressured Instructions:**

⇒ Block A/C: Now we are going to do something a little different. I want you to switch back and forth between saying as many fruits/vegetables and as many pieces of furniture/musical instruments as you can. It doesn't matter what letter they start with. So, you would say a fruit/vegetable, then a piece of furniture/musical instrument and so on. You can start with either a fruit/vegetable or a piece of furniture/musical instrument. Do you have any questions? Begin when you are ready < Allow at least 60 seconds or longer if participant is still generating items- score only those from first 60 seconds>

⇒ Block B/D: This time we are going to do this again with two new categories. I want you to switch back and forth between saying as many fruits/vegetables and as many pieces of furniture/musical instruments as you can. It doesn't matter what letter they start with. You will have 60 seconds before I tell you to stop. Do you have any questions? Begin when you are ready < Allow at least 60 seconds or longer if participant is still generating items- score only those from first 60 seconds>

⇒ **Condition 3: Category Switching- Time Pressured Instructions:**

⇒ Block A/C: Now we are going to do something a little different. I want you to switch back and forth between saying as many fruits and as many pieces of furniture/musical instruments as you can. It doesn't matter what letter they start with. You will have 60 seconds before I tell you to stop. So, you would say a fruit/vegetable, then a piece of furniture/musical instrument and so on. You can start with either a fruit/vegetable or a piece of furniture/musical instrument. I am still measuring the number of words you can generate in 60 seconds so work very fast. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 60 seconds.>

⇒ Block B/D: This time we are going to do this again with two new categories. I want you to switch back and forth between saying as many fruits/vegetables and as many pieces of furniture/musical instruments as you can. It doesn't matter what letter they start with. You will have 60 seconds before I tell you to stop. I am still measuring the number of words you can generate in 60 seconds so work very fast. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 60 seconds.>

Design Fluency

⇒ The *Design Fluency Test* measures one's initiation of problem-solving behavior, fluency in generating visual patterns, creativity in drawing new designs, simultaneous processing in drawing the designs while observing the rules and restrictions of the

task, and inhibiting previously drawn responses.

⇒ **Condition 1: Filled Dots- Untimed Instructions:**

⇒ Block A/C: Here are three squares, each with dots inside. I want you to make a *different* design in each square by connecting dots and always using straight lines. I'd like you to make the designs using *only four straight lines* to connect the dots. Make sure each line you draw starts with a dot and ends with a dot. Also, make each line touch at least one other line at a dot, like this. [DRAW EXAMPLE] See how these two lines touch at this dot? It's OK if your lines cross each other, and it doesn't matter whether or not your designs can be named. Do you have any questions?

[INSTRUCTIONS GO THROUGH SEVERAL EXAMPLES]

When you are ready to begin, draw as many *different* designs as you can. Remember, use only four straight lines to connect the dots and make each line touch at least one other line at a dot. Start here (point to the square at the examinee's upper left) and go this way (gesture from the examinee's left to right). When you finish this line, go to the next (gesture to the next lower line). Any questions? Begin when you are ready.

⇒ Block B/D: Here are three squares, each with dots inside. I want you to make a *different* design in each square by connecting dots and always using straight lines. I'd like you to make the designs using *only four straight lines* to connect the dots. Make sure each line you draw starts with a dot and ends with a dot. Also, make each line touch at least one other line at a dot, like this. [DRAW EXAMPLE] See how these two lines touch at this dot? It's OK if your lines cross each other, and it doesn't matter whether or not your designs can be named. Do you have any questions?

[INSTRUCTIONS GO THROUGH SEVERAL EXAMPLES]

When you are ready to begin, draw as many *different* designs as you can. Remember, use only four straight lines to connect the dots and make each line touch at least one other line at a dot. Start here (point to the square at the examinee's upper left) and go this way (gesture from the examinee's left to right). When you finish this line, go to the next (gesture to the next lower line). Any questions? Begin when you are ready.

⇒ **Condition 1: Filled Dots- Time-Pressured Instructions:**

⇒ Block A/C: Here are three squares, each with dots inside. I want you to make a *different* design in each square by connecting dots and always using straight lines. I'd like you to make the designs using *only four straight lines* to connect the dots. Make sure each line you draw starts with a dot and ends with a dot. Also, make each line touch at least one other line at a dot, like this. [DRAW EXAMPLE] See how these two lines touch at this dot? It's OK if your lines cross each other, and it doesn't matter whether or not your designs can be named. Do you have any questions?

[INSTRUCTIONS GO THROUGH SEVERAL EXAMPLES]

⇒ When I say begin, draw as many different designs as you can in 60 seconds. Remember, use only four straight lines to connect the dots and make each line touch at least one other line at a dot. Start here (point to the square at the examinee's upper left) and go this way (gesture from the examinee's left to right). When you finish this line, go to the next (gesture to the next lower line). Any questions? . Remember, I am measuring the number of different designs you can create in 60 seconds. So work as fast as you can. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 60 seconds.>

⇒ Block B/D: Here are three squares, each with dots inside. I want you to make a *different* design in each square by connecting dots and always using straight lines. I'd like you to make the designs using *only four straight lines* to connect the dots. Make sure each line you draw starts with a dot and ends with a dot. Also, make each line touch at least one other line at a dot, like this. [DRAW EXAMPLE] See how these two lines touch at this dot? It's OK if your lines cross each other, and it doesn't matter whether or not your designs can be named. Do you have any questions?

[INSTRUCTIONS GO THROUGH SEVERAL EXAMPLES]

⇒ When I say begin, draw as many different designs as you can in 60 seconds. Remember, use only four straight lines to connect the dots and make each line touch at least one other line at a dot. Start here (point to the square at the examinee's upper left) and go this way (gesture from the examinee's left to right). When you finish this line, go to the next (gesture to the next lower line). Any questions? . Remember, I am measuring the number of different designs you can create in 60 seconds. So work as fast as you can. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 60 seconds.>

⇒ **Condition 2: Empty Dots Only- Untimed Instructions:**

⇒ Block A/C: Here are three squares, each with ten dots. Five of the dots are filled and five of them empty (point to an example of each). I want you to make a difference design in each square by connecting only empty dots. That is, don't touch the filled dots; just connect the empty dots. Like before, use only straight lines and make each line touch at least one other line at the dot. Do you have any questions?

[INSTRUCTIONS GO THROUGH SEVERAL EXAMPLES]

When you are ready to begin, draw as many *different* designs as you can. Remember, use only four straight lines to connect the dots and make each line touch at least one other line at a dot. Start here (point to the square at the examinee's upper left) and go this way (gesture from the examinee's left to right). When you finish this line, go to the next (gesture to the next lower line). Any questions? Begin when you are ready.

- ⇒ Block B/D: Here are three squares, each with ten dots. Five of the dots are filled and five of them empty (point to an example of each). I want you to make a difference design in each square by connecting only empty dots. That is, don't touch the filled dots; just connect the empty dots. Like before, use only straight lines and make each line touch at least one other line at the dot. Do you have any questions?
[INSTRUCTIONS GO THROUGH SEVERAL EXAMPLES]

When you are ready to begin, draw as many *different* designs as you can. Remember, use only four straight lines to connect the dots and make each line touch at least one other line at a dot. Start here (point to the square at the examinee's upper left) and go this way (gesture from the examinee's left to right). When you finish this line, go to the next (gesture to the next lower line). Any questions? Begin when you are ready.

⇒ **Condition 2: Empty Dots Only- Time-Pressured Instructions:**

- ⇒ Block A/C: Here are three squares, each with ten dots. Five of the dots are filled and five of them empty (point to an example of each). I want you to make a difference design in each square by connecting only empty dots. That is, don't touch the filled dots; just connect the empty dots. Like before, use only straight lines and make each line touch at least one other line at the dot. Do you have any questions?
[INSTRUCTIONS GO THROUGH SEVERAL EXAMPLES]

- ⇒ When I say begin, draw as many *different* designs as you can in 60 seconds. Remember, use only four straight lines to connect the dots and make each line touch at least one other line at a dot. Start here (point to the square at the examinee's upper left) and go this way (gesture from the examinee's left to right). When you finish this line, go to the next (gesture to the next lower line). Any questions? . Remember, I am measuring the number of different designs you can create in 60 seconds. So work as fast as you can. Go!
<Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 60 seconds.>

- ⇒ Block B/D: Here are three squares, each with ten dots. Five of the dots are filled and five of them empty (point to an example of each). I want you to make a difference design in each square by connecting only empty dots. That is, don't touch the filled dots; just connect the empty dots. Like before, use only straight lines and make each line touch at least one other line at the dot. Do you have any questions?
[INSTRUCTIONS GO THROUGH SEVERAL EXAMPLES]

- ⇒ When I say begin, draw as many different designs as you can in 60 seconds. Remember, use only four straight lines to connect the dots and make each line touch at least one other line at a dot. Start here (point to the square at the examinee's upper left) and go this way (gesture from the examinee's left to right). When you finish this line, go to the next (gesture to the next lower line). Any questions? . Remember, I am measuring the number of different designs you can create in 60 seconds. So work as fast as you can. Go!
<Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 60 seconds.>

⇒ **Condition 3: Switching- Untimed Instructions:**

⇒ Block A/C: Here are three squares, each with ten dots. Five of the dots are filled and five of them empty (point to an example of each). I want you to make a difference design in each square by connecting only empty dots. That is, don't touch the filled dots; just connect the empty dots. Like before, use only straight lines and make each line touch at least one other line at the dot. Do you have any questions?

[INSTRUCTIONS GO THROUGH SEVERAL EXAMPLES]

When you are ready to begin, draw as many *different* designs as you can. Remember, use only four straight lines to connect the dots and make each line touch at least one other line at a dot. Start here (point to the square at the examinee's upper left) and go this way (gesture from the examinee's left to right). When you finish this line, go to the next (gesture to the next lower line). Any questions? Begin when you are ready.

⇒ Block B/D: Here are three squares, each with ten dots. Five of the dots are filled and five of them empty (point to an example of each). I want you to make a difference design in each square by connecting only empty dots. That is, don't touch the filled dots; just connect the empty dots. Like before, use only straight lines and make each line touch at least one other line at the dot. Do you have any questions?

[INSTRUCTIONS GO THROUGH SEVERAL EXAMPLES]

When you are ready to begin, draw as many *different* designs as you can. Remember, use only four straight lines to connect the dots and make each line touch at least one other line at a dot. Start here (point to the square at the examinee's upper left) and go this way (gesture from the examinee's left to right). When you finish this line, go to the next (gesture to the next lower line). Any questions? Begin when you are ready.

⇒ **Condition 3: Switching- Time-Pressured Instructions:**

⇒ Block A/C: Here are three squares, each with ten dots. Five of the dots are filled and five of them empty (point to an example of each). I want you to make a difference design in each square by connecting only empty dots. That is, don't touch the filled dots; just connect the empty dots. Like before, use only straight lines and make each line touch at least one other line at the dot. Do you have any questions?

[INSTRUCTIONS GO THROUGH SEVERAL EXAMPLES]

⇒ When I say begin, draw as many *different* designs as you can in 60 seconds. Remember, use only four straight lines to connect the dots and make each line touch at least one other line at a dot. Start here (point to the square at the examinee's upper left) and go this way (gesture from the examinee's left to right). When you finish this line, go to the next (gesture to the next lower line). Any questions? Remember, I am measuring the number of different designs you can create in 60 seconds. Work as fast as you can. Go!

<Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 60 seconds.>

- ⇒ Block B/D: Here are three squares, each with ten dots. Five of the dots are filled and five of them empty (point to an example of each). I want you to make a difference design in each square by connecting only empty dots. That is, don't touch the filled dots; just connect the empty dots. Like before, use only straight lines and make each line touch at least one other line at the dot. Do you have any questions?
[INSTRUCTIONS GO THROUGH SEVERAL EXAMPLES]

- ⇒ When I say begin, draw as many different designs as you can in 60 seconds. Remember, use only four straight lines to connect the dots and make each line touch at least one other line at a dot. Start here (point to the square at the examinee's upper left) and go this way (gesture from the examinee's left to right). When you finish this line, go to the next (gesture to the next lower line). Any questions? Remember, I am measuring the number of different designs you can create in 60 seconds. Work as fast as you can. Go!
<Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 60 seconds.>

Card Sorting

- ⇒ The *Sorting Test* measures concept-formation skills, modality-specific problem-solving skills (verbal/nonverbal), and the ability to explain sorting concepts abstractly
- ⇒ Free Sorting- Pre-Instructions: I'm going to show you six cards that can be sorted in different ways. I want you to see how many different ways you can sort the cards. Let me show you what I mean with these cards>. Look at these cards. Watch how I sort them into two groups with three cards in each group. <point> Next, I'll explain how I sorted them by saying, this group has circles, and this group has squares. Notice how I explained both groups not just one of them. Now watch while I sort them another way, again with two groups on three cards in each group. I will explain how I sorted them by saying, this group has boys' names and this group has girls' names. Do you have any questions about how I did this?

⇒ **Condition 1: Free Sorting- Unpressured Instructions:**

- ⇒ Block A/C:
- ⇒ Card Set 1/3: I'm going to show you six new cards that can be sorted in many different ways. I'd like to see how many different ways you can sort the cards. Each time, make only two groups with three cards in each group. The three cards in each group should be similar in some way. After you sort two cards into two groups, tell me how you did it. Be sure to tell me how you sorted both groups, not just one of them. Once you sort the cards one way, do not sort them that way again. Take as much time as you need. Here is a page that will help you remember these rules. <flip card> Now, try sorting these cards in as many different ways as you can. Ready? Begin. <Use Card Set 1/3> Stop time when

examinee completes his or her sort and begins to describe the sorting strategy> Now try to sort them in a different way <restart timer during sort>

- ⇒ Card Set 2/4: I'm going to show you six *new* cards that can be sorted in many different ways. Like before, I'd like to see how many different ways you can sort these cards. Each time, make only *two* groups with *three* cards in each group. The three cards in each group should be similar in some way. After you sort two cards into two groups, tell me how you did it. Be sure to tell me how you sorted both groups, not just one of them. Once you sort the cards one way, do not sort them that way again. Take as much time as you need. Again here is a page that will help you remember these rules. <flip card> Now, try sorting these cards in as many different ways as you can. Ready? Begin. <Use Card Set 1/3> Stop time when examinee completes his or her sort and begins to describe the sorting strategy> Now try to sort them in a different way. <restart timer during sort>
- ⇒ <Discontinue after 4 minutes sort time (doesn't include description time) or when participant indicates that they cannot think of another way>
- ⇒ Block B/D:
- ⇒ Card Set 1/3: I'm going to show you six new cards that can be sorted in many different ways. I'd like to see how many different ways you can sort the cards. Each time, make only two groups with three cards in each group. The three cards in each group should be similar in some way. After you sort two cards into two groups, tell me how you did it. Be sure to tell me how you sorted both groups, not just one of them. Once you sort the cards one way, do not sort them that way again. Take as much time as you need. Here is a page that will help you remember these rules. <flip card> Now, try sorting these cards in as many different ways as you can. Ready? Begin. <Use Card Set 1/3; Stop time when examinee completes his or her sort and begins to describe the sorting strategy> Now try to sort them in a different way <restart timer during sort>
- ⇒ Card Set 2/4: I'm going to show you six *new* cards that can be sorted in many different ways. Like before, I'd like to see how many different ways you can sort these cards. Each time, make only *two* groups with *three* cards in each group. The three cards in each group should be similar in some way. After you sort two cards into two groups, tell me how you did it. Be sure to tell me how you sorted both groups, not just one of them. Once you sort the cards one way, do not sort them that way again. Take as much time as you need. Again here is a page that will help you remember these rules. <flip card> Now, try sorting these cards in as many different ways as you can. Ready? Begin. <Use Card Set 1/3; Stop time when examinee completes his or her sort and begins to describe the sorting strategy> Now try to sort them in a different way. <restart timer during sort>
- ⇒ <Discontinue after 4 minutes sort time (doesn't include description time) or when participant indicates that they cannot think of another way>

⇒ **Condition 1: Free Sorting– Time-Pressured Instructions:**

- ⇒ Block A/C:
- ⇒ Card Set 1/3: I'm going to show you six new cards that can be sorted in many different ways. I'd like to see how many different ways you can sort the cards. Each time, make only two groups with three cards in each group. The three cards in each group should be

- similar in some way. After you sort two cards into two groups, tell me how you did it. Be sure to tell me how you sorted both groups, not just one of them. Once you sort the cards one way, do not sort them that way again. Remember, I am measuring the number of different sort you can complete in 4 minutes. Work as fast as you can. Here is a page that will help you remember these rules. <flip card> Now, try sorting these cards in as many different ways as you can. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 240 seconds.> <Use Card Set 1/3; Stop time when examinee completes his or her sort and begins to describe the sorting strategy> Now try to sort them in a different way <restart timer during sort>
- ⇒ Card Set 2/4: I'm going to show you six *new* cards that can be sorted in many different ways. Like before, I'd like to see how many different ways you can sort these cards. Each time, make only *two* groups with *three* cards in each group. The three cards in each group should be similar in some way. After you sort two cards into two groups, tell me how you did it. Be sure to tell me how you sorted both groups, not just one of them. Once you sort the cards one way, do not sort them that way again. Remember, I am measuring the number of different sorts you can complete in 4 minutes. Work as fast as you can. Here is a page that will help you remember these rules. <flip card> Now, try sorting these cards in as many different ways as you can. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 240 seconds.> <Use Card Set 1/3> Stop time when examinee completes his or her sort and begins to describe the sorting strategy> Now try to sort them in a different way. <restart timer during sort>
- ⇒ <Discontinue after 4 minutes sort time (doesn't include description time) or when participant indicates that they cannot think of another way>
- ⇒ Block B/D:
- ⇒ Card Set 1/3: I'm going to show you six new cards that can be sorted in many different ways. I'd like to see how many different ways you can sort the cards. Each time, make only two groups with three cards in each group. The three cards in each group should be similar in some way. After you sort two cards into two groups, tell me how you did it. Be sure to tell me how you sorted both groups, not just one of them. Once you sort the cards one way, do not sort them that way again. Remember, I am measuring the number of different sorts you can complete in 4 minutes. Work as fast as you can. Here is a page that will help you remember these rules. <flip card> Now, try sorting these cards in as many different ways as you can. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 240 seconds.> <Use Card Set 1/3> Stop time when examinee completes his or her sort and begins to describe the sorting strategy> Now try to sort them in a different way <restart timer during sort>
- ⇒ Card Set 2/4: I'm going to show you six *new* cards that can be sorted in many different ways. Like before, I'd like to see how many different ways you can sort these cards. Each time, make only *two* groups with *three* cards in each group. The three cards in each group should be similar in some way. After you sort two cards into two groups, tell me how you did it. Be sure to tell me how you sorted both groups, not just one of them. Once you sort the cards one way, do not sort them that way again. Remember, I am measuring the number of different sorts you can complete in 4 minutes. Work as fast as you can.

Here is a page that will help you remember these rules. <flip card> Now, try sorting these cards in as many different ways as you can. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 240 seconds.> <Use Card Set 1/3> Stop time when examinee completes his or her sort and begins to describe the sorting strategy> Now try to sort them in a different way. <restart timer during sort>

⇒ <Discontinue after 4 minutes sort time (doesn't include description time) or when participant indicates that they cannot think of another way>

⇒ **Condition 2: Sort Recognition- Unpressured Instructions:**

⇒ Block A/C:

⇒ Card Set 1/3: Now I'm going to put these cards into two groups of three cards each. The three cards in each group will be the same in some way. I want you to tell me how the cards are the same in each group. Be sure to tell me how I sorted both groups, not just one of them. I will use different way of sorting the cards each time I put them into groups. Take as much time as you need. <place cards into set according to rules in test manual; wait for participant to explain sort.> Good, now I'm going to sort the cards in a different way. Again I want you to tell me how I sorted the two groups. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 240 seconds.> <Repeat through 8 sorts>.

⇒ Card Set 2/4: Like before, I'm going to put these cards into two groups of three cards each. The three cards in each group will be the same in some way. I want you to tell me how the cards are the same in each group. Be sure to tell me how I sorted both groups, not just one of them. I will use different way of sorting the cards each time I put them into groups. Take as much time as you need. <place cards into set according to rules in test manual; wait for participant to explain sort.> Good, now I'm going to sort the cards in a different way. Again I want you to tell me how I sorted the two groups. Take as much time as you need. <Repeat through 8 sorts>.

⇒ Block B/D:

⇒ Card Set 1/3: Now I'm going to put these cards into two groups of three cards each. The three cards in each group will be the same in some way. I want you to tell me how the cards are the same in each group. Be sure to tell me how I sorted both groups, not just one of them. I will use different way of sorting the cards each time I put them into groups. Take as much time as you need. <place cards into set according to rules in test manual; wait for participant to explain sort.> Good, now I'm going to sort the cards in a different way. Again I want you to tell me how I sorted the two groups. Take as much time as you need. <Repeat through 8 sorts>.

⇒ Card Set 2/4: Like before, I'm going to put these cards into two groups of three cards each. The three cards in each group will be the same in some way. I want you to tell me how the cards are the same in each group. Be sure to tell me how I sorted both groups, not just one of them. I will use different way of sorting the cards each time I put them into groups. Take as much time as you need. <place cards into set according to rules in test manual; wait for participant to explain sort.> Good, now I'm going to sort the cards

in a different way. Again I want you to tell me how I sorted the two groups. Take as much time as you need. <Repeat through 8 sorts>.

⇒ **Condition 2: Sort Recognition – Time-Pressured Instructions:**

⇒ Block A/C:

⇒ Card Set 1/3: Now I'm going to put these cards into two groups of three cards each. The three cards in each group will be the same in some way. I want you to tell me how the cards are the same in each group. Be sure to tell me how I sorted both groups, not just one of them. I will use different way of sorting the cards each time I put them into groups. I am measuring how fast you can identify the sorting rules. Work as fast as you can. <place cards into set according to rules in test manual; wait for participant to explain sort.> Good, now I'm going to sort the cards in a different way. Again I want you to tell me how I sorted the two groups. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. As soon as one is identified, sort new set and say Go! <Repeat through 8 sorts>.

⇒ Card Set 2/4: Like before, I'm going to put these cards into two groups of three cards each. The three cards in each group will be the same in some way. I want you to tell me how the cards are the same in each group. Be sure to tell me how I sorted both groups, not just one of them. I will use different way of sorting the cards each time I put them into groups. I am measuring how fast you can identify the sorting rules. Work as fast as you can. <place cards into set according to rules in test manual; wait for participant to explain sort.> Good, now I'm going to sort the cards in a different way. Again I want you to tell me how I sorted the two groups. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. As soon as one is identified, sort new set and say Go!. <Repeat through 8 sorts>.

⇒ Block B/D:

⇒ Card Set 1/3: Now I'm going to put these cards into two groups of three cards each. The three cards in each group will be the same in some way. I want you to tell me how the cards are the same in each group. Be sure to tell me how I sorted both groups, not just one of them. I will use different way of sorting the cards each time I put them into groups. I am measuring how fast you can identify the sorting rules. Work as fast as you can. <place cards into set according to rules in test manual; wait for participant to explain sort.> Good, now I'm going to sort the cards in a different way. Again I want you to tell me how I sorted the two groups. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. As soon as one is identified, sort new set and say Go! <Repeat through 8 sorts>.

⇒ Card Set 2/4: Like before, I'm going to put these cards into two groups of three cards each. The three cards in each group will be the same in some way. I want you to tell me how the cards are the same in each group. Be sure to tell me how I sorted both groups, not just one of them. I will use different way of sorting the cards each time I put them into groups. I am measuring how fast you can identify the sorting rules. Work as fast as you can. <place cards into set according to rules in test manual; wait for participant to explain sort.> Good, now I'm going to sort the cards in a different way. Again I want you

to tell me how I sorted the two groups. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. As soon as one is identified, sort new set and say Go! <Repeat through 8 sorts>.

Twenty Questions

⇒ The *Twenty Questions Test* measures the ability to categorize, formulate abstract, yes/no questions, and incorporate the examiner's feedback to formulate more efficient yes/no questions

⇒ **Original Instructions:**

⇒ Block A/C: Now we are going to do something where you ask *me* questions. I have picked one of these pictures and I want you to figure out which one by asking me questions. You can only ask questions that I can answer yes or no. You can ask any question at all, as long as I can answer yes or no. Try to guess the picture that I have picked with the fewest number of questions you can. I am going to write down your questions so I can remember them. You can take as much time as you need to think of the questions. But you are limited to a total of 20 questions to figure out which picture I have selected. 2nd Task: Good, Let's try the next one. I've picked a new picture, and I want you to ask me the fewest number of yes/no questions you can to figure out which one it is. Take as much time as you need. Begin when you are ready. (Form A/C items: banana, spoon, owl, helicopter)

⇒ Block B/D: Block A/C: Now we are going to do something where you ask *me* questions. I have picked one of these pictures and I want you to figure out which one by asking me questions. You can only ask questions that I can answer yes or no. You can ask any question at all, as long as I can answer yes or no. Try to guess the picture that I have picked with the fewest number of questions you can. I am going to write down your questions so I can remember them. You can take as much time as you need to think of the questions. But you are limited to a total of 20 questions to figure out which picture I have selected. 2nd Task: Good, Let's try the next one. I've picked a new picture, and I want you to ask me the fewest number of yes/no questions you can to figure out which one it is. Take as much time as you need. Begin when you are ready. (Form A/C items: airplane, rose, stove, corn)

⇒ **Time-Pressured Instructions:**

⇒ Block A/C: Now we are going to do something where you ask *me* questions. I have picked one of these pictures and I want you to figure out which one by asking me questions. You can only ask questions that I can answer yes or no. You can ask any question at all, as long as I can answer yes or no. Try to guess the picture that I have picked with the fewest number of questions you can. I am going to write down your questions so I can remember them. I am measuring how fast you can ask me the questions and you are limited to a total of 20 questions to figure out which picture I have selected. 2nd Task: Good, Let's try the next one. I've picked a new picture, and I want you to ask me the

fewest number of yes/no questions you can to figure out which one it is. I am measuring how fast you are. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. > (Form A/C items: banana, spoon, owl, helicopter)

- ⇒ Block B/D: Block A/C: Now we are going to do something where you ask *me* questions. I have picked one of these pictures and I want you to figure out which one by asking me questions. You can only ask questions that I can answer yes or no. You can ask any question at all, as long as I can answer yes or no. Try to guess the picture that I have picked with the fewest number of questions you can. I am going to write down your questions so I can remember them. I am measuring how fast you can ask me the questions and you are limited to a total of 20 questions to figure out which picture I have selected. 2nd Task: Good, Let's try the next one. I've picked a new picture, and I want you to ask me the fewest number of yes/no questions you can to figure out which one it is. I am measuring how fast you are. Go! <Prominently display stopwatch and show that you have pressed the start button to begin timing. > (Form A/C items: airplane, rose, stove, corn)

Torrance Test of Creative Thinking Alternate Instructions
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⇒ **Product Improvement**

⇒ **Original Instructions for Written Response (For reference only- not used)**

- ⇒ Here is a stuffed toy monkey/elephant of the kind you can buy in most novelty stores for about five to six dollars. It is about six inches tall and weighs about six ounces/half a pound. In the spaces on this page and the next one, I want you to give me a list of the cleverest, most interesting and unusual ways you can think of for changing this toy monkey/elephant so that children would have more fun playing with it. Don't worry about how much the change would cost. Think only about what would make it more fun to play with as a toy.

⇒ **Aphasia Friendly Instructions, Verbal response, and Physical object**

- ⇒ This is a toy monkey/elephant (hand to the participant). You might buy it for about five to six dollars. As you can see, it is about six inches tall and weighs about six ounces. For this task, I want you to give me a list of the cleverest, most interesting and unusual ways you can think of for changing this toy monkey/elephant so that children would have more fun playing with it. Don't worry about how much the change would cost. Think only about what would make it more fun to play with as a toy.
- ⇒ Participant is allowed (although not told) to pick up and manipulate object but will only be given credit for verbal responses.

⇒ **Time Pressure Condition- Aphasia Friendly Instructions, Verbal response, and Physical object**

- ⇒ This is a toy monkey/elephant (hand to the participant). You might buy it for about five to six dollars. As you can see, it is about six inches tall and weighs about six ounces. For this task, I want you to give me a list of the cleverest, most interesting and unusual ways you can think of for changing this toy monkey/elephant so that children would have more fun playing with it. Don't worry about how much the change would cost. Think only about what would make it more fun to play with as a toy. **You only have 3 minutes. So work quickly and use your time wisely. Go!** <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 3 minutes.>
- ⇒ Participant is allowed (although not told) to pick up and manipulate object but will only be given credit for verbal responses.

Unusual Uses

⇒ **Original Instructions for Written Response (For reference only- not used)**

- ⇒ Most people throw their empty cardboard boxes away, but they have thousands of interesting and unusual uses. In the spaces below and on the next page, list as many of these interesting and unusual uses as you can think of. Do not limit yourself to any one size of box. You may use as many boxes as you like. Do not limit yourself to the uses you have seen or heard about; think about as many possible uses as you can.

⇒ **Aphasia Friendly Instructions and Verbal response**

- ⇒ Most people throw their empty cardboard boxes away, but they have thousands of interesting and unusual uses. For this task, I want you to list as many of these interesting and unusual uses as you can think of for a cardboard box. Do not limit yourself to any one size of box. You may use as many boxes as you like. Do not limit yourself to the uses you have seen or heard about; think about as many possible uses as you can.

⇒ **Time Pressure Condition- Aphasia Friendly Instructions and Verbal response**

- ⇒ Most people throw their empty cardboard boxes away, but they have thousands of interesting and unusual uses. For this task, I want you to list as many of these interesting and unusual uses as you can think of for a cardboard box. Do not limit yourself to any one size of box. You may use as many boxes as you like. Do not limit yourself to the uses you have seen or heard about; think about as many possible uses as you can. **You only have 3 minutes. So work quickly and use your time wisely. Go!** <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 3 minutes.>

Common Uses

⇒ **Verbal response**

⇒ We use duct tape/string for an endless variety of things. For this task, I want you to list as many of the common ways we use duct tape. Think about ways that you have seen duct tape used. You have all the time you want.

⇒ **Time Pressure Condition- Verbal response**

⇒ We use duct tape/string for an endless variety of things. For this task, I want you to list as many of the common ways we use duct tape. Think about ways that you have seen duct tape used. . **You only have 3 minutes. So work quickly and use your time wisely. Go!** <Prominently display stopwatch and show that you have pressed the start button to begin timing. Time allowed = 3 minutes.>