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## PHYSIOLOGY & REHABILITATION | RESEARCH ARTICLE

# The relationship of language and attention in elders with nonfluent aphasia

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**Abstract:** *Background:* Researchers have questioned whether aphasia coincides with deficiencies in the non-linguistic executive functions needed to coordinate cognitive-linguistic skills. Attention, an important component of executive function, may be compromised in the presence of aphasia. The relationship of attention to recovery of functional language skills in aphasia requires additional investigation. *Aims:* This exploratory multiple case comparison investigated whether a measurable weakness in attention is present in elderly persons with nonfluent aphasia and whether there is a trend for these measures that coincides with the severity of the nonfluent aphasia. *Methods and procedures:* Three female and five male participants, ages 57–79 with nonfluent aphasia, completed tests of language and attention: the *Western Aphasia Battery Bedside Screener-Revised*, the *Test of Everyday Attention*, the *Cognitive Linguistic Quick Test*, and the *Leiter International Performance Scale-Revised*. *Outcomes and results:* All participants demonstrated deficits in language and attention to varying degrees. Overall, the data did not establish a trend between measures of language and attention. The degree to which participants' attentional skills were affected was not consistently related to their severity of aphasia. Each participant demonstrated unique strengths and weaknesses. For two participants, language was a strength in relation to attention. For three participants, attention was a strength in relation to language. Three participants did not demonstrate a relative strength in either language or attention. *Conclusions:* This

### ABOUT THE AUTHORS

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### PUBLIC INTEREST STATEMENT

Aphasia is a medical condition that involves the loss of the ability to use spoken and written language. It occurs as the result of a stroke, head injury, or neurological disorder. There are approximately 80,000 new cases of aphasia per year in the United States. Approximately 1 million people in the US and 376,000 people in the United Kingdom are living with aphasia. About 15% of individuals under age 65 experience aphasia. About 43% of persons age 85 and older have aphasia. This study explored whether persons who have language loss due to aphasia have also experienced a hindrance in their ability to use their attention skills. This study found that it is not always the case that an impairment of attention occurs with aphasia, but in some cases aphasia seems to coexist with a decrease in the ability to control the use of one's attention.

report concludes with multiple case comparisons that describe each participant's performance in detail. Implications for diagnosis and treatment arise from these case interpretations. Clinicians need to consider the how attention may be uniquely affected in each person with nonfluent aphasia. Limited attentional skills present a possible barrier to rehabilitation. Attention is integral to learning and for responsiveness to interventions, and lesser attentional skills may inhibit a person's ability to respond to interventions geared toward recovery of language skills. Knowledge of the attentional skills of persons with nonfluent aphasia may allow clinicians to capitalize on strengths and rehabilitate weaknesses.

**Subjects:** Language & Communication Difficulties; Rehabilitation Medicine; Speech and Language Therapy; Aging; Disability; Stroke; Neurological Rehabilitation; Communication Disorders

**Keywords:** aphasia; acquired language disorder; attention; multiple case study; geriatrics

### 1. Introduction

Researchers and clinicians have commonly held that injury to the area of the left hemisphere of the brain that governs language may result in aphasia without other forms of cognitive disturbance (Papathanasiou, Coppens, & Potagas, 2013). As such, speech-language rehabilitation has focused on recovery of language skills. However, some researchers have questioned whether other cognitive factors apart from residual language ability are involved in the clinical presentation of aphasia and the rehabilitation of language skills in persons with aphasia. A primary consideration is whether a brain lesion that results in aphasia affects language abilities alone, or whether other cognitive skills are also affected. A second consideration is whether persons with aphasia call upon other cognitive capacities to help them regain their language skills. Clinicians need to be aware of the concomitant impairments that may occur with aphasia in order to provide appropriate assessment and treatment.

### 2. Cognitive abilities and aphasia

Some definitions of aphasia suggest that aphasia may be a disorder that involves the cognitive systems that underlie language. In their seminal work on aphasia, Schuell, Jenkins, and Jimenez-Pabon (1964, as cited by McNeil & Copland, 2011) stated that the language impairment that defines aphasia is often accompanied by other sensory, motor, and cognitive disorders that are not in and of themselves aphasia. Darley (1982) and McNeil (1988) suggested that aphasia affects the cognitive processes that interface with language. Ellis and Young (1988) stated that aphasia results from a focal injury that brings about a selective breakdown of language processing and of the underlying cognitive resources necessary for using language. Murray, Holland, and Beeson (1997) conjectured that an impairment of cognitive processes, such as working memory, allocation of attention, and sequencing, exists in persons with aphasia (as cited in Fridriksson, Nettles, Davis, Morrow, & Montgomery, 2006). Murray and Chapey (2001) defined aphasia as an acquired impairment of language and of other cognitive processes that underlie language. Hula and McNeil (2008, p. 169) stated that aphasia is a "disorder of language or a disorder of the cognitive apparatus used to comprehend and produce language."

Various authors surmised that nonfluent aphasia in conjunction with impairments of non-linguistic cognitive functions might present a compounded problem that inhibits successful recovery of communication abilities. Nicholas, Sinotte, and Helm-Estabrooks (2005) implicated non-language cognitive factors in instances of limited recovery from aphasia.

Past studies explored cognitive abilities in persons with aphasia. Vallila-Rohter and Kiran (2013, p. 80) obtained data that suggested that non-linguistic cognitive impairments in persons with aphasia may interfere with the "online construction" and "transaction success" of language processes,

thus reducing how an individual might successfully regain communicative competence. These investigators and proposed that a person's ability to learn is a better predictor of success in aphasia therapy than degree of language skill. Purdy (2002) showed that executive functioning and problem solving ability in persons with aphasia were less efficient. No participants in Purdy's sample were able to complete tests that required more complex cognitive processing. Fridriksson et al. (2006) administered a test battery that revealed that levels of capability in executive functioning and functional communication were closely related in persons with aphasia. Helm-Estabrooks (2002) measured cognitive ability in individuals whose aphasia ranged from mild to severe by using the cognitive linguistic quick test (CLQT; Helm-Estabrooks, 2001) to compare performance on linguistic and non-linguistic cognitive tasks. All participants with aphasia scored below the normal cut-off score for each linguistic task, and only two of 13 persons with aphasia scored above the normal cut off score for non-linguistic cognitive tasks. Persons with severe aphasia showed great variability on nonlinguistic cognitive scores. Helm-Estabrooks concluded that there are cognitive deficits in some persons with aphasia, but language scores cannot predict the severity of cognitive deficits.

### 3. Attentional allocation

Attention is an aspect of executive functioning that governs the ability to maintain voluntary focus on particular stimuli without being distracted by co-occurring internal and external stimuli (Diamond, 2013). Attentional allocation mediates goal-directed learning, remembering, and behavior (Filley, 2002; Fischler, 2000). Murray (1999) suggested that allocation of attention is regulated by several characteristics: the novelty of the input, the intent to attend to a specific stimulus, and arousal level.

#### 3.1. Types of attentional allocation

McCallum (2003) describes three specific types of attentional allocation. Selective attention refers to the ability to attend to a specific signal while inhibiting attention to competing signals. Sustained attention is the ability to maintain a particular response set for an extended period of time. Divided attention is the ability to simultaneously attend to multiple tasks. When attention is divided between two tasks, performance on each task often suffers (McCallum, 2003). Attention affects the execution of higher-level cognitive abilities, due to its limited capacity and propensity to bottleneck.

### 4. Attentional capacity

An individual will not effectively complete a task if its demands exceed his/her attentional capacity or if his/her attentional resources are not appropriately used. The limited capacity theory of attention holds that human performance is compromised when overloaded with multiple stimuli (Gazzaniga, Ivry, & Mangun, 2009). Researchers speculated that, within the attentional system, one or more pools of attention processing resources exist. Although attentional capacity is limited, persons can flexibly allocate attentional resources to preferred stimuli (Murray, 1999).

The central bottleneck theory states that some forms of information within the attentional system can be processed in a parallel, concurrent fashion, but particular components of competing tasks are processed serially (Hula & McNeil, 2008). If concurrent operations bottleneck, then the completion of one operation must wait (Murray, 1999). The problem of limited capacity is overcome by the bottleneck's ability to efficiently pass through the high-priority information before attending to less pressing stimuli (Gazzaniga et al., 2009).

### 5. Attentional abilities and aphasia

Investigators have considered the possibility that the attentional processes that underlie and support language may be impaired in persons with aphasia (Murray, 1999). Researchers have debated whether or not attention, as a cognitive process, is affected by the language loss that occurs in aphasia, or whether language loss inhibits attention, or whether there is evidence of some combination of these two affects (Murray, 1999).

The structure of the brain suggests some evidence for attention being implicated in the linguistic performance of persons with aphasia. Attention is represented in the brain as a diffuse system that is centered within the frontal lobe, but the system is not hemisphere specific (Filley, 2002). The left middle cerebral artery (MCA) runs through the language areas of the brain, but also has many connections within the prefrontal cortex and frontal lobe region. Damage to the artery can cause language impairments and reduce executive functioning (Fridriksson et al., 2006). If the area nourished by the left MCA is injured, an individual may be vulnerable to diffuse attentional dysfunction. Persons experiencing this condition may become overwhelmed by incoming stimuli and have difficulty maintaining attention to even a single stimulus (O'Donnell, 2002). In a study of persons not reported to have aphasia, Godefroy and Rousseaux (1996) found that attention in participants with a left hemispheric lesion was impaired when the superior areas of the prefrontal cortex and the head of the caudate nucleus were damaged. Performance readily decreased when the number of perceptual channels increased. Godefroy and Rousseaux noticed that the left dorsolateral area of the prefrontal cortex may be involved in attention regulation across perceptual channels. The study demonstrated the possibility that persons with anterior aphasia, namely those with a lesion in the frontal lobe, may experience impaired attention in addition to impaired language.

Connor and Fucetola (2011) argued that attention plays a role in comprehension of every level of language, from phoneme identification to discourse processing. Kurland (2011) reasoned that language is dependent upon appropriate sustained attention, response selection, and response inhibition. Helm-Estabrooks (2002) pointed out that, in persons with aphasia, failure to attend equals failure to process information, despite what may be spared in the ability to understand spoken and written stimuli. Hula and McNeil (2008) argued that language is attentional in nature, and reasoned that when central bottlenecks occur in persons with aphasia, intermittent serial processing delays disrupt the language construction stream, which leads to a breakdown in using words to represent thoughts and ideas. The completion of the linguistic operation must wait during the bottleneck's prioritization process (cf., Gazzaniga et al., 2009; Murray, 1999). Alexander (2006) noted that weaknesses in executive function and/or attention that impair goal directed behaviors could explain some difficulties that some persons with aphasia have in producing extended discourse.

Kurland (2011), Murray (2012), and Villard and Kiran (2015) evidenced that attention skills can be identified in persons with aphasia by using measures that are language dependent as well as measures that are language independent. Kurland (2011), exploring language dependent measures, found that attention is linked to self-monitoring, error detection, and self-correction during verb generation tasks. Murray (2012), exploring language independent measures, studied the relationship between cognition and aphasia by administering tests of attention to participants with aphasia. Data revealed a variation in performance on attention assessments. Complex attention skills, such as divided attention tasks, showed lower performance when compared to basic attention skills, such as sustained attention. Participants in the Villard and Kiran (2015) study evidenced variability in their attentional skills, which the authors suggested could potentially account for some of the fluctuations in language performance in persons with aphasia.

Murray (1999) hypothesized an attentional model of aphasia: under linguistic conditions where attentional demands are reduced, individuals with aphasia should demonstrate increased linguistic performance. Murray showed this hypothesis to be true, especially when tasks demands were minimized due to the automaticity of target responses. These results can account for why some individuals with aphasia have variable performances on linguistic tasks within the same environment.

Aphasia is much more prevalent in elderly persons. Fifteen percent of people under the age of 65 experience aphasia; this percentage increases to 43% for individuals 85 years of age and older (Engelter et al., 2006). Older persons with aphasia may have fewer attentional and/or working memory resources prior to the onset of aphasia and may bring fewer cognitive resources to communication contexts. Murray (1999) reported that as language task demands increased, elders' performance

decreased, but the performance deficits may not have been related to language alone, with age and attentional resources being possible factors.

Understanding the impact aphasia has on attention, as well as the relationship between language and attention impairments in aphasia, is important for providing clinical speech-language pathology services; this knowledge will assist clinicians in appropriate assessment, goal setting, and treatment of persons with aphasia (Murray, 2002; Villard, 2017).

## 6. Purpose of the study

The purpose of the present study was to investigate the relationship between language and attention in elders with nonfluent (anterior) aphasia by employing measures of attention that rely on language comprehension and use and measures of attention that are independent of language comprehension and use. This study obtained multiple case comparative data in order to answer the following research questions:

- (1) Can it be identified whether attention is affected in elders with nonfluent aphasia?
- (2) Is there a trend for how attention is affected in elders with nonfluent aphasia based on the severity of aphasia?

## 7. Methods

### 7.1. Participants

The institutional review board (IRB) of the authors' university approved the recruiting of participants, participant consent, and the study procedures. As criteria for participation, each participant would be English-speaking, have at least an eighth grade education, and would have sustained a left hemisphere stroke resulting in nonfluent aphasia that was diagnosed by a speech-language pathologist (SLP). Participants would not have any other neurological conditions or dementia. Inclusionary age criteria for elders followed the World Health Organization's flexible definition: an elder is an individual 60 years of age or older, but age 60 is somewhat arbitrary ("Definition of an older or elderly person," n.d.). There was no stipulation as to participants' amount of time post onset of aphasia, although this characteristic was obtained.

The first author recruited participants via phone calls and emails to SLPs employed at skilled nursing and long-term care facilities in a large Midwest metropolitan area in the United States in order to obtain referrals to the patients served by these SLPs. The SLPs shared a study synopsis with prospective participants and their families, then, for those who expressed interest, conducted chart reviews to establish the presence of the inclusionary criteria and noted the length of time post onset of aphasia for each participant. The SLPs then provided the researchers with names and contact information for prospective participants.

### 7.2. Materials: Test selection and administration requirements

#### 7.2.1. WAB-R: Screening for aphasia

The western aphasia battery bedside screener-revised (WAB-R; Kertesz, 2006) yields information about aphasia severity and type (fluent or nonfluent). Measures include spontaneous speech (content and fluency), auditory verbal comprehension, sequential commands, repetition, object naming, reading, writing, and motor apraxia. The WAB-R defines severity based on an aphasia quotient (AQ).

#### 7.2.2. TEA: A language dependent measure of sustained and divided attention

The test of everyday attention (TEA; Robertson, Ward, Ridgeway, & Nimmo-Smith, 1994), normed on ages 18–80, includes language dependent measures of sustained attention and divided attention. Murray (2002) stated the TEA is useful in assessing variety of attention functions while utilizing everyday life materials. Murray (2012) used the TEA to clarify the relationship between aphasia and

attention. The TEA uses tasks common to everyday life. The present study employed two TEA subtests. The TEA Map Search provides verbally dictated directions meant to measure sustained attention during two one-minute testing segments. The participant searches a map for a total of two minutes while circling target symbols. When one minute elapses, the participant is instructed to switch colors of markers, which reveals the ability to sustain attention and self-organization after a minor interruption, and allows for performance on the first and second minutes to be compared. The assessment captures the participant's ability to inhibit irrelevant stimuli while attending to a set task. The Telephone Search while Counting subtest uses two tasks. First, the participant searches through a telephone directory and identifies target symbols, applying sustained attention. Second, the participant completes a similar search task while simultaneously counting strings of tones presented on an audio recording, utilizing attention divided. Each part of the test is timed to completion. The participant's accuracy and efficiency on each task are compared. The subtests require limited fine motor skills; each task can be completed by a non-dominant hand and does not require expressive language.

#### *7.2.3. CLQT: A language dependent measure of sustained attention*

The cognitive linguistic quick test (CLQT; Helm-Estabrooks, 2001), normed on ages 18–89, assesses cognitive abilities, such as memory, attention, executive functions, language, and visuospatial skills, in adults with compromised neurological function. Helm-Estabrooks (2002) and Nicholas et al. (2005) utilized the CLQT to study linguistic and nonlinguistic task performance, as well as impaired and intact cognitive functions, in persons with aphasia.

The present study employed two subtests of the CLQT, Symbols Trails and Mazes. Symbol Trails test sustained attention and entails visual attention and processing, selective attention, self-regulation, and ability to regain attention to task after a mistake. Directions are given verbally, taxing receptive language. Participants draw lines between shapes, from smallest to largest, then draw lines connecting alternating shapes, and then draw lines connecting alternating shapes from smallest to largest. Symbols Trails allots training periods to ensure the participant understands the task. The CLQT Mazes, a verbally dictated test of sustained attention, requires completion of two mazes of increasing complexity, revealing the ability to self-monitor, self-correct, inhibit incorrect responses, and recognize the end of a task. Mazes involves going through two mazes without crossing over walls, stopping before the finish point, or deviating from the correct path, and thereby assesses sustained attention. Directions for the CLQT are simple and short. The subtest requires limited motor skills and can be completed with a non-dominant hand.

#### *7.2.4. Leiter-R: A language independent measure of sustained attention*

The Leiter international performance scale revised (Leiter-R; Roid & Miller, 1997), normed on ages 2–20, is a nonverbal test of cognition that provides language independent assessments of sustained and divided attention. The Leiter-R is a test for adults, but there are no norms for the age range under study. The current study reported a raw score criterion measure (total correct items out of total possible items) rather than a standardized measure obtained by comparison to age norms. The test is free of the need for a verbal response.

The Leiter-R Attention Sustained subtest features directions given in the form of gestures and nonverbal cues. The examiner indicates to the participant that he/she should cross out as many of the target pictures as possible in a given amount of time. The test has minimal need for fine motor skill. A teaching trial with cueing ensures the participant's comprehension of the task. Table 1, Subtest Measures, provides a summary and comparison of the characteristics of each test.

### **7.3. Procedures**

All participants were residents of skilled nursing and long-term care facilities and required assistance to perform some or all activities of daily living. Testing was conducted at each person's residence. The first author verbally reviewed the consent form individually with each participant then obtained written consent before testing commenced. Nine persons between the ages of 57 and 79

**Table 1. Subtest measures**

	Measure of language	Measure of sustained attention	Measure of divided attention	Language dependent	Language independent
WAB-R	+			+	
TEA map search		+		+	
TEA telephone search while counting		+	+	+	
CLQT symbol trails		+		+	
CLQT mazes		+		+	
Leiter-R sustained		+			+

**Table 2. Characteristics of participants**

Participant	Age	Gender	Education	Time post onset
A	57	Male	Associate's degree	21 mos
B	79	Female	High school diploma	27 mos
C	67	Male	High school diploma	7 mos
D	74	Male	Some college	220 mos
E	71	Female	High school diploma	26 mos
F	64	Male	Bachelor's degree	54 mos
G	57	Male	High school graduation equivalency diploma	90 mos
H (Refusal)				
I	67	Female	High school diploma	24 mos

gave consent. Participants were given the confidential identifiers A through I sequentially as they entered the study. Participant H withdrew at the start of testing, resulting in a sampling of five males and three females, identified as A–G and I. All had nonfluent aphasia and had been right hand dominant pre-morbidly. Participant demographics are reported in Table 2, Characteristics of Participants.

Each participant's testing session began with the WAB-R, and confirmed that each participant presented with nonfluent aphasia. Then the other subtests were given in random order to avoid testing effects. The WAB-R took approximately 15 min, the TEA Map Search approximately five minutes, the TEA Telephone Search while Counting (sustained and divided attention subparts) approximately 10 min, the CLQT Symbol Trails approximately five minutes, the CLQT Mazes approximately three minutes, and the Leiter-R Sustained Attention subtest approximately seven minutes. With breaks and time for conversational rapport, assessment lasted approximately 90 min per individual.

## 8. Results

To address the first research question, test scores revealed the performance of each individual, such that an interpretation can be made as to whether attention was affected in each of the elders with nonfluent aphasia. Summary statistics reported the group's results. To address the second research question, the trend for how attention was affected in these persons with nonfluent aphasia as based upon their severity of aphasia was explored via interpretive comparisons across the participants' scores and by determining the correlation coefficient for the aphasia severity scores and the attention test scores. Finally, in-depth qualitative interpretations of the performance of each participant yielded within-participant findings as well as multiple case comparisons between participants. These interpretations allow for further responses to each research question.

## **8.1. Language measures**

### **8.1.1. WAB-R**

Individualized administration of the WAB-R yielded an AQ of up to 100 based on the subtest scores divided by six, then multiplied by 10, making the quotient comparable to a percentage correct score. An AQ of 0–25 indicates very severe aphasia, 26–50 is severe, 51–75 is moderate, and 76–100 is mild. Table 3, Participants Ranked by Severity of Nonfluent Aphasia, Based on WAB-R AQ, and Figure 1, WAB-R AQs, depict participants' scores, which ranged from 13.33 to 82.5, with one participant having mild aphasia, one having moderate aphasia, five having severe aphasia, and one having very severe aphasia. The AQ scores followed no trend in regards to age or time post onset of aphasia.

Participants tended to perform best on the Verbal Comprehension subtest, which required answers to yes/no questions of increasing complexity. Scores on Fluency generally hovered around 4 and 5, which denoted nonfluent, effortful, agrammatic responses with some paraphasias and anomia. Scores on the Content and Repetition subtests were lower in persons whose overall severity of aphasia was greater. Scores on the Naming and Sequential Commands subtests showed variability and did not share a trend with aphasia severity. Participants who performed better on the Naming portion independently used auxiliary methods to help themselves produce responses (for example, using gestures to explain an object's traits).

## **8.2. Sustained and divided attention measures**

### **8.2.1. TEA map search**

Subtest scoring information provided in the TEA examiner's manual (Robertson et al., 1994) indicates that the low average score for the number of symbols identified by persons age 50–60 years is 52; the researchers used this number as the criterion for the total number of symbols participants were expected to circle. Participants' scores ranged from 0 to 30 (0–50% accuracy; see Table 4, Participants' Scores on all Measures of Attention). Participant I was unable to complete the test due to the inability to see the symbols on the map.

Comparing participants' performance on the first minute and the second minute, participant F and participant B were able to maintain a similar performance. Participants C and G were able to increase the quantity of symbols found in the second minute. Participant A's performance decreased in the second minute.

### **8.2.2. TEA telephone search while counting**

The TEA Telephone Search while Counting is a two-part timed subtest. The first part obtained the amount of time a participant took to circle target symbols in a telephone directory, measuring accuracy and efficiency under a sustained attention condition. Participants' scores ranged from 0 to 100%. The second part required the participant to repeat the identical task while counting strings of tones presented on a compact disk recording, measuring accuracy and efficiency under a divided attention condition. Participants' scores ranged from 0 to 95%. Table 4, Participants' Scores on all Measures of Attention, depicts the differences in performance under conditions of sustained attention versus divided attention. Participant I's performance remained stable throughout both tasks. Participant G's, participant D's, and participant C's performances suffered in the divided attention task, although these participants did not attempt to count the string of tones, thus demonstrating that they needed to use sustained attention to complete the search task. It took less time for these three participants to circle target symbols in the divided attention task, although their accuracy suffered.

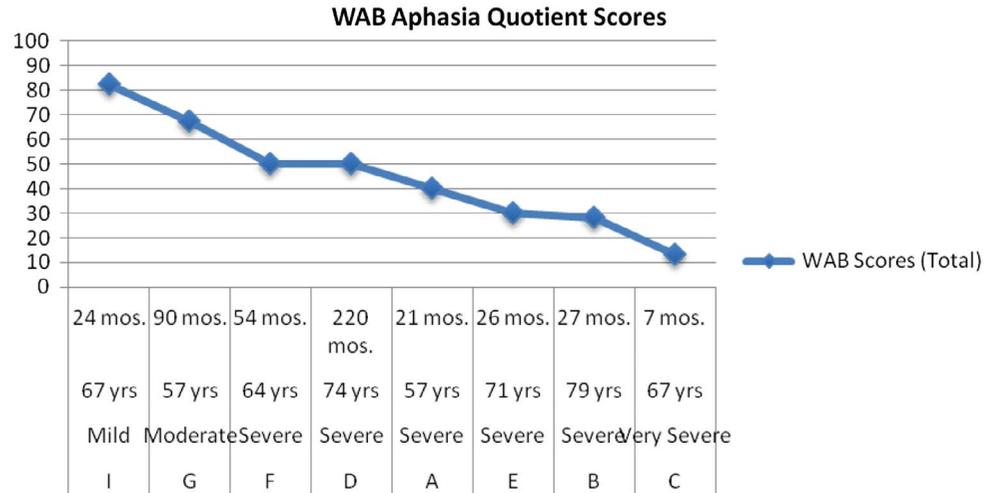
### **8.2.3. CLQT symbol trails**

The CLQT Symbol Trails, a verbally dictated test of sustained attention, has a possible score is 10. Participants' scores ranged from 0 to 100%. Results (shown in Table 4, Participants' Scores on all Measures of Attention) varied across participants; no pattern was seen between performance and aphasia severity, time post onset, or age.

**Table 3. Participants ranked by severity of nonfluent aphasia, based on WAB-R AQ**

Participant	Age	Gender	Time post onset	Quotient (criterion of 100)	Aphasia severity	Content (criterion of 10)	Fluency (criterion of 10)	Verbal comprehension (criterion of 10)	Sequential commands (criterion of 10)	Repetition (criterion of 10)	Naming (criterion of 10)
I	67	Female	24 mos	82.5	Mild	7	5	10	10	9	8.5
G	57	Male	90 mos	67.5	Moderate	6	5	8	4	8	9.5
F	64	Male	54 mos	50	Severe	5	4	8	2	7	4
D	74	Male	220 mos	50	Severe	5	4	7	4	3	7
A	57	Male	21 mos	40	Severe	1	4	9	2	3	5
E	71	Female	26 mos	30	Severe	1	1	9	6	1	0
B	79	Female	27 mos	28.3	Severe	1	4	7	1	2	2
C	67	Male	7 mos	13.33	Very severe	0	0	8	0	0	0

Figure 1. WAB-R AQs.



8.2.4. CLQT mazes

The CLQT Mazes, a verbally dictated test of sustained attention, requires completion of two mazes of increasing complexity. Table 4, Participants’ Scores on all Measures of Attention, shows how well participants obtained the possible scores of up to four points per maze, eight points total. Participants’ scores ranged from 0 to 100%. Participant I and participant B were unable to complete the second maze. Results varied across participants; no pattern was found in relation to participants’ ages, severity of aphasia, or time post onset.

8.2.5. Leiter-R

The administration directions for the Leiter-R, a nonverbal test of sustained attention, describe how to use gestures to direct participants to cross out target symbols. The measure is entirely nonverbal. The highest possible score is 145. Participants’ scores, as shown in Table 4, Participants’ Scores on all Measures of Attention, ranged from 2 to 41%. Participant A, participant F, and participant B revealed their ability to sustain attention. Participant G, participant D, and participant I made a larger number of mistakes, but made fewer wrong selections than correct selections. Participant E and participant C had a larger number of incorrect selections than correct selections.

8.3. Trends for attention scores based on severity of aphasia

Interpretive comparisons allow for exploration of the trends for how attention was affected in these persons with nonfluent aphasia as based upon their severity of aphasia. For purposes of establishing a performance strength, the researchers designated a score of 60% or greater as a higher performance. These scores appear in bold type in Table 4, Participants’ Scores on all Measures of Attention. This designated score is perhaps comparable to a midrange AQ of 60, which denotes moderate aphasia, suggesting that 60% represents a moderate level of skill that is not severely impaired. This is not to suggest that the two 60% metrics are commensurate in any way; it is only to suggest that 60% accuracy is a common representation of a passable performance and shows reasonable performance on measures of attention.

The present data revealed no trend for how attention was affected in this sample of persons with nonfluent aphasia. Only participants I and G, who had mild and moderate aphasia, respectively, had AQs greater than 60, yet participant I had no attention scores that reached 60% and G had only two scores above 60%. Participants with severe aphasia fared better than those with mild or moderate aphasia. Participant F, with an AQ of 50, had one attention subtest score above 60%. Participant D, also with an AQ of 50, had two attention subtest scores above 60%. Participant A, with an AQ of 40, had four attention subtest scores above 60%. Participant B, with an AQ of 28, had two attention subtest scores above 60%.

**Table 4. Participants' scores on all measures of attention**

Participant	Apha-sia severity	MS raw score (criterion of 52)	MS percent of criterion	MS raw score in one minute	MS raw score in two minutes	TS raw score (criterion of 20)	TS percent of criterion	TD raw score (criterion of 20)	TD percent of criterion	ST raw score (criterion of 10)	ST percent of criterion	Mazes raw score (criterion of 8)	Mazes percent of criterion	L-S raw score (criterion of 145)	L-S percent of criterion
I	Mild	N/A	N/A	N/A	N/A	9	45	9	45	3	30	4	50	52	36
G	Moderate	29	56	11	18	15	75	10	50	5	50	8	100	25	17
F	Severe	13	25	7	6	0	0	0	0	4	40	8	100	29	2
D	Severe	0	0	0	0	17	85	14	7	4	40	5.5	69	32	22
A	Severe	26	50	19	7	20	100	19	95	10	100	8	100	59	41
E	Severe	0	0	0	0	0	0	0	0	0	0	0	0	19	13
B	Severe	30	58	16	14	17	85	12	60	5	50	4	50	47	32
C	very severe	2	4	0	2	4	2	1	5	0	0	0	0	24	17

Notes: TEA map search (MS), TEA telephone search while counting—Sustained attention (TS), TEA telephone search while counting—divided attention (TD), CLQT symbol trails (ST), CLQT Mazes, Leiter-R sustained (L-S).

Participant I was unable to complete MS due to inability to see the symbols. Bold type indicates a score of 60% or greater.

**Table 5. Participants' relative strengths and weaknesses**

Participant	Language skills	Attention skills
I	+	-
G	+	-
F	-	-
D	-	+
A	-	+
E	-	-
B	-	+
C	-	-

Notes: A + sign indicated a strength. A - sign indicates a weakness.

**Table 6. Correlations between the WAB-R AQ and attention subtest scores**

	MS	TS	TD	ST	Mazes	L-S
WAB-R	0.36	0.24	0.24	0.25	0.54	0.21

Notes: TEA map search (MS), TEA telephone search while counting-sustained attention (TS); TEA telephone search while counting-divided attention (TD), CLQT symbol trails (ST), CLQT Mazes, Leiter-R sustained (L-S).

In sum, as depicted in Table 5, Participants' Relative Strengths and Weaknesses, for participants I and G, language appeared to be a strength when compared to attention. In three other participants, D, A, and B, all with severe aphasia, attention appeared to be a strength when compared to language. For participants F and E, with severe aphasia, and participant C, with very severe aphasia, neither language nor attention appeared to be a relative strength. Based on these interpretive comparisons, it cannot be said for certain that participants' reduction in attention is related to having aphasia or is commensurate with the severity of their nonfluent aphasia.

#### **8.4. Correlations between attention subtest scores and the WAB-R AQ**

In order to explore whether the trends showed any statistical weight, a Spearman Rank Order Correlation was calculated for each of the percentage scores for the attention subtests in relation to the WAB-R AQ. The correlations, shown in Table 6, Correlations between the WAB-R AQ and Attention Subtest Scores, were insignificant ( $p > 0.05$ ).

#### **8.5. Multiple case comparisons of the participants' language and attention measures**

The following within-participant descriptions show how each participant presented with a unique pattern of performance. Comparisons across these cases suggest that attention might be differentially affected in persons with nonfluent aphasia. The cases are presented in order of aphasia severity, from the least to the most severe.

##### **8.5.1. Participant I**

Participant I was a 67-year-old female with mild nonfluent aphasia who was 24 months post onset. The WAB-R revealed some word finding difficulties and paraphasias; overall, she spoke using mostly content words with missing grammatical markers. Participant I answered yes/no questions, followed directions, and repeated phrases.

On the sustained attention portion of the TEA Telephone Search, she attended to detail and systematically carried out the search, although she did so inaccurately. On the divided portion of the TEA Telephone Search, she attempted to count the auditory tones but had to stop searching for symbols while she counted and was unable to accurately count tones. During the CLQT Symbol Trails and CLQT Mazes, she was aware of when she made a mistake, but was unable to bring her attention (or her motivation) back to the task. She gave up on completing both CLQT subtests. On the sustained attention subtests, she demonstrated good self-awareness. Participant I accurately

completed the first two trials of the Leiter-R Attention Sustained subtest in an organized fashion. Once the symbols became more complex, she was unable to attend to the target pattern as a whole. In sum, her language appeared to be a strength as compared to her attention.

#### *8.5.2. Participant G*

Participant G was a 57-year-old male with moderate nonfluent aphasia who was 90 months post onset. The WAB-R revealed that his language contained mostly nouns and limited verbs. Participant G could provide the main idea of a message, but he was unable to provide full explanations with details. He required ample time to respond to questions and converse. He answered yes/no questions and could partially complete the Sequential Commands portion of the WAB-R with repetition of directions. He completed the repetition subtest but with word omissions and paraphasias as the complexity of the phrases increased.

Participant G achieved higher than 60% on the WAB-R, the CLQT Mazes, and the TEA Telephone Search Sustained. He completed the TEA Map Search accurately and efficiently, increasing his rate of symbol identification through the second minute of the task. On the TEA Telephone Search Sustained, he methodically looked for one target symbol at a time. He did miss some symbols. During the TEA Telephone Search Divided, he did not search for the symbols separately. Also, he attempted to count tones while searching, but gave up after the second string. Participant G presented with affected attention skills, both sustained and divided.

During CLQT Symbol Trails, participant G completed the practice trials with 100% accuracy, but he became overwhelmed during the testing trial. He was unable to regain attention to the task. He accurately completed CLQT Mazes, although the second, more complex maze took him the given two minutes to complete. He demonstrated sustained attention throughout the Leiter-R Sustained, but required prompts to continue work when he came to the end of each line. When shape patterns became more complex, he treated each shape as a different entity instead of looking at the pattern as a whole. In sum, his language appeared to be a strength as compared to his attention.

#### *8.5.3. Participant F*

Participant F was a 64-year-old male with severe nonfluent aphasia who was 54 months post onset. The WAB-R revealed that participant F used some content words to give partial answers to questions. He answered yes/no questions, although he demonstrated increased difficulty when questions became complex. He had difficulty naming objects, but independently used gestures to help himself recall words. He had difficulty accurately completing Sequential Commands, and could only repeat single words and simple sentences.

Participant F demonstrated difficulty with both language and attention tasks, with performance being somewhat comparable. He exhibited adequate sustained attention, although with a longer processing time, which affected his ability to complete tasks efficiently. He systematically searched during the TEA Map Search. He was unable to complete the TEA Telephone Search; he told the examiner that he was unable to tell the difference between the symbols on the test materials. As such, there is no measure of divided attention for him. He did not show awareness of the mistakes he made on the CLQT Symbol Trails. He accurately completed both CLQT Mazes. He completed the Leiter-R in an organized fashion and did not make any mistakes. He demonstrated awareness that the tasks of increasing complexity would be more challenging, and worked slowly to ensure accuracy. In sum, Participant F achieved above 65% solely on the CLQT Mazes, and his overall attention skills were not strong. Neither language nor attention was a relative strength.

#### *8.5.4. Participant D*

Participant D was a 74-year-old male with severe nonfluent aphasia who was 220 months post onset. The WAB-R revealed that participant D had slow, effortful speech comprised of only content words. He communicated the main points of his messages using nouns, but was unable to use verbs and function words to provide a full message. He required repetition of directions for the Verbal

Comprehension and Sequential Commands portions of the WAB-R. He adequately completed both tasks and demonstrated self-awareness when he was not able to respond correctly. He was only able to repeat one-word phrases.

Participant D did not understand how to complete the TEA Map Search, even when given supplemental instruction. He accurately completed the sustained portion of the TEA Telephone Search, but his performance suffered on the divided attention portion. He did not attempt to count the string of tones. On the CLQT Symbol Trails, he was unable to identify some symbols. He planned out his moves before completing the task, but showed no self-awareness of the mistakes he made. Participant D was able to complete the first of the CLQT Mazes accurately and efficiently. For the second maze, he took incorrect pathways and mentioned he wished he could erase the lines. He did not recognize when he had finished. On the Leiter-R Sustained Attention Subtest, he completed the first two tasks (single symbols) in an organized fashion. On the last two tasks (when the target became symbol patterns), he demonstrated difficulty recognizing correct patterns, and his organization decreased.

In sum, Participant D appeared to have better attention skills than language skills, although his overall attentional skills were not strong. Perhaps some elements of visual processing and/or selective attention may have prohibited him from accurately completing some tasks.

#### *8.5.5. Participant A*

Participant A was a 57-year-old male with severe nonfluent aphasia who was 21 months post onset. He exhibited anxiety throughout testing but declined offers to discontinue. The WAB-R revealed that participant A had effortful, agrammatic speech with a limited repertoire of words and phrases. He had severe anomia, especially during conversational speech. He required ample processing time during conversation and repetition of WAB-R directions. He struggled with completion of the Repetition and Sequential Commands tasks.

Participant A demonstrated little difficulty with attention tasks. He completed the TEA Map Search accurately and in an organized fashion, but used ample processing time. He required repetition of directions for the TEA Telephone Search, but accurately completed symbol identification in sustained and divided attention conditions. He did not accurately count the strings of tones, and said “end” instead of providing a number at the end of the strings of tones. He completed the CLQT Symbol Trails and Mazes accurately and efficiently, maintaining concentration throughout. He completed the Leiter-R Sustained Attention with no mistakes but required ample processing time. In sum, Participant A appeared to have better attention skills than language skills.

#### *8.5.6. Participant E*

Participant E was a 71-year-old female with severe nonfluent aphasia who was 26 months post onset. The WAB-R revealed that she had anomic, effortful speech with apraxic-like symptoms, stereotypic utterances, and meaningful intonation. She demonstrated comprehension and adequately completed Verbal Comprehension and Sequential Commands, but was unable to complete Repetition due to imprecise, effortful articulation and paraphasias.

Participant E demonstrated difficulty completing the attention subtests primarily due to impulsivity. The TEA Map Search began with practice pointing to target symbols on a map, which she did accurately, but when given a pen, she drew lines haphazardly. On the TEA Telephone Search, she was distracted by the names of the businesses on the testing material and was unable to complete the sustained attention portion of the subtest. The divided attention portion was not attempted. On the CLQT Symbol Trails, impulsivity prevented her from completing the directed pattern. On the CLQT Mazes subtest, she traced the first maze to completion with her finger, but, when given a writing utensil, she colored in the mazes, even after directions were repeated. Participant E demonstrated difficulty understanding the nonverbal directions given in the Leiter-R Sustained Attention. She attended to the task, but did not discriminate between shapes. In sum, neither her language nor attention was a relative strength.

#### 8.5.7. Participant B

Participant B was a 79-year-old female with severe non-fluent aphasia who was 27 months post onset. The WAB-R revealed that she had agrammatic, effortful speech. She had difficulty accessing correct vocabulary and used word substitutions. She relied on a repertoire of three phrases to communicate. She required repetition of directions and ample processing time. Verbal Comprehension revealed her difficulty comprehending complex yes/no questions. She exhibited difficulty completing Sequential Commands and Repetition.

Participant B demonstrated some difficulty completing most of the attention subtests. She accurately completed the TEA Map Search without becoming distracted. She successfully completed the sustained attention portion of the TEA Telephone Search, but not the divided attention portion. She attempted to count tones while circling symbols at the beginning of the task, but she demonstrated awareness that she could not complete both activities and ceased counting tones. She did not exhibit awareness of the mistakes she made on the CLQT Symbol Trails. She completed the first maze of the CLQT Mazes accurately. On the second, more complex maze, she was aware that she could not complete the activity and drew an outline around the maze. She self-corrected her mistakes during the Leiter-R Sustained Attention, but demonstrated difficulty locating symbol patterns once the task increased in complexity. However, attention skills were a strength in relation to language skills.

#### 8.5.8. Participant C

Participant C was a 67-year-old male with very severe nonfluent aphasia who was 7 months post onset. The WAB-R revealed that he used short, sometimes stereotypical and/or non-propositional utterances, such as “yes, yes, yes.” He adequately completed Verbal Comprehension but was unable to follow sequential commands, repeat verbally presented phrases, or name objects.

Participant C demonstrated difficulty completing all attention subtests, but language comprehension deficits may have had an impact. On the TEA Map Search, he did not refer to the target symbols but rather drew meaningless circles over the map. On the TEA Telephone Search, he was distracted by the names on the test materials and rarely referred to the symbols. On the divided attention portion of the TEA Telephone Search, participant C stopped searching through the test template in order to listen to the tones and responded “yes” after each string of tones. He completed the CLQT Symbol Trails but was unable to follow the necessary pattern. He could not correctly complete the CLQT Mazes. He drew random dots throughout the mazes. Participant C demonstrated comprehension of the Leiter-R Sustained Attention directions, but could not inhibit his selection of symbols other than the target. His search through the template was unorganized and haphazard.

Participant C did not achieve above 65% on any subtest and his overall attentional skills were not strong. In sum, neither his language nor attention was a relative strength.

### 9. Discussion

Regarding the first research question, whether attention is affected in persons with nonfluent aphasia, this investigation found that persons in this sample evidenced difficulty completing attention tests and obtaining criterion scores. Each of the eight participants had the opportunity to complete six measures of attention, yielding 48 scores that were represented as percentage correct of criterion. Removing the one instance of the TEA Map Search that Participant I simply could not see, there remained 47 opportunities for participants to score at or above the 60% correct criterion. On only 11 opportunities did participants score at or above the criterion, which means that 23% of the time tests yielded a performance at or above criterion. Seventy-seven percent of the time tests did not yield a score at or above criterion. However, these data only revealed that participants exhibited diminished attention. It remains uncertain whether participants' reduction in attention was related to having aphasia.

Pertaining to the second research question, which explored whether there is a trend for how attention is affected in persons with nonfluent aphasia based on the severity of aphasia, this investigation found no trend. No statistical correlation was obtained. Nor did multiple case comparisons yield a trend. Performance was too variable across participants to establish a trend (and sometimes performance was highly variable within participants as well).

## 10. Implications

The variability observed allows for the current findings to contribute to the study of the relationship between attentional abilities and aphasia and to the practical treatment of elders with nonfluent aphasia. The finding that attention was shown to be affected to varying degrees in elders with nonfluent aphasia supports the many definitions of aphasia that implicate possible deficits in the cognitive processes that interface with language (e.g. Darley, 1982; Ellis & Young, 1988; McNeil, 1988; Murray & Chapey, 2001; Murray et al., 1997; Villard & Kiran, 2015). The current findings coincide with prior studies (Fridriksson et al., 2006; Nicholas et al., 2005; Purdy, 2002) that revealed that persons with aphasia may exhibit some characteristics of impaired executive function. The variability discovered herein is consistent with prior findings; for example, Villard (2017) described several accounts of fluctuations in intra-participant performance on tasks of attention and language. Vallila-Rohter and Kiran (2013) concluded that persons who appear to have a higher level of language competency do not necessarily have intact cognitive systems. Helm-Estabrooks (2002) stated that language test scores cannot predict the severity of cognitive deficits in persons with aphasia.

It might be possible to question whether a central bottleneck may be a factor in the slow processing time seen in this sample of persons with nonfluent aphasia. Murray (1999) stated that an individual cannot effectively complete a task if the task's demands exceed an individual's capacity or if an individual's resources are not appropriately used. The attentional system may not be able to automatically prioritize information, which may slow the time it takes to complete a task.

The results of the current study may contribute to the practical treatment of elders with nonfluent aphasia. The importance of an individual's ability to attend and learn is critical to successful interventions (Vallila-Rohter & Kiran, 2013). As Basso (2003) proposed, clinicians should consider factors other than language impairment that may affect recovery of language skills. Resources for assessment of executive functions (Mueller & Dollaghan, 2013), including impairments of attention, provide clinicians with methods for examining the interface of language and attention. Clinicians need to account for an individual's attentional skills and shortcomings and use this knowledge to appropriately plan and execute therapy services.

## 11. Limitations of the current study

The study had several limitations, most notably a small sample size that resulted in a limited amount of test data. All participants were not able to complete all subtests, thus reducing the data-set. Testing was one-shot, such that the reliability of participants' skills was not ascertained. Other than having nonfluent aphasia, the participants were not a homogeneous group in terms of their other characteristics, such as age, gender, severity of aphasia, and time post onset of aphasia. A more homogenous sample may yield less variability in performance.

Some of the attention testing may not have strong construct validity. Certain subtests relied on additional cognitive processes beyond attention, which may have interfered with obtaining discrete measures of attention. The validity of the Leiter-R measure of nonverbal divided attention was possibly hampered by some participants' reliance on language to complete the task. However, in sum, the researchers took care to safeguard validity by documenting detailed within-participant descriptions that showed how each participant presented with a unique pattern of attentional performance. As such, the construct of attention was observed and reported upon in depth.

## 12. Directions for future research

The interface of language and attention is still not fully understood. Whether aphasia disrupts the mechanisms of attention or solely disrupts the use of the language needed to bring attentional resources to bear during tasks is as yet unknown. Specific aspects of attention in persons with aphasia, for example, focus, selectivity, prioritization, and inhibition (Hula & McNeil, 2008) lend themselves to detailed studies. The processes needed for fluent spoken language may rely on rapid access to cognitive resources, such as attention. Given these questions and a number of other possibilities, the study of attention skills in persons with aphasia merits considerable future consideration.

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The authors declare no competing interest.

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