The Effect of Word Context on the Reading Ability of Individuals with Aphasia and Acquired Alexia

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Word List Vs. Sentence Context Reading in Aphasia

ABSTRACT

Some individuals with acquired reading impairments (alexia) can read words in sentence contexts easier than in list format. It has been proposed that this may be due to relatively intact sentence production processes (Mitchum et al., 2005). In this project, we investigated this hypothesis in five individuals with fluent aphasia and acquired alexia. Participants read aloud words varying in part of speech (nouns, verbs, adjectives, functors) in sentence and list contexts; sentence production skills were quantified using the Quantitative Production Analysis (QPA; Saffran et al., 1989) on discourse samples. A 2 (context condition) x 4 (word type) ANOVA was used to determine a) if sentence contexts facilitate word reading, and b) which word types are facilitated. A regression analysis examined the relationship between QPA and reading accuracy in both contexts.

Context (list vs. sentence) had a significant effect on word reading accuracy in only one of the five individuals in this study. Participants with aphasia were less accurate at reading verbs than functors in both list and sentence contexts. Results of the regression analysis revealed that the mean length of utterance in the discourse samples significantly predicted the accuracy of word reading in sentences.

Only one participant demonstrated a context effect in reading words. This participant also had a much slower reading rate than the others in the group, which may have contributed to this effect. Further research studies are needed to better characterize the nature of context effects in reading.

INTRODUCTION

In order to be a functional member of society, one must be able to read with a substantial degree of efficiency. Everyday living requires literacy, and the increasing electronic communication channels such as texting, internet, and e-mail, make reading even more pivotal to one's ability to function. Any reading disability is therefore a significant problem to those who suffer from it.

In normal reading, there are typically two routes through which a word is read orally:

1) In the direct route, the person carries out visual analyses then accesses the word's representation in their "visual word store or orthographic lexicon" (Cherney, 2004). The semantic representation or meaning of the word is accessed, and then its pronunciation is determined by the phonological processor and the word is then read aloud. This process allows for quickly accessing and "sight-reading" familiar words.

2) In the indirect route, unfamiliar words are read using grapheme-to-phoneme correspondence rules. These rules allow the reader to pronounce the word based on the sounds that each letter (or group of letters, i.e. 'ch') makes. This route is also known as the non-lexical or sublexical route, because the unfamiliar word has not been stored in the reader's orthographic or semantic word stores. This process can be used for reading words that are spelled regularly, or unfamiliar words that can be pronounced by "sounding" it out.

Three types of reading deficits are identified by Cherney (2004) that result from damage to any of the components along the reading routes described above. They are described as follows:

1) ***Surface alexia*** is caused by damage to word representations in the orthographic lexicon. Because of this deficit, a person is likely to read words using grapheme-phoneme (letter-to-sound) conversion mechanisms. Although words with regular spelling correspondences can be read accurately, irregularly spelled words, such as “yacht”, or “knife” are often read incorrectly.

2) ***Phonological alexia*** is characterized by an inability to use the grapheme-phoneme conversion. A person with phonological alexia needs to rely on the recognition of the whole word. As a result, these individuals have difficulty reading unfamiliar or non-words. So, for example, a non-word such as “flig” may not be readable to a person with phonological alexia because they do not have a whole-word representation for it. These individuals may substitute a real word (e.g. “fig” or “flag”) when reading nonwords.

3) ***Deep alexia*** involves an inability to decode words using both the orthographic lexicon and the letter to phoneme correspondence. As such, the reader shows the same deficits as those found in phonological alexia, as well as having difficulty reading unfamiliar words.

While cognitive models for reading can be useful for understanding single word reading, they do not account for reading text. Because text reading is generally the ultimate goal of rehabilitation of individuals with acquired alexia, exploration of factors that can improve reading in these individuals is very important.

Acquired reading impairments (alexia) associated with left-hemisphere damage are often the central focus of aphasia treatment. There are numerous types of treatments available to these individuals, including sound-letter conversion training (phonological awareness), homophone training, cross-modality training and text-based reading. Text-based reading is an

effective treatment for most types of alexia for many reasons. Thompson et al. (2003) have proposed the Complexity Account of Treatment Efficacy (CATE), which suggests that language training in complex structures is more likely to generalize to simpler structures. Also, because the goal of reading treatment is to be able to read text, using a text-based strategy in treatment may be more efficient. Clients who are receiving therapy for alexia may also benefit from text-based treatment simply because it feels as though they are moving forward more quickly than if they begin at a grapheme-phoneme level.

Text based reading treatments have been shown to be quite effective for a variety of alexia subtypes (see Cherney, 2004 for a review). Cherney (2004) presents two case studies of individuals with phonological alexia and deep alexia who were treated using Multiple Oral Rereading (MOR: Moyer, 1979; Beeson, 1998) and Oral Reading for Language in Aphasia (ORLA: Cherney et al., 1986), respectively. In both of these cases, the participants benefitted from treatment, demonstrating increased reading rate and comprehension. Additionally, the individual with deep alexia demonstrated generalization "to other language modalities," including the spoken language domain. In another case study of text-based reading treatment, Mayer & Murray (2002) alternated text-based reading treatment using a modified version of MOR with treatment targeting attention and working memory for an individual with acquired alexia. The participant in this study also improved in speed and comprehension of reading skills. Although exact mechanisms of improvement following text-based reading treatments are unclear, Beeson and Insalaco (1998) suggest that it may be due to "improved word-form recognition due to the top-down influence provided by the semantic and syntactic context" (p. 623). However, it has also been argued that improved reading is due to overlap in words

between trained and untrained passages (Lacey et al., 2010). Although opinions differ, the notion of context effects facilitating the reading of individuals with acquired alexia is one that requires further examination.

Text-based reading is somewhat more natural than reading word lists because it follows natural language patterns in structure. Reading word lists is less natural, because although it requires similar processing, it does not follow these language patterns. Because of this, we might hypothesize that readers would find it easier to read words when they are situated in text than in word lists. Although evidence of a "context effect" (i.e., more accurate/faster word reading when in text than in lists) exists (Andreewsky & Seron 1975; Mitchum et al., 2005; Silverberg et al., 1998), not all individuals with alexia demonstrate this effect (Katz & Lanzoni, 1992; Friedman, 1996). The question, then, is why is it not always easier to read words in sentence context rather than in lists? Are there certain characteristics of the reader or of the reading material that contribute to this context effect?

Further, some investigators have proposed that it may be only certain types of words that are facilitated by being situated in text. Silverberg et al. (1998) discuss a "grammatical category effect" in terms of three categories: *open class* (i.e., nouns, adjectives and verbs), *bound closed class* (i.e., bound morphemes), and *free closed class* (i.e., function words). In the case of deep alexia, they note that when the participants read closed class words from a list, their errors were more likely to be words from within that same class. The authors found that "the grammatical category of substitution errors on closed class items was constrained by sentential context, in only one of [their] patients" (pg. 348). They concluded that the reason some patients can more readily retrieve closed class items is that they have relatively intact

grammar; that is, they have the syntactic "frame" in mind, and can determine that only certain types of words will be able to fit within the constraints of the framework.

Along these same lines, Mitchum et al. (2005) hypothesized that "alexic patients with relatively intact sentence production skills, and some ability to read isolated function words, may show improved reading of words in sentences compared to lists" (P. 618). If this is the case, then a patient who is able to produce relatively grammatical sentences would be able to read better in sentences, based on their knowledge of syntactic frames. In their study, Mitchum et al. (2005) assessed sentence production ability in five participants with aphasia by having each participant recite the story of Cinderella to the best of their ability. The Quantitative Production Analysis (QPA; Saffran et al., 1989; Rochon et al., 2000) was used to transcribe and score their stories. The participants were then asked to read 100 words in list format, and 28 meaningful sentences that had been generated using the same words. Mitchum et al. (2005) found that two of their five participants demonstrated a context effect. These two participants did indeed have very good sentence production, however, there was another participant whose sentence production was as good, but who did not read words significantly better in sentence context. To determine why this might have been, Mitchum et al. (2005) reviewed many different aspects of the correct productions in both the word lists and the sentences. They found that intact sentence production along with intact knowledge of grammatical class seemed to work together to allow a patient to read words more accurately in sentences than in word lists. The two patients who showed the context effect noted above also showed a grammatical class effect, in which their errors within the context of sentences were more likely constrained to the grammatical class of the target word. Mitchum et al. (2005) concluded that,

"knowledge of grammatical class was argued to improve patients' reading by combining with other influences (e.g., orthographic structure, imageability) to substantially reduce the number of candidate word responses." (p. 615).

In an earlier study by Silverberg et al. (1998), three participants with deep alexia whose "spontaneous speech reflected some retained ability to produce grammatical utterances," (p. 343) were considered. The participants were presented with text, and with a word list based on the same text to read aloud. According to the authors, all three patients showed a context effect, and the effect was more likely for more constrained grammatical classes.

Given the evidence that some individuals with aphasia display a context effect during oral reading, and this appears to be related to grammatical class of words, the purpose of this study was to examine these phenomena in a group of individuals with fluent aphasia. The purpose of this study was to answer the following three questions: 1) Is there a context effect for reading words in sentences vs. reading words in lists for people with acquired aphasia who have good sentence production?, 2) If there is a context effect, does part of speech play a role?, 3) What are the contributions of sentence production skills to presence/absence of context effect in reading?

METHOD

Participants

10 participants were included in this study; 5 were diagnosed with fluent aphasia and 5 were healthy controls, matched to the first group based on age, sex and education level (refer to Table 1 for details). All participants were between 35 and 66 years old (mean of participants

with aphasia = 52.6; mean of controls = 52.6) and their education levels ranged from 8 - 18 years (mean of participants with aphasia = 11.6; mean of controls = 13.6). All of the individuals with aphasia were more than 2 years post-onset, with a range of 3 to 22 years. The spoken language abilities of the participants with aphasia was characterized by administering the Western Aphasia Battery – Revised (WAB-R; Kertesz, 2006). The average Aphasia Quotient of participants was 80.4, ranging from 65.9 to 96.7.

Table 1: Participant Demographics

Aphasia group	Age (years)	Gender	Education level (years)	Time Post Onset (years)	Aphasia Quotient
JM	41	M	12	8	83.2
GZ	55	M	14	22	76.7
RD	66	M	8	4	65.9
TH	66	M	8	3	79.5
CS	35	F	16	4	96.7
Average	52.6	4M/1F	11.6	8.2	80.4
Control group	Age	Gender	Education level	Onset	
DS	54	M	14	N/A	N/A
NS	52	F	14	N/A	N/A
SS	58	F	12	N/A	N/A
BS	59	M	18	N/A	N/A
GF	40	M	10	N/A	N/A
Average	52.6	3M/2F	13.6	N/A	N/A

Assessment

In order to characterize each participant's reading performance, the following tests were administered:

The Arizona Battery for Reading and Spelling (ABRS; Beeson et al., n.d.) is a list of 40 regular and 40 irregular words (balanced for frequency, length, and imageability), and 20

pronounceable nonwords. This list was administered to characterize alexia profile of individuals with aphasia.

Gray Oral Reading Test – 4th Edition (GORT-4; Wiederholt et al., 2001) (Levels 1-5) is a reading assessment that measures oral reading rate (words per minute), accuracy (number of deviations from print), and comprehension (measured with multiple-choice questions at the end of each story). Only levels 1-5 were included in our analysis due to the fact that these were levels achieved by all of the participants.

Reading Comprehension Battery for Aphasia – 2nd Edition (RCBA-2; LaPointe & Horner, 1998) is an assessment that evaluates reading comprehension for words, sentences and paragraphs in adults with aphasia. The RCBA was administered solely to the aphasia group.

Experimental Tasks

All participants completed the following experimental tasks: Word List reading, Sentence reading, and discourse production. Control participants completed all assessment and experimental tasks on the same day, while individuals with aphasia completed assessment and experimental tasks on separate days as part of their participation in a larger study.

Stimuli. A set of 60 target words (15 adjectives, nouns, verbs and functors) were used as experimental stimuli in this study (see appendix A). The words were matched on length, number of syllables, and frequency of the word (see Table 2), with the exception of functors. Functors occur more frequently than all other parts of speech in the English language, and thus could not be matched to the other parts of speech in this regard. The verbs included were made up of both regular and irregular verbs and were all in past tense. The words were also not matched for imageability across the four parts of speech. Due to the fact that not all words had

available imageability values, these data were collected by having 52 graduate students at the University of Alberta rate each word on a scale of 1 (not imageable at all) to 7 (very imageable).

Table 2: Lexical characteristics of word stimuli

	Functors	Adjectives	Nouns	Verbs
Word length (in letters)	5.50	5.27	5.73	5.64
Number of syllables	1.79	1.47	1.67	1.14
Frequency (in occurrences per million words)	2219.18	146.44	126.38	112.23
Imageability	2.39/7	4.65/7	6.36/7	6.85/7

List Reading. In the list reading condition, E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA) was used to present single words to participants, who were instructed to read the words aloud. A fixation cross was presented for one second before the word appeared in the centre of the screen. Responses were recorded by voice key and were scored online as accurate, inaccurate, or self-corrected. Timing began as soon as the word was presented, and reaction time was recorded as soon as they made a response. Accuracy of the spoken words and reaction times were recorded for all participants. Reaction times from participants' false starts and self-corrections were not included in the analyses, but these responses were counted in terms of accuracy data. A mean reaction time and standard deviation was calculated for words within each category, and outliers (+/- 2 standard deviations from the mean) were also omitted from the results. Table 3 shows the percentage of words that were omitted by part of speech due to false starts, self-corrections or outliers for each of the participants:

Table 3: Percentage of words omitted from reaction time calculations

Aphasia group	Adjectives	Functors	Nouns	Verbs
JM	10 %	3 %	7 %	5 %
GZ	15 %	7 %	15 %	20 %
RD	10 %	3 %	7 %	18 %
TH	10 %	10 %	8 %	13 %
CS	3 %	7 %	3 %	3%
Control group				
DS	2 %	3 %	2 %	3 %
NS	2 %	2 %	0 %	2 %
SS	0 %	3 %	3 %	3 %
BS	0 %	2 %	2 %	0 %
GF	0 %	2 %	2 %	2 %

Sentence Reading. The stimulus sentences contained the same target words as those found in the word list (refer to appendix A), and were composed so that the stimulus words did not fall at the beginning or the end of the sentence, as these are regions known to affect the validity of eye movements (Rayner, 1998). Sentences were presented on a single line on a computer monitor and participants were instructed to read the sentence aloud. A fixation cross was presented for one second, and then the sentence appeared. Reaction time values for stimulus words were not calculated in the sentence context condition. Scoring was marked as either correct or incorrect for each word within the sentence, including the target word.

In reviewing the sentences, it was noted that the word “like”, which was to be listed as a functor, was in verb form, and that there was no sentence with the word “liked”. As such, these words were not analyzed as a part of the data in the word lists or the sentences. As a result, there were only 14 verbs and functors. A list of the words and sentences used in this study can be found in Appendix A and B.

Discourse Analysis. Sentence production skills were quantified using Quantitative Production Analysis (QPA; Saffran et al., 1989; Rochon et al., 2000). This system is used to

quantify the structural complexity and grammaticality of narratives produced by individuals with aphasia. In this study, only the "structural measures" portions of the QPA (see Table 6) were analyzed. When collecting the discourse sample, a spoken segment of at least 150 words was required for analysis. In order to ensure that this requirement was met, each participant was asked to produce three separate discourse samples: the first sample was a story retelling (Cinderella). The second discourse sample was a picture description, using "The Birthday Party" scene (Nicholas & Brookshire, 1993), and the third sample was a procedural description of how to wash dishes. All three discourse samples were videotaped for accurate transcription and analysis.

Each speech sample was transcribed and segmented for QPA assessment, adapted from the guidelines outlined by Saffran et al. (1989). Table 4 provides samples of discourse productions and how the samples were extracted based on QPA rules.

Table 4: Transcription and extraction of two speech samples

Cinderella story before application of extraction rules:	
RD: He's uh on its always...yeah one time ago there was a a daughter and her dad...And they were were were ma ma they were... his ma ma ma his dad got married to a lady and two kids... Girls... And then what happened was he went and he got killed… and after a while the lady was not very good	TH: The the story about inder-cella was uh she she she worked in a place with a couple of uh her sisters um uh to do work all the time and they heard about about this this about everybody come to have a ball and and uh she ended up uh she had to stay here and the other one's left her didn't want her to go, eh
Cinderella story after application of extraction rules:	
RD: [One time ago there was a daughter and her dad] [his dad got married to a lady and two kids] [what happened was he went] [he got killed] [after a while the lady was not very good]	TH: [The story about indercella was she worked in a place with a couple of her sisters to do work all the time] [they heard about where everybody come to have a ball] [she had to stay here and the other ones left her] [didn't want her to go]

Reliability

Three individuals listened to the participants' responses in the oral reading of words and sentences and scored them based on the above methods. Discrepancies were reviewed and a score was assigned based on consensus. The QPA analysis was conducted by two individuals working together, discussing and reviewing the results for the above transcription and analysis methods. A third individual reviewed approximately 40% of the discourse samples to ensure that transcription, extraction, and analysis was consistent between participants.

RESULTS

Reading Assessment

Total word reading accuracy and non word reading accuracy were derived from the ABRS assessment. The GORT-4 was used to establish the participants' average reading rate (in words per minute) and average reading accuracy (in errors per 100 words). The RCBA provided reading comprehension scores. Overall, participants with aphasia demonstrated slower, less accurate single word and text reading relative to controls. Refer to Table 5 for the results of these reading assessments.

The ABRS was used to assess each participant's alexia profile: two participants (GZ and RD) demonstrated profiles consistent with phonological alexia, one participant (JM) presented with surface alexia, and one participant (TH) had a mixed surface and phonological alexia. The final participant (CS) produced too few errors to classify a specific alexia type, yet still demonstrated impaired reading relative to controls so she was characterized as having "residual alexia" (after Schattka et al. 2010).

Table 5: Reading Assessment results

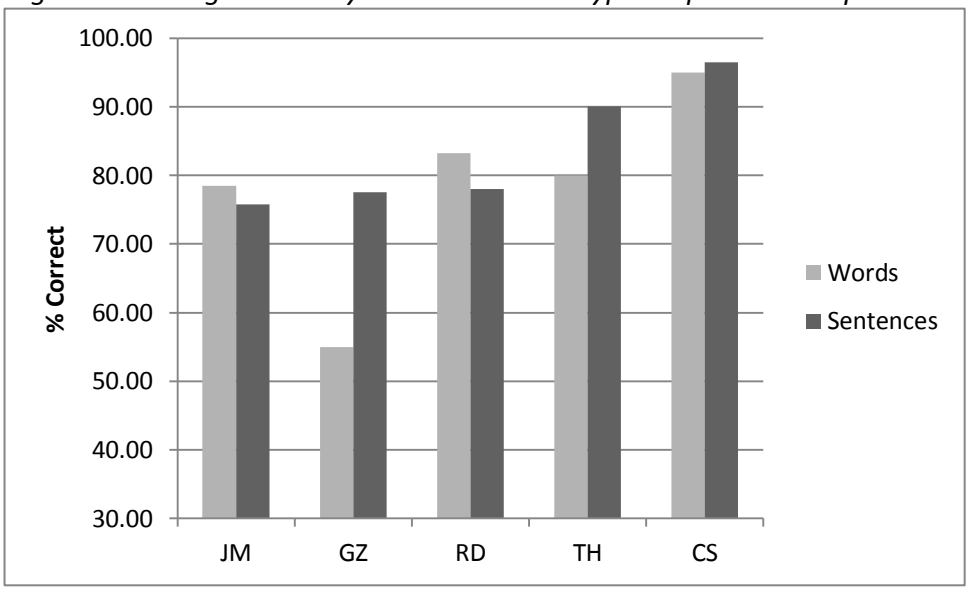
	ABRS total (%)	ABRS Non Words (%)	Avg. reading rate (WPM)	Avg. reading accuracy (errors/100wds)	RCBA total (out of 100)
JM	71	60	75.54	12.34	93
GZ	63	40	27.22	11.5	90
RD	55	15	85.96	5.76	82
TH	78	60	60.04	7.14	75
CS	97	85	178.79	0.78	95
Average for controls	100	100	193.76	0.35	N/A

Effect of context on word reading accuracy

The percentage of words read accurately was calculated for both list and sentence contexts ("word list" accuracy and "word-in-sentence" accuracy, respectively). In this study, we attempted to measure reaction time for all participants during the word list reading task, and the sentence reading task. We chose to focus on accuracy rather than reaction time for two reasons: (1) Many of the participants' reaction times were delayed, and thus omitted, because they did not speak loudly enough for the microphone to pick up, and (2) A reliable reaction time measure for the same words in sentences was not attainable. Figure 1 presents overall reading accuracy for words in list vs. sentence context for each individual in the aphasia group. A 2 (group) x 2 (context) repeated measures ANOVA revealed a significant group difference for word reading accuracy overall, $F(1, 8) = 12.63$, $p < .01$, which is expected when comparing a group of readers with alexia to typical readers. There was no significant effect of context on word reading for either group (neither group read target words more accurately in the sentence than the word list context enough to make is a statistically significant difference), $F(1, 8) = 1.44$, $p = .26$. Although three of the five aphasia participants read more target words correctly in the sentence context over the word list context (Figure 1), one-way ANOVAs on

each individual's word reading data revealed GZ was the only participant to demonstrate a significant context effect, $F(1, 3) = 29.07$, $p < .05$ (see Figure 3). GZ's results are discussed in more detail in the discussion.

Figure 1: Average Accuracy Across all Word Types- Aphasia Group



Effect of part of speech on word reading accuracy

Although there was no effect of context on word reading accuracy, we wondered if the word category (i.e. part of speech) would affect the probability of being read accurately by participants with aphasia, as observed in participants described by Mitchum et al. (2005) and Silverberg et al. (1998). A repeated measures ANOVA 2 (group: patients, controls) x 4 (Part of Speech: Adjectives, Functors, Nouns, Verbs) was run on two measures: word list reading accuracy and word-in-sentence reading accuracy.

Figure 2: Mean Accuracy of Part of Speech

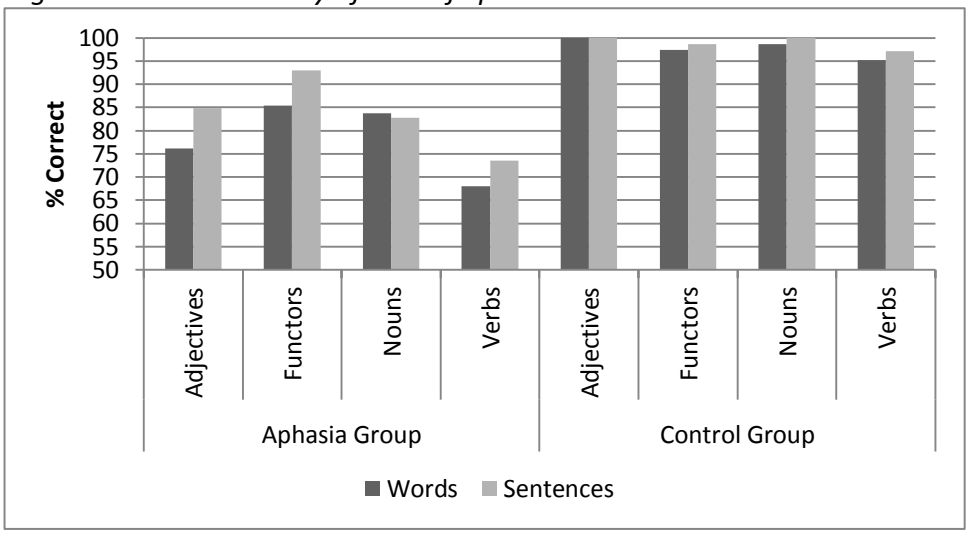
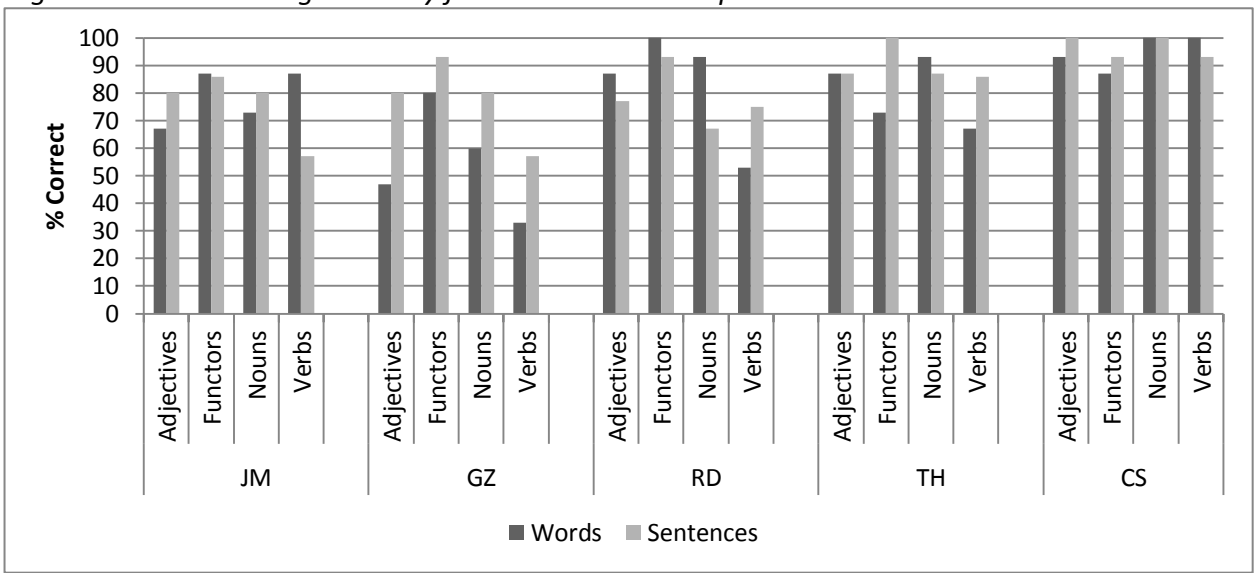


Figure 2 displays the mean accuracy of each part of speech for the Aphasia and Control groups in word list and sentence contexts. As expected, there was a significant main effect of group, $F(1, 8) = 8.47$, $p < .05$, with control participants reading all parts of speech more accurately than participants with aphasia. Examining the aphasia group's performance separately, one way ANOVAs revealed no significant part of speech effect on word list reading accuracy $F(3, 12) = 1.59$, $p = .24$. However, there was a significant part of speech effect on word reading accuracy in the sentence condition, $F(3, 12) = 5.06$, $p < .05$. Post-hoc tests (Tukey's HSD) revealed that reading functors in sentences (mean accuracy = 93%) was significantly more accurate than reading verbs in sentences (mean accuracy = 74%).

Figure 3 displays the word reading accuracy for individuals with aphasia divided by part of speech word category. GZ was the only participant to have improved accuracy in all four word categories in the sentence context.

Figure 3: Word Reading Accuracy for Individuals with Aphasia



Discourse Analysis

Table 6 summarizes the results of our Quantitative Production Analysis for all five participants with Aphasia, and for the five control participants. Although the proportion of words per sentence and mean sentence length was lower for the participants with aphasia than the control group, the well-formedness index (how grammatically well formed the produced sentences are with respect to morphology and syntax), was the same for both groups.

Table 6: Results of QPA Analysis for Participants with Aphasia and Control Participants

Aphasia Group	**Prop. wds/sentence**	**Well-form. index**	**Mean sent. length**
JM	.87	.95	6.42
GZ	1	1	6.42
RD	.95	.96	5.96
TH	.96	.92	12
CS	.97	.92	11.77
Average	.95	.95	8.51
Control Group	**Prop. wds/sentence**	**Well-form. index**	**Mean sent. length**
DS	1	.91	14
NS	1	1	12.15
SS	1	1	7.95
BS	1	1	18
GF	.93	.82	9.76
Average	.99	.95	12.37

The Relationship between Sentence Production Skills and Word Reading Accuracy

Simple and multiple linear regression analyses were run to examine the contribution of sentence production skills on reading accuracy in adults with aphasia. The mean sentence length of utterances in the discourse sample significantly predicted how accurately words were read in sentences, $b = .95$, $t(3) = 12.55$, $p < .01$. This variable also explained a significant proportion of variance in 'word in sentence' reading accuracy scores, $R^2 = .91$, $F(1,3) = 28.69$, $p < .05$. No other discourse variables significantly predicted how accurately words were read in sentences.

DISCUSSION

Although many studies have looked at the effects of aphasia on reading abilities, questions still remain about the existence of context effects for patients with aphasia. In this study, three main questions were addressed. First, we examined whether participants with fluent aphasia demonstrated a difference between reading target words in a list format vs. in a sentence context (context effect). Second, we looked at whether grammatical parts of speech are affected differently when in these two reading contexts. Last, we were interested in determining if sentence production skills contribute to whether a context effect does or does not occur.

First, context (i.e. whether words were presented in list or sentence format) was not seen to affect word reading accuracy for four of the five individuals with fluent aphasia. Only GZ's results were found to be quite different than those of the other individuals in the aphasia group. GZ was the only participant to show a context effect in reading words in sentences vs.

word lists, across all parts of speech. His reading was extremely slow, as evidenced by slow text passage reading speeds and single word reading reaction times that were approximately three times longer than the next-slowest participant (see Table 7). It is possible GZ's slow reading rate had a positive effect on his accuracy.

Table 7: GZ- Reaction time vs. other participants in Aphasia group

	Average reaction time in word lists (ms)	**Average speed in passage reading (WPM)**
GZ	2985	25.31
JM	621	86.17
RD	910	73.58
TH	691	63.72
CS	587	172.75

GZ's results are similar to Mitchum's (2005) participant DS in that they both read functors with the highest accuracy and showed improvements in word reading in the sentence context. It is possible that during list word reading, GZ was processing the words before saying them aloud. If this is the case, then reading the sentences at a slower rate may have also allowed him time to process the context of the words in the sentences and therefore benefit from the contextual cues. Perhaps the other participants, who read at faster speeds, could have benefitted from the sentence context cues, had they given themselves more time to process the words. However, exact reasoning of what it was about the sentence context that facilitated reading in both GZ and Mitchum's (2005) participant DS remains to be determined.

For people without brain damage, having a context often facilitates reading single words embedded within it more than if it were on its own. For adults with brain damage, the helpfulness of a context may be counterbalanced by the increased cognitive load, and effort of having to read an entire sentence versus a single word. The results of our study from a small

sample of participants seems to imply that while some words do seem to be easier to read in sentences format than in word lists, there is no significant "context effect" surrounding them.

The second question we wished to answer was to determine whether context differentially affected accuracy of reading words from different grammatical categories. As is pointed out in Silverberg (1998), each word is likely facilitated differently by the context that it is presented in based on whether it is an open or closed class word, and has bound or free elements to it. Our findings from analyzing parts of speech also suggest that there is a relationship between grammatical class and reading accuracy for participants in the aphasia group. The participants in this group showed a difference in accuracy of reading functors vs. verbs in sentence context, suggesting that the constraints imposed on closed-class function words have an effect on how easily they are read. However, since functors and verbs were most different in terms of frequency, it is difficult to determine whether this is a part of speech effect or a frequency effect. There was no significant difference between the other parts of speech. The results of Mitchum (2005) suggest that appreciation for part of speech was the single most robust predictor in why reading for two of their participants was improved in the sentence context over the single word context.

Some other interesting findings regarding part of speech, that may have an effect on how these individuals in the aphasia group read orally are presented below:

While adjectives were not the highest or lowest in accuracy, they did show the most context effect (i.e., on average, accuracy was higher in sentence context than in word lists). This may be due to the fact that adjectives are more context-dependent than other parts of speech, with the exception of functors.

The aphasia group had a higher accuracy rate for function words in both word lists and in sentences than all other parts of speech. This may be due to the frequency with which they appear in language, as well as their highly context-dependent nature. These results are parallel with the Silverberg et al. (1998) hypothesis that patients can read closed class items more easily if they have intact grammar because they can use a syntactic "frame" to determine that a functor must belong in that position in a sentence.

Nouns were the only part of speech overall in the aphasia group that had a positive accuracy difference between word lists and sentences, indicating that accuracy was higher in word lists than in sentence context. This could be due to the fact that nouns are generally more concrete and have fewer constraints than other parts of speech.

Verbs had the lowest accuracy overall for the aphasia group in both word lists and sentences. We were surprised by this result, as verbs scored the highest on imageability and we had presumed that the easier it is to picture a word, the easier it will be for a person to identify accurately. However, the added morphology of past tense may have caused some confusion for the aphasia group, which could account for the low accuracy and slow reaction time.

Our final aim was to determine whether sentence production skills had an effect on whether individuals with aphasia demonstrated context effects in their oral reading. It has been thought that individuals who are stronger in discourse production may show an improvement in word reading in sentences than in list format. As pointed out by Mitchum (2005), if patients do not have intact sentence production abilities, reading of sentences may simply be processed as a horizontal line of single words. In this study, aside from GZ, the participants that did well on language production, as defined by high scores on QPA parameters, did not do significantly

better on word reading in sentences than in list format. However, the results suggest that the mean length of utterances in discourse samples explained 90.5% of the variance in sentence reading accuracy. So, although the well-formedness of utterances, number of words that are part of sentences, and overall sentence accuracy did not seem to have an effect on a participant's ability to read words in sentences, the length of their utterance does have a significant effect on it. The reason for this may go back to the idea of clients with aphasia having difficulty cognitively processing entire sentences as well as reading them accurately. If the client naturally produces longer sentences, they may be able to process longer sentences more easily, and the more cognitive reserve they will have for reading the words within it accurately. Participants with aphasia that generally produce short sentences, likely optimally understand short sentences and are faced with decreased accuracy as the length increases. So, if the length of a person's utterance correlates with their sentence reading accuracy, increasing the length of sentences during discourse speaking should have a positive effect on reading abilities.

GZ was the only individual in the aphasia group who scored 100% for well-formedness and proportion of words per sentence in the discourse analysis. As part of the study, we were interested in determining whether adults with aphasia who have good sentence production show a context effect when orally reading sentences vs. word lists, which he did. More information on this finding is required in order to determine whether this effect can be generalized. However this supports the hypothesis that intact sentence production skills may affect reading words in sentences.

Mitchum (2005) states that with their two participants that showed a context effect for sentences, many of the errors produced were constrained to the same grammatical class as the target word. If this is the case, then the sentence context is allowing the patient to use residual sentence production capabilities to prime them for what grammatical class would occur in which position within a sentence. So as is pointed out by Silverberg (1998) and hypothesized by the results of this study, for participants with intact sentence production reading words in a sentence format may be optimal, and at least some intact sentence production abilities may be a pre-requisite for reading therapy delivered in a sentence format.

The present results suggest that: (1) For patients with aphasia, reading sentences at a slow rate may allow them sufficient time to process and obtain the benefits of the extra context when reading single words; (2) due to the concreteness of nouns, their readability may be less affected (than functors for example) by the context that they are presented in; (3) knowledge of syntactic frames may allow a person to parse possible candidates for each word in a sentence, based on its positioning, and; (4) Patients with intact sentence production may benefit from words presented in a sentence context during reading therapy.

There were several limitations in this study that could have affected the significance of the results. This study involved a small sample size (n=5), which reduced its statistical power, and made it difficult to achieve significant or generalizable results. With a larger sample size, it is possible that we would have achieved more substantial results on the effects of context on accurate word production. Further, the word list and sentence lists used were not originally developed for use in this study. They were created for another experiment, and the words that we used were extracted for our purposes. Also, all of the verbs that were used in this study

were in the past tense. This was done in order to have verbs of similar length and frequency in the language, compared to the other parts of speech that were used. Using past tense verbs could have had an effect on the relationship between the two contexts, or made the verbs more difficult for the group in general because of the processing involved in their morphology.

More research is needed in order to determine how to make reading treatments more effective for clients with aphasia, and specifically alexia. Replication of these findings in a larger population of patients is important. Furthermore, it is necessary to investigate: (1) For which candidates do sentence rather than list context improve word reading ability; (2) If improving discourse production improves reading abilities; and (3) What the nature of the target word errors when presented in word list vs. sentence context is (i.e., does the error remain within the same grammatical class, are they phonemically or semantically close to the target word etc.).

Any spoken or written language that one is exposed to on a daily basis, such as newspapers, magazines, television programs, advertisements, and conversations with friends are delivered in sentences. It is rare to come across spoken or written language that is composed of only a number of unrelated single words. As a cognitively advanced species, we are adept to listening and learning from larger chunks of related words delivered in a sentence format. So, it seems natural to assess whether treatment of patients with aphasia should likewise be in a sentence format, not only because it is what one is more used to, but also because it provides a facilitative context to prime each single word within it. One of the overarching goals of this study was to gain a better understanding the strengths and deficits of clients with aphasia and acquired alexia when reading in different contexts. Further insight into

this topic would ensure that patients with aphasia are receiving treatment in a format that facilitates their learning as greatly as possible.

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APPENDIX A- WORD LIST

Adjectives	***Functors***	***Nouns***	***Verbs***
fresh	through	church	thought
poor	because	apple	held
busy	wherever	money	filed
best	until	basket	bought
biggest	with	grief	blew
messy	some	letter	drank
large	that	closet	worked
third	from	food	caused
sick	whenever	costume	praised
open	over	kitchen	mailed
white	before	dinner	kissed
slight	every	napkin	voted
thirsty	around	singer	pulled
frantic	along	speech	agreed
naughty	~~like~~ (omitted- not analyzed)	house	~~liked~~ (omitted- not analyzed)

APPENDIX B- SENTENCES

The results of the election were not available until today.

The engagement ring had a large diamond on a gold band.

The naughty boy caused trouble wherever he went.

The man in the house heard a report on the television.

The singer lost her voice, and cancelled the show.

The slight breeze was a welcome addition.

She wore a wedding dress trimmed with antique lace.

The emerald was the biggest jewel in the queen's crown.

Both sides agreed the next period would be the last one.

The woman thought her voice was her best feature.

There were many options to choose from in the horror group.

The sick child ran a fever for three days.

On Sunday, she went to church for morning mass.

She mailed the letter to her grandmother.

The man opened the window for fresh air.

The boy kissed his mother on the cheek and said goodbye.

The victims of the crime filed a report at the police station.

He pushed it back with his napkin at the kitchen table.

The woman put the juice in her shopping basket.

She wiped her mouth with her napkin at the dinner party.

The cool breeze blew through the open window.

The little girl had trouble whenever she ate.

The girl drank some apple juice along with her snack.

The widow was stricken with grief over her husband's death.

She looked for a dress in the messy closet.

The last item she bought was blush at the store.

The president made a speech before the crowd.

The man went to the station that morning.

The score was tied in the third period of the hockey game.

The train pulled into the station at midnight.

The poor man did not have enough money to buy food.

She checked herself into the hospital because of her back pain.

The woman was praised by the minister for her actions.

The political party held an election to choose a new leader.

The bus dropped the children off at school every morning.

The busy woman brought the kitten to her friend's house.

The thirsty man begged for some water to drink.

She worked on the jigsaw puzzle on the table.

The mother cat licked the kitten with the white paws.

The committee voted to fix up the school next year.

She wore a Halloween costume to the party.

The frantic woman could not find the money she had lost.

She was the teacher's best student by far.

She passed the salt and pepper around the table.