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The Serial Position Effect and Lexical Processing During Story-Retelling in Adults with and without Aphasia

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ROUGH DRAFT

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Abstract

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The Serial Position Effect and Lexical Processing

During Story Retelling in Adults with and without Aphasia

Further comprehending the cognitive and linguistic demands of story retelling tasks is integral to understanding what they measure. McNeil and colleagues (Brodsky et al., 2002; Doyle et al., 1998, 2000; McNeil et al., 2001) have used the Story Retelling Procedure (SRP) to yield information about these demands. The SRP is a standardized procedure for assessing aphasia in connected language (Doyle & McNeil, 1998) containing 12 stories from the *Discourse Comprehension Test* (Brookshire & Nicholas, 1993). This task measures the information retold from auditory presentations of short stories using set numbers of information units (IUs) for each story. IUs are words or word strings with "informative accurate content related to the story" (McNeil et al., p. ??? – IS THIS THE RIGHT YEAR?). Two types of IUs (i.e., direct and alternate) yield different memorial expectations according to Brodsky and colleagues (2002). Further understanding what this task measures is necessary to explain individual perfomance. Therefore, we further explored the characteristics of alternate use in individuals with and without aphasia to better understand the findings of Brodsky and colleagues (2002).

Before discussing Brodsky and colleagues (2002), it is necessary to distinguish between direct and alternate IUs and their implications for memory. A direct IU is repeated straight from the story with out any morphological changes (CITATION). If a person is merely repeating the phonological form of the direct IU, it is not necessary to access the deeper semantics. That is, a person can repeat the phonological form of what they hear without understanding its deeper meaning. Conversely, an alternate IU is a legitimate synonym of morphologically inflected form of a direct IU (CITATION). Access to a synonym that is more than a morphological inflection (e.g., *mitt* for *glove*) may indicate a deeper level of processing of that particular IU as the person goes beyond using an exact phonological replication of the IU to using a semantically related word. To validate the difference between direct and alternate IUs, it is necessary to examine their use in story retells.

McNeil and colleagues (Brodsky et al., 2002; McNeil et al., 2001) have examined this distinction in story retells of individuals with and without aphasia. McNeil and colleagues (2001) determined that individuals with aphasia use fewer IUs during retells than do normal individuals. With regards to the general distinction between direct and alternate IUs, both groups recalled more direct IUs than alternate IUs (McNeil et al., 2001). Upon finding a significant serial position effect (SPE) for direct IUs *only* by both groups, Brodsky and colleagues (2002) argued that alternate and direct IUs utilized different processing strategies.

The serial position effect (SPE) is a memory phenomenon whereby individuals remember information occurring at the beginning and end of a list better than information from the middle (Myers, 1995). Better recall of items presented initially compared with items presented in the middle of a list or story is called a primacy effect. The primacy effect is proposed to require active and voluntary cognitive processes (Williams, McCoy, & Kuczaj, 2000). Better recall of items presented recently compared with recall of items presented in the middle is called a recency effect. The recency effect is hypothesized to reflect passive automatic cognitive processes in memory (Williams et al., 2000). Therefore the serial position effect for direct IUs may reflect active processes to maintain the information from the beginning of the story and automatic processes to access the information from the end of the story. These processes may have employed the phonological representation of the direct IUs because of possible ease of maintenance for primacy effects and the automaticity of memory for recent phonological representations.

This hypothesis is further supported by the lack of a general SPE for alternate IUs (Brodsky et al., 2002). To determine if this lack of an SPE for alternate IUs resulted from the use of identical phonological representations when using direct IUs for story retelling, Brodsky and colleagues (2002) examined the production of phonologically similar alternate IUs during the SRP. Using shared initial phonemes between the direct and alternate IUs as their criteria for phonological similarity, these authors did not have enough data to test the SPE for these alternates. However, they describe their findings as indicating there was an increased use of alternates sharing initial phonemes in the initial thirds and declining to the final third. They propose that with more data this might indicate that the first bits of information to leave the memory store is phonological. However, with this proposal it would seem that they should have seen a recency effect for phonologically similar information versus a primacy effect unless the retelling compromised the phonological representations for the recent portions of the stories.

A story is a primary part of communication. People narrate their activities and this narration is hypothetically constructed using the surface code (i.e., phonological representations), the conceptual meaning of the propositions, and the overall theme devised from interactions between information in the story and the listener's prior knowledge (Maguire, Frith, & Morris, 1999). Unlike sentence recall, individuals are less likely to recall a complete story verbatim; therefore, some link to conceptual information must be made by the listener during the initial story telling. This conceptual link should be made to words that are semantically related to the original IUs in the story. Whether this link is stronger between words that are phonologically and semantically related compared with words that are merely semantically related is a question that needs further exploration. Therefore, researchers have used sentence recall and picture naming errors.

Further evidence for the influence of phonological similarity between two words on memory comes from short-term recall of auditorily presented sentences (Rummer & Englekamp, 2001) and semantic errors during picture naming (Cutting & Ferreira, 1996; Martin, Gagnon, Schwartz, Dell, & Saffran, 1996; Morsella & Miozzo, 2002; Rapp & Goldrick, 2000). Rummer and Englekamp (2001) manipulated the presentation (auditory vs. visual) of sentences with lists presented before or after them. Phonological information was not disrupted in sentences if the list was presented first, but was disrupted if the list was presented following the sentences. Therefore, the presentation of the lists following the sentences may have functioned like the process of retaining the recent phonological information in the SRP (Brodsky et al., 2002) by disrupting it.

Martin and colleagues (1996) examined the influence of phonological information in naming errors. One major difference between picture naming and story retelling concerns the specificity of the expected responses. In picture naming, a single response is usually allowed for a given picture; whereas in the SRP multiple accepted alternate IUs are allowed for a single direct IU. Therefore, some of the semantically related errors in naming might be considered acceptable alternates in the SRP. In Experiment 1, Martin and colleagues (1996) found preservation of phonological information and syllabic structure in the semantic naming errors of individuals with and without aphasia. Further bolstering this finding, Martin and colleagues (1996, Experiment 2) determined that there was no inherent tendency for semantically related words to be phonologically similar. Likewise, Rapp and Goldrick (2000) evaluated the naming errors of three brain-damaged individuals according the predictions of different theories of spoken naming. Their findings agree with restrictively interactive theories of spoken naming.

Further support for interaction between semantic and phonological activation comes from Cutting and Ferreira's (1996) examination of homophone picture naming. They compared non-homophone picture naming and homophone picture naming with semantic related and phonologically related distractors. Findings indicated that non-homophone pictures were influenced by semantic interference and no influence of phonological distractors. Conversely, homophone picture naming was facilitated by semantic distractors (e.g., *dance* for *ball* – toy). Again their results conform with the predictions of cascading models of picture naming where semantic and phonological processing overlap. Similarly, Morsella and Miozzo (2002) examine picture naming with superimposed phonologically related pictures and non-phonologically related pictures. Their findings supported facilitation of picture naming by phonologically related pictures further implicating a cascaded model of picture naming.

All of the previous research has overlooked one additional influence on similarity: morphological changes to a word. Morphologically inflected variations on a root word are closest in lemma relationship than semantically related words not sharing the root word. Using only IUs sharing the initial phoneme as phonologically similar, Brodsky and colleagues (2002) may have limited their sample of alternates to these morphologically inflected variations. Additionally, Martin and colleagues (1996) defined phonological similarity between two words as having a common phoneme in the same position. Therefore, we employed a quantitative approach to defining phonological similarity, a similarity distance algorithm (Kirchoff & Gibbon, 1995). We also recorded whether the alternate IU was a morphologically inflected version of the direct IU.

With the evidence for phonological influences on memory and generating semantically related words and the previous implications for the serial position effect in story retelling from Brodsky and colleagues, we decided to further define the mechanisms of the SPE for the direct IUs in the SRP by examining the phonological and morphological characteristics of the alternate IUs. By doing so, we also attempted to further define the memory demands of the connected language comprehension and production task to further understand what this task measures in individuals with and without aphasia.

In summary, this study was designed to describe the characteristics of alternate IUs used during story retelling and to describe the motivating influences of the serial position effect of alternate IUs. The following sets of experimental questions guided our description of alternate using in the story retelling procedure:

1. Describing characteristics of alternate IU use:
    a. Are participants more likely to use phonologically similar/morphologically inflected alternates than chance?
    b. Is one group more likely to use one type of alternate than another?
2. Serial position effect and alternate use:
    a. Is there a serial position effect for phonologically similar alternates?
    b. Is there a serial position effect for morphologically inflected alternates (e.g., plurals, tense variations, etc.)?

Methods

Participants

Data for individuals with and without aphasia were take from Brodsky and colleagues (2002) IS THIS ACCURATE, IT LOOKS LIKE THE INDIVIDUALS WITH APHASIA WERE

USED IN ALL OTHER STUDIES. Participants without history of neurological impairment had a mean age of 43.7 years (15 male & 16 female, *SD* = 17.2, *range* = 22-80). These control participants passed the *Hearing Handicap Inventory for Adults* (Newman, Weinstein, Jacobseon, & Hug, 1990; Ventry & Weinstein, 1982) and performed within expected limits for their age on the immediate and delayed story retelling subtests from the *Arizona Battery for Communication Disorders of Dementia* (Bayles & Tomoeda, 1993). Therefore, the normal participants' performance was consistent with normal immediate and short-term memory skills.

There were 15 participants (11 male & 4 female, *M* =62.7, *SD* = 9.1, *range*=47-74 years) with mild to moderate aphasia as defined by McNeil and Pratt (2001) and measured by the Porch Index of Communicative Ability (Porch, 1981; *M* = 79th percentile; *range* = 53rd to 97th percentile). All participants with aphasia passed a pure-tone audiometric screening at 35 dB HL at 500, 1000, 2000, and 4000 Hz unilaterally. Table 1 contains further descriptive information on participants with aphasia.

Procedure

All 12 SRP stories were presented auditorily in a randomized order to each participant in this investigation. Participants were placed in from of a computer with a 15-inch monitor for the story presentation. Before story presentation, participants were instructed about the task and retelling the story in their own words upon completion. The stories were presented auditorily at 170 syllables per minute by a male speaker at about 70-7 dB SPL via computer speakers on both sides of the monitor. As the story was presented, six full-screen, black and white illustrations were presented in temporal association with the story's plot. When the story was complete, participants were again instructed to retell the story in their own words. A uni-directional microphone was attached to the computer and placed in front of the participant and a backup lapel microphone was connected to an analog cassette recorder and clipped to the participant's collar to record each of the story retells.

Trained and reliable scorers (McNeil et al., 2001) orthographically transcribed each story retell from the recording for each subject. Correct IUs were then identified as being directs or alternates. Scoring was item-based and not sensitive to order. Of these, only the uses of alternate IUs were examined in this study.

Phonological Similarity

To measure the phonological similarity between the direct and alternate IUs, we used a similarity distance algorithm (a.k.a., edit distance, Levenshtein distance; Kirchoff & Gibbon, 1995) modified by D. Gibbon (2001). This algorithm measures the minimal number of insertions, deletion, and substitutions needed to convert one phonetic string to another phonetic string by providing a phoneme-by-phoneme comparison yielding a relative distance score ranging from zero to one. Normalized for word length, zero indicates the two phonological representations are identical (e.g., homophones) and one indicates two entirely different words not sharing any phonemes. While this measure does not account for all of the complexities of natural language, it is the only method we found to quantify phonological similarity. In addition, this variations of the relative distance score are commonly and reliably used to predict orthographic and phonological similarity errors related to drug names (Johnson, Dunn, & Wolfe, 1998; Lambert, 1997; Lambert, Lin, Chang, & Gandhi, 1999).

We implemented a relative distance score cut-off of 0.3 as being the maximum phonological distance of the alternate IU from the direct IU. Therefore, any alternate IU compared to its direct IU with a relative distance score greater than this was not considered phonologically similar to its corresponding direct IU. This cut-off was chosen because it did not include only alternate IUs that were morphological inflection changes from the direct IU. That is, a majority of all alternate IUs with relative distance scores less than 0.18 were morphological inflected versions of the direct IU. Subjectively, we determined that alternate IUs relative distance scores greater than 0.30 were not phonologically similar enough to their direct IUs to be included.

Prior to subjecting the alternate and direct IUs to the similarity distance algorithm the first author phonetically transcribed both sets of IUs using the SAMPA alphabet (Gibbon, 2000; Wells, 2001) and the most common pronunciation of the IU. The SAMPA alphabet (Gibbon, 2000; Wells, 2001) provides a plain text (ASCII) format that could be interpreted by the algorithm.

Morphological Inflections

Morphological inflections included plurals, tense shifts (including irregular past tense), adverb forms, adjective forms, pronoun case shift (e.g., *she – her*) and compound words sharing the initial part with the direct IU.

Determining Chance Values

Rather than using an arbitrary value of chance (e.g., 0.5) to compare with the proportion of phonologically similar alternate IUs and morphologically inflected alternate IUs, we calculated possible chance proportions. That is, if there were four possible alternates for a direct IU and only one of these was phonologically similar to the direct IU, then the chance value for that alternate's use was 0.25. This was computed for all possible direct IUs and then averaged across all IUs to determine the chance of using phonologically similar and morphologically inflected alternate IUs. Based upon this, the chance proportion for using phonologically similar alternate IUs was set at 0.27 and the chance proportion for using morphologically inflected alternate IUs was set at 0.20.

Preparing to Examine the Serial Position Effect

The 12 stories were divided into thirds according to their IUs: the primacy (initial third), middle, and recency (final third) sections. Phonologically similar alternate IUs and morphologically inflected alternate IUs were summed separately by their position in each story third, across stories by participant. To ensure that findings were not because of a general pattern of behavior for both groups of participants, the same was completed for non-phonologically similar and non-morphologically inflected alternate IUs. The means of the sums were analyzed using a repeated measures ANOVA with position as a within-subjects factor. Additionally, we examined the type of function (i.e., linear or quadratic) best describing the data for both groups. If there was a significant main effect of position, boneferroni-corrected pairwise comparisons were examined.

Results

Characteristics of Alternate IU Use

Were phonologically similar or morphologically inflected alternate IUs used greater than chance?

Participants were significantly less likely to use a phonologically similar alternate IU ($t_{normals}(30)=-12.157$, $p<.001$; $t_{aphasics}(14)=-14.120$, $p<.001$) than chance. Participants were again less likely than chance to use a morphologically inflected alternate IU ($t_{normals}(30)=-8.534$, $p<.001$; $t_{aphasics}(14)=-13.353$, $p<.001$) than chance. Table 2 provides the descriptive statistics of the proportion of alternate IU use.

Was one group more likely to use one type of alternate IU than another group?

Although both groups used phonologically similar and morphologically inflected alternate IUs significantly less than chance, there were significant associations between groups and use of different alternate IUs. A chi-squared test of association between groups (normal and aphasic) and phonologically similar alternate usage (similar and dissimilar) indicated a significant association between group and alternate use ($\chi^2(1, N=5301)=15.955, p<.01$). The normal group used more phonologically similar alternate IUs than expected (1448 vs. 1399.2) and the aphasic group used fewer phonologically similar alternates than expected (208 vs. 256.8).

Likewise, there was an association between group and using morphologically inflected IUs. A chi-squared test of association between groups (normals and aphasics) by alternate type (morphologically inflected vs. not morphologically inflected) was significant ($\chi^2(1, N=4446)=62.663, p<.01$). Again, the normal group used more derived alternates than expected (1128 vs. 1039.7) and the aphasic group used less derived alternates than expected (119 vs. 203). Together these results indicate that normal participants used a significantly greater proportion of phonologically similar and morphologically inflected alternate IUs than participants with aphasia.

Characteristics of the Serial Position Effect for Alternate IUs

Phonologically Similar Alternate IUs

Table 3 shows the means and standard deviations for the use of phonologically similar alternates according to story position for the participants with and without aphasia. For the participants without aphasia, the main effect of position was not significant ($F(2, 60)=.863$, $p=.427$). As indicated in Figure 1, there appears to be a serial position effect for participants without aphasia; however it is much shallower. The non-significant findings for the normal group may be due to a genuinely more shallow SPE or a lack of observed power (power = .192). In the normal group, the patterns of phonologically similar alternate IU use were as follows: 5 participants showed a primacy effect, 7 showed a middle effect, 8 showed a recency effect and 11 showed an SPE.

Participants with aphasia showed a significant main effect of position ($F(1.379, 19.300)=7.427$, $p<.01$) for using phonologically similar alternate IUs. Figure 1 illustrates the significant quadratic trend of the position data ($F(1, 14)=37.716$, $p<.01$) and pairwise comparisons using Bonferroni correction confirm the SPE for the participants with aphasia. That is, significantly more phonologically similar alternate IUs were produced in the primacy and recency positions than in the middle position ($p(\text{primacy})<.01$; $p(\text{recency})<.05$) and the number of phonologically similar alternate IUs produced in the primacy and recency positions was not significantly different ($p>.05$). In the aphasic group, 8 participants followed the SPE patterns, 1 showed a middle effect, 2 showed a recency effect, and 4 showed a primacy effect.

To confirm that this was not a general effect of alternate use by both groups, we examined the SPE for non-phonologically similar alternate IUs (see Table 4 and Figure 2). Both groups show similar patterns of non-phonologically similar alternate IUs used according to story position. As indicated in Table 4 there is a significant main effect of story position for alternate IU use for both groups ($F_{\text{normals}}(2, 60)=112.83$, $p<.01$; $F_{\text{aphasics}}(1.30, 18.21)=9.104$, $p<.01$). The normal group shows a significant recency effect with the number of non-phonologically similar alternate IUs produced in the primacy position significantly less than the number produced in the middle ($p<.01$) and recency positions ($p < .01$); and the number produced in the middle significantly less than the number produced in the recency position ($p < .01$). The aphasic group shows a flattened recency effect with significantly fewer non-phonologically similar alternate

IUs produced in the primacy position than in the middle (p = .02) and recency positions (p <.01); but there is no significant difference between the middle and recency positions (p = .47). Therefore, both groups show a similar pattern of results. Additionally, examining the individual data yield similar patterns of results for both groups. In the normal group, 22 participants had a recency effect, 1 an SPE, and 8 a middle effect. In the aphasic group, 9 participants had a recency effect, 1 an SPE, 2 a middle effect, and 3 a primacy effect.

Morphologically Inflected Alternate IUs

Descriptive statistics the number of morphologically inflected alternate IUs by story position for participants with and without aphasia are shown in Table 5. For the normal group there was a significant main effect of position ($F(2, 60)=14.377$, $p<.01$). Figure 3 illustrates the significant linear function of the data ($F(1, 30)=26.763$, $p<.01$) indicating that a straight-line over time versus the SPE characterized U-shaped curve. Pairwise comparisons indicated no significant difference between the primacy and middle positions ($p>.05$); however, there were significantly more morphologically inflected alternate IUs produced in the recency position than the primacy position ($p <.01$) and the middle position ($p<.01$). This indicates a significant recency effect for the morphologically inflected IUs in the normal group as is illustrated in Figure 3. The group followed this pattern as 15 participants showed a recency effect, 1 a primacy effect, 6 a middle effect, and 9 an SPE.

For the aphasic group, the main effect of position was not significant ($F(2, 28)=2.293$, $p>.05$; Table 5). Although the main effect of position was not significant, the within-subjects contrasts indicated a significant quadratic function for the data ($F(1, 14)=7.528$, $p<.05$). This quadratic trend accounts for the U-shaped curve illustrated in Figure 3, which is another measure of the serial position effect. There was not enough observed power (power = .426) to detect a main effect of position. However, adding more participants may not necessarily lead to findings a significant SPE for this group. This is apparent when examining the disparity of individual's performance: 7 manifested an SPE, 5 manifested a primacy effect, 2 manifested a recency effect, and 1 manifested a middle effect.

Again to ensure that the findings for both groups did not reflect general characteristics of alternate IU production, we examined the serial position effect for non-morphologically inflected alternate IUs (Table 6; Figure 4). Both groups showed a main effect of position ($F_{normals}(2, 60)=99.36$, $p<.001$; $F_{aphasics}(1.41, 19.72)=5.87$, $p=.017$). The normal group showed a significant recency effect with significantly more non-morphologically inflected alternate IUs produced in the recency position than in the middle ($p<.001$) and the primacy positions ($p = .008$). Additionally, normal participants produced significantly more non-morphologically inflected alternate IUs in the middle position than in the primacy position ($p < .001$). This recency effect is evident in Figure 4 and is also evident for the morphologically inflected alternate IUs, indicating that this may be a general effect for alternate IUs by normal individuals versus showing anything special about the influence of morphological inflections on memory. The tendency to show a recency effect prevailed for individual data: 20 normal participants showed a recency effect, 10 a middle effect, and 1 an SPE.

Contrasting their significant quadratic function for the morphologically inflected alternate IUs, participants with aphasia showed a significant linear function for the non-morphologically inflected alternate IUs ($F(1,14)=6.62$, $p = .022$). Likewise, significantly more non-morphologically inflected alternate IUs were produced in the middle position compared with the primacy position ($p = .049$). Because of the variance of the difference between the primacy and recency positions there is not a significant recency effect ($p = .066$) even though the mean for the recency position is greater than the means for the middle and primacy positions. Most individual participants evidenced a recency effect (11). Two participants showed a primacy effect and 2 showed a middle effect. This does not implicate different memory processes for morphologically inflected alternate IUs compared with non-morphologically inflected alternate IUs for participants with aphasia.

Discussion

Our first goal was to describe the characteristics of alternate IU use along the dimensions of phonological similarity and morphological inflections. Contrary to expectations for characteristics of alternate IU use, both groups used phonologically similar and morphologically inflected alternate IUs less than chance. However, our finding of proportionally fewer phonologically similar and morphologically inflected alternate IUs produced by participants with aphasia compared with participants without aphasia was congruent with our expectations. Secondly, we wanted to further understand the mechanisms of the serial position effect for the direct IUs using the alternate IU characteristics of phonological similarity and morphological inflection. Participants with aphasia showed a significant SPE for phonologically similar alternate IUs unlike their normal counterparts. This same effect did not appear for the non-phonologically similar alternate IUs for either group, indicating that it was particular to phonological representations for the participants with aphasia. Conversely, morphological inflection of IUs did not change the results for the participants without aphasia indicating this does not play a special role in memory. However, participants with aphasia had a significant quadratic shape for their morphologically inflected alternate IUs and a significant linear shape for the non-morphologically inflected alternate IUs. Because the pairwise comparisons for the two did not differ, whether the aphasic group used a genuinely different memory process than the normal group is questionable.

Previously Martin and colleagues (1996) determined that semantically related picture naming errors tended to hold a phonological relationship with the target. Martin and colleagues (1996) further determined that the phonological relationship between semantic errors and the target was not due to any inherent tendency for the words to be phonologically similar. Their chance proportions of phonological similarity are less than ours (.050-.071 vs. .27 respectively). Perhaps this is because our study used a different measure of phonological similarity than Martin and colleagues (1996) or because we examined alternate IUs in story retelling whereas they looked at semantic errors in naming.

As participants with aphasia used proportionally fewer phonologically similar and morphologically inflected alternate IUs than participants without aphasia, it seems that they have reduced access to the lexicon overall. This finding is similar to the previous finding of McNeil and colleagues (2001) where the aphasic group produced fewer IUs than the normal group during retells. The current study merely indicates that this finding crosses phonologically similar and morphologically inflected alternate IUs.

Regarding the findings for the SPE for phonologically similar and morphologically inflected alternate IUs, there appears to be a general recency effect for non-phonologically similar and non-morphologically inflected alternate IUs. Therefore, the recency effect appears to be the rule of alternate IUs contrary to the finding of Brodsky and colleagues (2002). Perhaps their finding was diluted by the complexity of their statistical procedures. The significant SPE for phonologically similar alternate IUs for participants with aphasia was different from the shallow recency effect they evidenced for non-phonologically similar alternate IUs (Figures 1 &

2) indicating different retrieval or processing strategies for the two alternate IUs and indicates that Brodsky and colleagues' (2002) hypothesis regarding the mechanism of the SPE for the direct IUs. That is, the SPE for direct IUs may result from the use of phonological representations to retell the story versus always deeply processing the direct IUs. Without further replication of this study in a variety of contexts we cannot determine if this use of phonological representations will generalize to individuals without aphasia. If it does not, it could indicate that individuals with aphasia rely on more shallowly processed forms during story retelling and list recall than individuals without aphasia.

Unlike previous studies, this study accounted for the possible role of morphological inflections on the memory system and determined that neither normal participants nor participants with aphasia evidenced a different pattern for the morphologically inflected alternate IUs from the non-morphologically inflected alternate IUs.

HERE IS WHERE I AM STILL TRYING TO FIGURE OUT WHAT ELSE TO SAY. THE SPE RESULTS ARE UNIQUE. I NEED FEEDBACK AND A CONCLUSION.

Figures

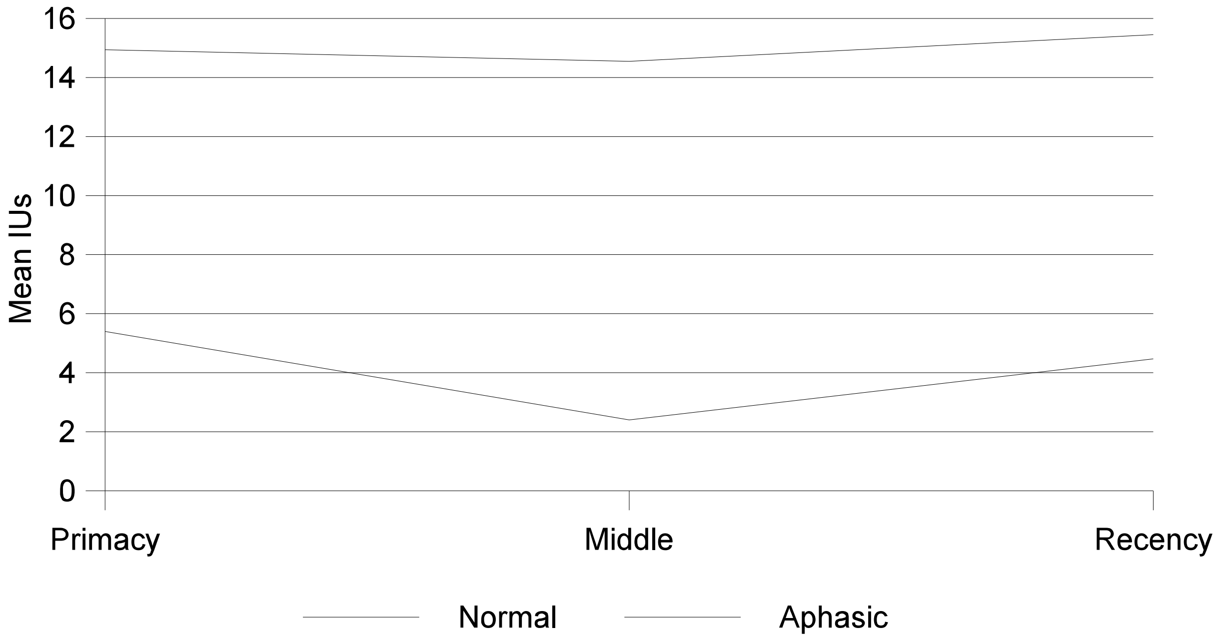

Figure 1. The mean phonologically similar alternate IUs used by group according to position in the story.

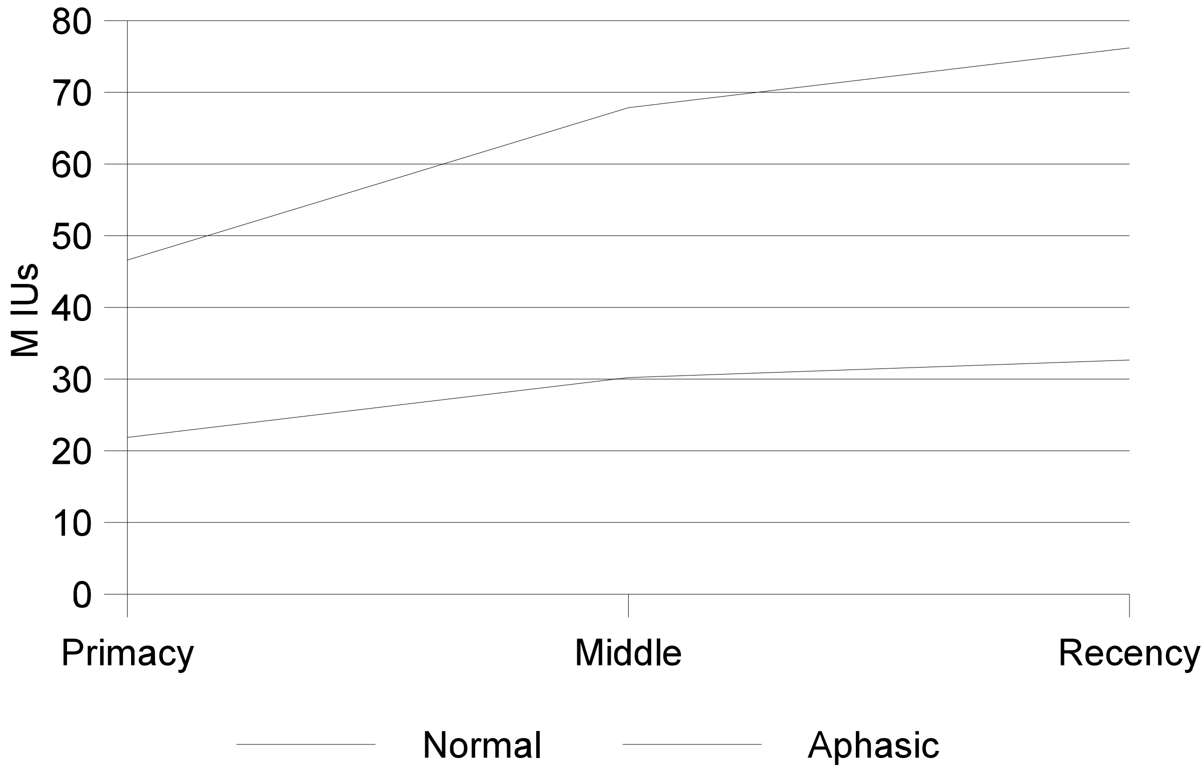

Figure 2. The mean number of non-phonologically similar alternate IUs used by group according to story position.

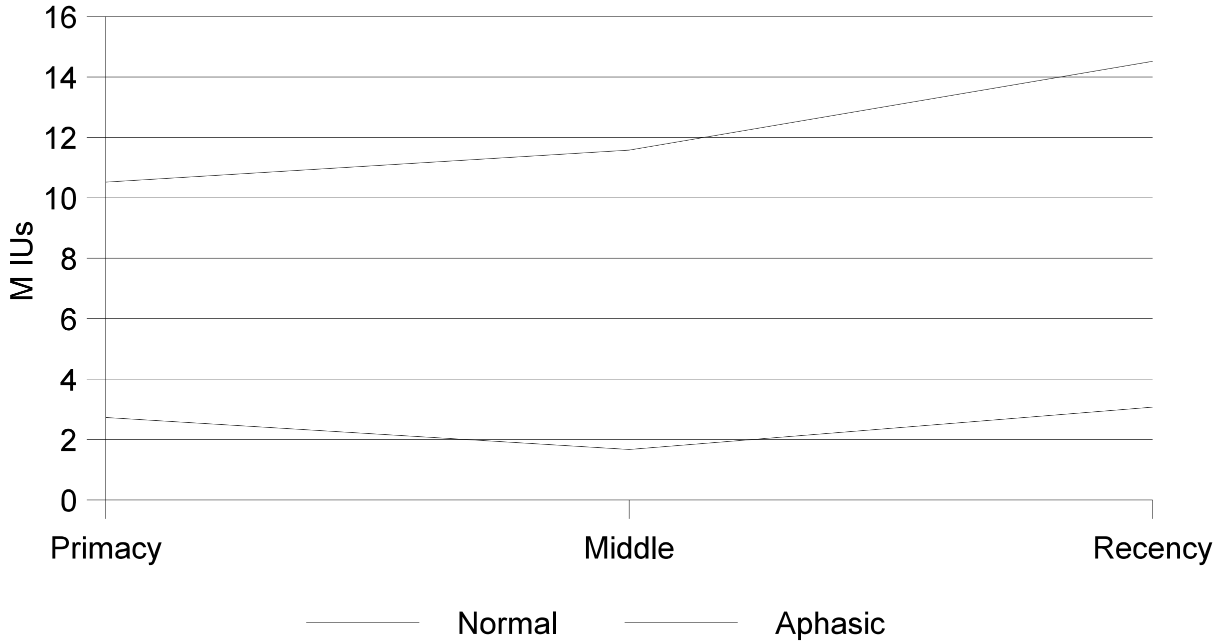

Figure 3. Mean number of morphologically inflected alternate IUs used by group for each story position.

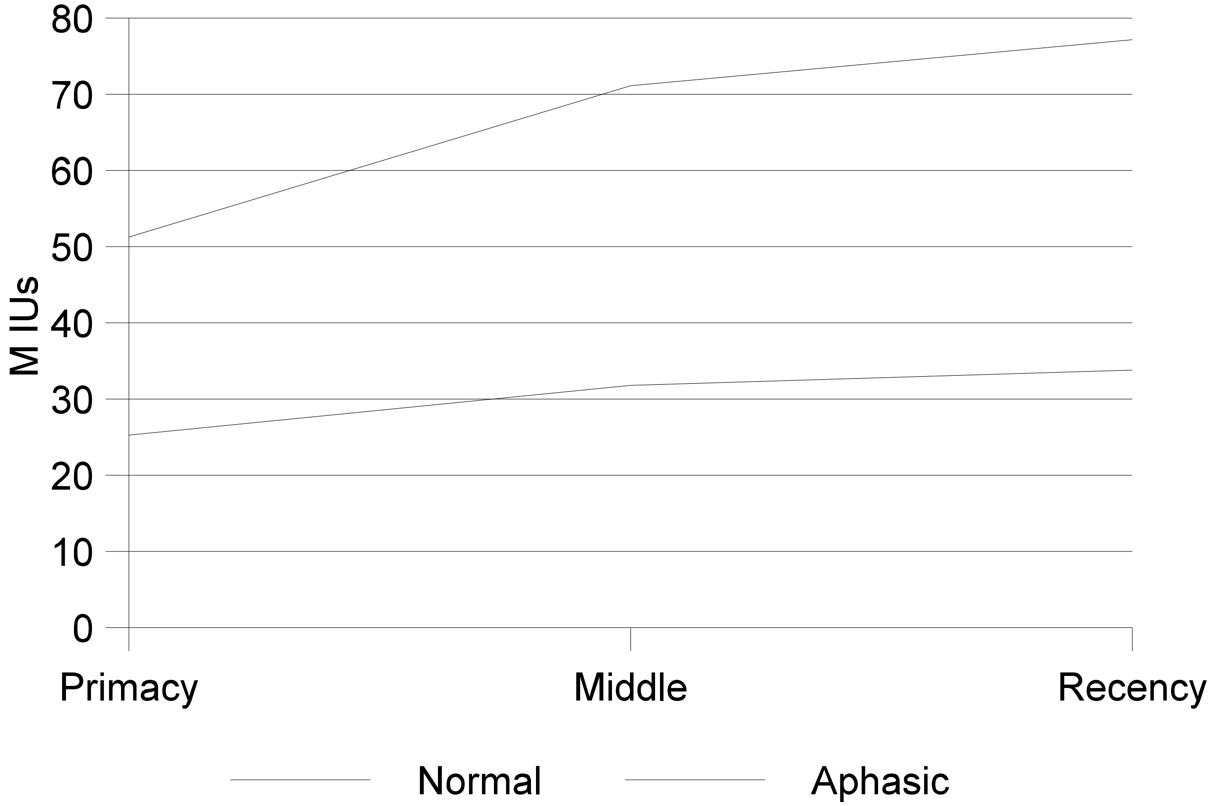

Figure 4. Use of non-morphologically inflected alternate IUs by group according to story position.

Tables

Table 1

Descriptive Characteristics of Participants with Aphasia.

Participant	Age	MPO	RTT Percentile	ABCD Ratio	Raven's	PICA OA Percentile	PICA VRB Percentile
1	62	11	73	84.62	34	92	78
2	77	44	19	118.18	24	59	63
3	47	11	4	100	24	65	54
4	51	77	53	133.33	29	87	60
5	79	13	77	233.33	20	75	77
6	56	84	95	100	32	87	89
7	74	71	96	85.7	27	94	98
8	55	30	63	100	32	75	71
9	66	33	80	100	27	89	76
10	57	85	58	125	27	86	25
11	64	252	14	91	24	93	68
12	71	94	4	100	22	43	37
13	52	17	92	100	36	87	91
14	73	23	66	116.66	21	76	70
15	74	11	54	100	18	63	54
M	63.87	57.07	56.53	112.52	26.47	78.07	70.67
SD	10.45	62.12	32.10	36.15	5.33	14.90	15.71

Note. MPO = Months post onset; RTT = *Revised Token Test* (McNeil & Prescott, 1978); ABCD ratio = *Arizona Battery for Communication Disorders of Dementia* ratio (Bayles & Tomoeda, 1993); Raven's = *Raven's Coloured Progressive Matrices* (Raven, 1976), raw score; PICA =

Porch Index of Communicative Ability (Porch, 1981), OA = overall percentile and VRB = verbal percentile.

Table 2

Descriptive Statistics: Proportion of Alternate IU Use

	Phonologically Similar		Morphologically Inflected	
	M	*SD*	*M*	*SD*
Normals (*N* = 31)	.32	.005	.30	.005
Aphasics (*N* = 15)	.26	.007	.17	.006

Table 3

Use of Phonologically Similar Alternates by Story Position

	Position		
	Primacy	Middle	Recency
	Normal Participants ($N = 31$)		
M	14.94	14.55	15.45
SD	4.39	4.16	4.26
	Participants with Aphasia ($N = 15$)*		
M	5.40	2.40	4.47
SD	2.53	2.26	3.76

Note. *$p < .01$

Table 4

Use of Non-phonologically Similar Alternate IUs by Story Position

	Position		
	Primacy	Middle	Recency
	Normal Participants ($N = 31$)*		
M	46.81	67.87	76.19
SD	8.77	10.51	8.97
	Participants with Aphasia ($N = 15$)*		
M	21.87	30.33	32.67
SD	8.68	15.70	18.63

Note. * $p < .01$

Table 5

Use of Morphologically Inflected Alternate IUs by Story Position

	Position		
	Primacy	Middle	Recency
	Normal Participants (*N* = 31)*		
M	10.52	11.58	14.52
SD	3.91	4.57	4.14
	Participants with Aphasia (*N* = 15)		
M	2.73	1.67	3.07
SD	1.33	2.19	2.76

Table 6

Use of Non-morphologically Inflected Alternate IUs by Story Position

	Position		
	Primacy	Middle	Recency
	Normal Participants (*N* = 31)**		
M	51.26	71.13	77.16
SD	9.30	10.28	9.05
	Participants with Aphasia (*N* = 15)*		
M	25.27	31.80	33.80
SD	10.08	16.43	19.70

Note. ***p* <.01; **p*<.05

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