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Real-time comprehension of wh- movement in aphasia: Evidence from eyetracking while listening ☆

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Abstract

Sentences with non-canonical wh- movement are often difficult for individuals with agrammatic Broca's aphasia to understand (Carramazza & Zurif, 1976, inter alia). However, the explanation of this difficulty remains controversial, and little is known about how individuals with aphasia try to understand such sentences in real time. This study uses an eyetracking while listening paradigm to examine agrammatic aphasic individuals' on-line comprehension of movement sentences. Participants' eye-movements were monitored while they listened to brief stories and looked at visual displays depicting elements mentioned in the stories. The stories were followed by comprehension probes involving wh- movement. In line with previous results for young normal listeners [Sussman, R. S., & Sedivy, J. C. (2003). The time-course of processing syntactic dependencies: evidence from eye movements. *Language and Cognitive Processes, 18*, 143–161], the study finds that both older unimpaired control participants ($n = 8$) and aphasic individuals ($n = 12$) showed visual evidence of successful automatic comprehension of wh- questions (like "Who did the boy kiss that day at school?"). Specifically, both groups fixated on a picture corresponding to the moved element ("who," the person kissed in the story) at the position of the verb. Interestingly, aphasic participants showed qualitatively different fixation patterns for trials eliciting correct and incorrect responses. Aphasic individuals looked first to the moved-element picture and then to a competitor following the verb in the incorrect trials. However, they only showed looks to the moved-element picture for the correct trials, parallel to control participants. Furthermore, aphasic individuals' fixations during movement sentences were just as fast as control participants' fixations. These results are unexpected under slowed-processing accounts of aphasic comprehension deficits, in which the source of failed comprehension should be delayed application of the same processing routines used in successful comprehension. This pattern is also unexpected if aphasic individuals are using qualitatively different strategies than normals to comprehend such sentences, as under impaired-representation accounts of agrammatism. Instead, it suggests that agrammatic aphasic individuals may process wh- questions similarly to unimpaired individuals, but that this process often fails to facilitate off-line comprehension of sentences with wh- movement.

Keywords: Broca's aphasia; wh- movement; Gap-filling; Eyetracking; Sentence processing

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1. Introduction

People with agrammatic Broca's aphasia often have difficulty understanding sentences with non-canonical movement, like (1a–b).

(1) a. Who_i did the boy kiss t_i today at school?
b. It was the $girl_i$ who_i the boy kissed t_i today at school.

Both structures involve wh- movement (Chomsky, 1977, 1986). The wh- question word "who" in (1a) and the wh- operator "who" in (1b) have moved to their surface positions, with a trace (t) occupying their basic position following the verb "kiss(ed)." This re-ordering results in a non-canonical word order, with the element receiving a Theme semantic role (who) appearing before the element receiving an Agent role (the boy). In standard picture-matching or act-out tasks used to test comprehension of these structures, individuals with agrammatic aphasia often perform no better than chance. For example, many aphasic individuals would be equally likely to say that (1b) matched a picture in which a girl was kissing a boy as one in which the girl was being kissed. (See Grodzinsky, 2000 for a summary of much crosslinguistic evidence of this comprehension deficit.) Clearly, something about relating the moved element in sentences to the trace position from which it is moved is difficult for many individuals with agrammatic Broca's aphasia, particularly when the moved element appears in non-canonical position.

There is still considerable controversy regarding the source of this comprehension difficulty. Some accounts of agrammatic comprehension deficits claim that impaired processing is responsible for agrammatic aphasic individuals' failure to comprehend movement sentences. They posit that some part of the language processing system is severely slowed or weakened due to injury, and that this slowdown creates particular problems for structures involving non-canonical movement. One influential version of this approach claims that *slowed processing* is what underlies aphasic individuals' comprehension difficulties. For example, the activation of individual lexical items being reactivated during comprehension may be slowed (Swinney & Zurif, 1995), or the on-line assembly of phrase structure may be slowed (Burkhardt, Piñango, & Wong, 2003). The architecture of the comprehension system is intact in aphasia under these approaches, as is the grammatical representation of the sentences involved, but one part of the system's operation is pathologically delayed. The delay in successful processing of one component of the sentence's representation results in failed comprehension.

If the slowed processing view is correct, it predicts that people with aphasia should use the same processing routines to construct the same representations as people without aphasia, but in a much slower manner. For example, when confronted with a movement sentence, aphasic individuals compute the same syntactic dependency between a moved element and its underlying position in a sentence as unimpaired individuals, just more slowly. It also predicts that failed comprehension in aphasia is extremely slow comprehension: when aphasic individuals fail to comprehend a movement sentence, it is because they have computed the relationship between the moved element and the subcategorizing verb too late for the information to be of use. (In contrast, successful comprehension should be associated with relatively fast and normal-like computation of the syntactic dependency.)

A competing view claims that what is at issue in aphasia is not slowed construction of intact grammatical representations, but a deficit in the representations themselves. These *impaired representation* accounts of aphasic language deficits claim that brain injury has resulted in damage to some aspect of a sentence's grammatical representation, which creates particular difficulty for comprehending and producing sentences with movement. For example, traces may be impaired or missing from a sentence's structure (Grodzinsky, 1990, 2000) or the referential indices which connect a trace to a moved element may be absent (Mauner, Fromkin, & Cornell, 1993). Under these accounts, one or more of the elements needed to compute a movement dependency is missing, so aphasic individuals are unable to assign a complete grammatical structure to movement sentences. As a result, they may use extralinguistic heuristics (Grodzinsky, 1990) or assign coreference at chance (Mauner et al., 1993) when they attempt to comprehend movement sentences. For example, they may assign a fronted NP an Agent thematic role based on a heuristic strategy which assumes that the first NP of a sentence is an Agent or actor (Grodzinsky, 1990; cf. Bever, 1970; Townsend & Bever, 2001). Under these approaches, people with aphasia are doing something fundamentally different from typical individuals when they try to understand a movement sentence: they are assigning different or incomplete syntactic representations to movement sentences. These approaches therefore predict that the way that aphasic individuals comprehend such sentences should be *qualitatively* different from how people without aphasia comprehend them. Since they cannot assign the same syntactic structure to the sentence as unimpaired individuals, aphasic individuals should not use the same syntax-driven strategies that typical comprehenders do during comprehension of sentences with movement. We will return to discuss these syntax-driven strategies below.

Both of the above accounts of aphasic comprehension deficits, the slowed-processing and impaired-representation accounts, successfully account for the fact that off-line comprehension of sentences with movement is impaired. However, off-line evidence alone is insufficient to decide between them as accounts of the comprehension impairment for such sentences.[1] The two approaches do make distinctive predictions regarding the on-line comprehension of movement sentences. As noted above, the slowed-processing account predicts that aphasic individuals' automatic comprehension of movement sentences will be slower than typical individuals' comprehension of the same sentences, and that their automatic comprehension should be slowest when comprehension fails. The impaired-representation account predicts that aphasic individuals' automatic comprehension of movement sentences should be qualitatively different from typical individuals' comprehension of such sentences, even for cases of successful comprehension, because the grammatical representations they are assigning to the sentence are fundamentally different from those assigned by typical comprehenders.[2]

To date, there has been relatively little evidence regarding real-time comprehension of movement sentences in aphasia. The existing evidence appears to favor slowed-processing accounts. Dickey and Thompson (2004) tested aphasic and unimpaired control participants in an auditory anomaly detection task, in which participants listened to sentences like (2a–b) and were instructed to press a button as soon as a sentence started to "sound strange" (analogously to the stop-making-sense task; cf. Boland, Tanenhaus, Garnsey, & Carlson, 1995).

(2) a. The girl put on a shirt$_i$ that her mother picked t_i for her before church today.
b. The girl put on a shirt$_i$ that her mother fried t_i for her before church today.

Aphasic participants who had been treated using Treatment of Underlying Forms (TUF; Thompson, 2001), which focuses on comprehension and production of movement structures, rejected the anomalous (2b) overwhelmingly more often than the non-anomalous (2a), as did control participants. This indicates that they had successfully associated the head of the relative clause ("shirt") with the relative clause's verb and evaluated the resulting verb + object combination for its plausibility. These participants frequently provided their rejection responses before the end of the sentence as well, also like controls, indicating comprehension of these sentences in real time. However, even treated aphasic individuals who displayed the above pattern were slower than typical comprehenders. Their correct rejections of sentences like (2b) came 1000 ms later on average than correct rejections by control participants. This pattern is consistent with a slowed-processing account of aphasic syntactic comprehension, in which even successful computation of movement dependencies is slowed.

A parallel line of evidence from cross-modal lexical priming (CMLP) also suggests that individuals with aphasia are able to associate a moved element with a trace, but that this process is pathologically slowed. Love, Swinney, and Zurif (2001) report data from a CMLP task suggesting that people with agrammatic Broca's aphasia show no evidence of priming of a moved element (such as "girl" in (2a–b) above) at the trace site, but do show evidence of priming 800 ms later. Similarly, Burkhardt et al. (2003) present evidence of delayed priming in wh- movement structures by aphasic comprehenders, in this case 650 ms later in the sentence. Assuming that priming is an index of automatic association of a moved element with a verb or trace, this delayed priming is evidence of a slowdown in the automatic processing routines of aphasic comprehenders. These delays are also consistent with the slow rejections Dickey and Thompson found in the anomaly detection task.

The limited on-line evidence regarding aphasic comprehension of wh- movement structures like (1a–b) and (2a–b) thus favors a slowed processing account of agrammatic comprehension deficits for sentences with movement. Individuals with agrammatic Broca's aphasia show some evidence of being able to associate a moved element with the position it is moved from, but only in a delayed fashion. However, these studies suffer from methodological concerns. As reaction-time based studies, their measures of comprehension are mediated by a button press, an external task requiring conscious control which could be independently slowed or impaired following brain damage. Slowed decision-making in either task could create the appearance of slower gap-filling routines, even if the automatic process of associating a moved element with a trace or gap was unimpaired.

In addition, both the lines of research described above suffer from two other limitations. First, neither one assesses what automatic processing is like for both successfully and unsuccessfully comprehended sentences. This comparison is crucial to testing a prediction of the slowed processing account: since aphasic individuals' failure to comprehend complex sentences is due to slowed processing, failure to comprehend should correlate with slower comprehension. For example, aphasic comprehenders should show slower or later priming for sentences they fail to comprehend than for sentences they succeed in comprehending. This sort of comparison is not possible at all in the anomaly detection task, since failure to correctly comprehend an anomalous movement sentence like (2b) results in no response (since they incorrectly

[1] There may be independent grounds for favoring one of these approaches over the other. For example, aphasic individuals' performance with other types of structures, such as pronominals, may favor some accounts over others in which the comprehension deficit for movement sentences is due to an impairment specific to traces. (See Mauner et al., 1993; Piñango, 2002, among others, for discussion.) However, the two approaches appear equally compatible with existing off-line data regarding aphasic individuals' performance with movement constructions specifically.

[2] This prediction holds only for the strongest versions of the impaired-representation accounts. Aphasic individuals' automatic processing of movement sentences should be qualitatively different from controls' only if traces or referential indices are *always* missing from their grammatical representations. However, this strong version appears to be what proponents of the impaired representation approach intend: Grodzinsky and Finkel (1998) argue that aphasic individuals' insensitivity to the presence of traces extends to grammaticality judgment, and that the deficit is therefore one of grammatical competence. Aphasic individuals' grammars simply do not generate representations with traces under this approach (see Grodzinsky, 2000; for discussion).

fail to reject it). Such comparisons are possible in principle for CMLP tasks, but to date, no such comparisons have been made. Second, neither task to date has probed comprehension or activation of elements other than the moved element. CMLP tasks have only been used to examine the reactivation of the moved element, and only at a specific point or points; the anomaly detection study in Dickey and Thompson (2004) only examined whether the verb + object combination related by movement was successfully comprehended. If aphasic individuals' difficulty in associating a moved element and a trace is because they are sometimes activating the wrong antecedent for the trace, for example, this activation would not show up in either of these on-line comprehension tasks.

Below, we present a study of aphasic individuals' real-time comprehension of wh- movement structures using an eyetracking while listening task. This technique has been successfully used with typical comprehenders in a number of studies over the past decade, to measure both sentence-level and word-level comprehension (Allopenna, Magnuson, & Tanenhaus, 1998; Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995), as well as to examine planning and attentional processes in language production (Griffin, 2001). In the eyetracking task, listeners look at a visual display of either computer-presented images or real-world objects while a camera monitors their gaze. They are asked comprehension questions or are engaged in a directed-action task, being asked to move or manipulate the elements in front of them. Previous research has shown that typical comprehenders' gaze is closely timelocked to the language they are hearing: they fixate a corresponding object within 200 ms of hearing a word naming that object (Cooper, 1974).

This task has also recently been used to study the comprehension of movement sentences directly. Sussman and Sedivy (2003) present eyetracking data from young typical comprehenders who listened to stories and answered questions like the ones in (3) below.

(3) Jody was eating breakfast one morning when she saw a big hairy spider creeping across the table towards her. Jody, whose terrible arachnophobia had caused her to seek therapy a few years ago, drew on the techniques of relaxation and anxiety management that her psychologist had taught her. Instead of screaming or freaking out, she calmly took off her shoe and slammed it down on top of the spider. She ate the rest of her Froot Loops in peace.
a. What did Jody squash the spider with?
b. Did Jody squash the spider with her shoe?

Participants answered either a wh- object question (3a) or a yes/no question (3b) following the story. The wh- question contained a tempting extraction site following the verb: at the position of "squash," listeners might be tempted to assume that the question was asking about the thing that got squashed, and that the wh- element "what" was moved from a post-verbal object position. Evidence from other paradigms, including self-paced reading, eyetracking while reading, stop-making-sense tasks, and ERPs, suggests that typical comprehenders assume precisely that. Listeners and readers behave as if they try to associate a moved element with the first possible trace position (Frazier & Flores d'Arcais, 1989). This has been shown crosslinguistically to be the default strategy employed by typical comprehenders in understanding sentences with movement. As soon as comprehenders identify an "active filler," such as a wh- element moved to a non-canonical position in an object cleft or object wh- question, they try to associate that filler with the first syntactically permissible gap or trace position in the sentence (viz. McElree & Griffith, 1998; Traxler & Pickering, 1996). We assume that this syntax-driven strategy is the one typical comprehenders use to resolve local and long-distance syntactic dependencies such as wh- movement.

Sussman and Sedivy found a parallel pattern in participants' fixations to pictures corresponding to the elements mentioned in the story. When listening to a wh- question like (3a) in the story context provided, participants began to fixate on a picture of the spider (the object of the squashing) as soon as they heard the verb "squash," indicating that they (briefly) assumed that "what" was the theme of the verb "squash."[3] Importantly, Sussman and Sedivy did not find evidence of looks to the picture of the spider at the position of the verb in the yes–no question (3b). This finding indicates that the anticipatory looks to the object at the position of the verb were specific to sentences with movement, and can be interpreted as visual evidence of *gap-filling*: participants associated the moved element (the filler) with the first possible trace position (or *gap*) in the sentence.[4]

The eyetracking while listening methodology affords at least three advantages which seem particularly useful for studying aphasic language comprehension. First, it provides data regarding comprehension of multiple words in the sentence, or at least those words which correspond to an element in a visual display. This allows investigators to study comprehension of not only elements which are affected by movement (such as the referent corresponding to the moved wh- element "what") but other elements in the sentence as well (such as the subject). Second, it does not depend on either a consciously controlled behavior or a capacity which is likely to be impaired in aphasia. Eye movements are automatic and unconscious; further, eye control and vision are often spared in aphasia. The task thus seems appropriate and easily adaptable for use with

[3] The fact that the verb in the wh- question is immediately followed by an object makes this structure potentially problematic for testing comprehension impairments in aphasia. If aphasic individuals' comprehension of wh- movement is simply slowed, as under slowed-comprehension accounts, the presence of an NP immediately after the verb might be sufficient evidence to cause them to suspend any gap-filling routines triggered at the verb. We will return to this issue in Section 2.2.

[4] This result is also compatible with a purely semantic strategy for interpreting the moved wh- element: comprehenders associate the fronted wh-phrase with the first element (in this case, a verb) which provides it with a semantic role (viz. Pickering & Barry, 1991; see also Boland et al., 1995). We will return to this possibility in Section 6.

individuals with aphasia. Third, it permits investigators to examine automatic comprehension of not only correctly but incorrectly comprehended sentences: participants' eye-movements can be paired with their sentences in response-contingent analyses, in which eye-movement patterns for trials eliciting different responses are analyzed separately. Such analyses are increasingly common in eye-movement studies with young typical comprehenders (viz. Runner, Sussman, & Tanenhaus, 2003).

1.1. Purpose

The purpose of this study is threefold. First, it uses eye-tracking while listening to examine the time-course and accuracy of comprehension of wh- movement sentences in agrammatic aphasic individuals. Second, it aims to test the predictions of slowed-processing and impaired-representation accounts of aphasic comprehension deficits outlined above. Third, it extends the Sussman and Sedivy design above to examine the processing of not only object wh-questions (1a) but also object clefts (1b).

(1) a. Who_i did the boy kiss t_i today at school?
b. It was the girl_I who_i the boy kissed t_I today at school.

These sentences are grammatically related, since they both involve wh- movement. The two sentence types are also functionally related in aphasia: individuals with aphasia who have difficulty understanding one often have difficulty understanding the other, and treatment targeting production and comprehension of one has been shown to improve performance for the other (Thompson, Shapiro, Kiran, & Sobecks, 2003).

Based on Sussman and Sedivy's previous results, successful comprehension of a movement sentence should manifest itself as anticipatory looks to a picture corresponding to the moved element at the position of the verb in sentences with wh- movement. For example, in a story context in which a boy kissed a girl, participants should look to a picture of the girl (the person kissed by the boy) when hearing the verb "kiss" in the wh- question "Who did the boy kiss that day at school?" "Kiss" signals the presence of a trace. These fixations on the object picture at the verb should not appear for sentences without wh- movement, such as yes–no questions. These sentences do not have a moved element which listeners will be trying to associate with a trace and a thematic-role assigner, in this case a verb.

Based on Dickey and Thompson's previous results, we expect that at least some agrammatic aphasic individuals will show visual evidence of associating a moved element with a verb, consistent with gap-filling and with their being able to successfully comprehend wh- movement sentences. Also based on these results (as well as the CMLP results discussed above), we might expect that the appearance of the object looks associated with linking a wh- element and a verb or trace would be delayed for aphasic listeners, perhaps not appearing at the position of the verb itself but somewhere downstream from the verb. Such a pattern of results would be consistent with slowed processing accounts of aphasic comprehension problems.

Comparison of correctly and incorrectly comprehended movement sentences should provide evidence regarding the contrasting predictions of the impaired-representation and slowed-processing accounts described above. If the slowed-processing account is correct, people with aphasia should be generally slowed in their processing of movement sentences, and they should be particularly slow for trials in which their comprehension has failed (for example, when they provide an incorrect answer or no answer to the wh-question). Under slowed-processing accounts, failed comprehension is extremely slowed comprehension of the movement dependency, and the slower the comprehension, the more likely it is to fail. However, the pattern of comprehension should be qualitatively similar for cases of successful and unsuccessful comprehension: in both cases, people with aphasia should show delayed looks to the picture corresponding to the moved element, and those movement-related looks should be more delayed when they fail to comprehend the sentence. In contrast, the impaired-representation account predicts that the pattern of fixations seen for aphasic individuals should be qualitatively different from those seen for unimpaired individuals. Aphasic individuals should apply guessing strategies based on incomplete syntactic representations, and these guessing strategies should differ from the automatic processing done by typical comprehenders for the same sentences. It is less clear what these looking patterns should be under the impaired-representation account—perhaps they would take the form of randomly distributed fixations to competitor pictures as well as the target moved-element picture. However, they should be different from the patterns seen for unimpaired individuals.

2. Methods

2.1. Participants

Twelve individuals with agrammatic Broca's aphasia (three female) and eight healthy age matched individuals (five female) served as participants. Language testing data for aphasic participants are provided in Table 1. The agrammatic participants were all mildly to moderately impaired, as assessed by the Western Aphasia Battery (Kertesz, 1982), with the exception of one participant, A4 in Table 1. (Participant A4 exhibited severe apraxia of speech, resulting in very low naming and repetition scores, but high comprehension scores.) Their mean WAB AQ was 67.6 (range: 30–89.5); they were between 1 and 21 years post-onset and between 34 and 78 years of age at the time of testing. All aphasic participants showed impaired comprehension and agrammatic production: their speech lacked grammatical morphology and (with the exception of A2 and A12) was non-fluent. The control participants were between 34 and 67 years of age. All subjects (except A3 and

Table 1
Language profiles, aphasic participants

Participant	Western Aphasia Battery				
	Aphasia Quotient (AQ)	Fluency	Comprehension	Repetition	Naming
A1	64	4	8	6.4	6.6
A2	85.8	9	6.9	8.8	8.2
A3	64.1	4	8.95	6.7	5.4
A4	30	2	8.1	1.2	0.7
A5	74.4	5	8.6	7.2	8.4
A6	75	4	9.9	7	8.6
A7	64.8	4	8.4	5.2	6.8
A8	66.8	5	8.5	9.4	7.5
A9	78.6	6	9	6.6	8.7
A10	54.2	4	7.2	6	4.9
A11	64.5	4	8.55	5.6	7.1
A12	89.5	9	9.95	8.8	8

A11) were premorbidly right-handed, and all were well educated, native monolingual speakers of English and demonstrated good visual and hearing acuity. Demographic data for all participants are presented in Table 2. All participants provided signed informed consent prior to participating in the study.

2.2. Materials

Materials for this study consisted of 50 pairs of brief stories and panels depicting objects mentioned in the stories. The stories were presented monoaurally over a loudspeaker, while the panels were presented on a computer screen placed at a comfortable viewing distance for participants. Thirty of the 50 story-panel pairs served as experimental items, while the remaining 20 served as fillers. More detail about the linguistic and visual stimuli is provided below.

Table 2
Demographic data, all participants

Participant	Age	Gender	Education (years)	Years post-onset
A1	54	M	20	21
A2	52	M	15	13
A3	49	F	17	7
A4	67	M	13	7
A5	34	M	17	2
A6	68	M	16	10
A7	59	M	15	3
A8	57	M	17	2
A9	55	M	20	13
A10	55	F	14	9
A11	36	M	19	1
A12	78	F	17	9
C1	46	M	19	n/a
C2	56	F	19	n/a
C3	61	F	22	n/a
C4	56	M	17	n/a
C5	34	F	19	n/a
C6	54	M	22	n/a
C7	56	F	19	n/a
C8	67	F	18	n/a

Note: A = aphasic participant; C = control participant; M = male; F = female; n/a = not applicable.

2.2.1. Linguistic stimuli

The stories for all 50 stimulus pairs had the same structure. Each story was four sentences long and was followed by a comprehension probe. A sample story with comprehension probes is found in (4) below.

(4) This story is about a boy and a girl.
One day, they were at school.
The girl was pretty, so the boy kissed the girl.
They were both embarrassed after the kiss.
a. Who did the boy kiss that day at school?
b. Did the boy kiss the girl that day at school?
c. It was the girl who the boy kissed that day at school.

Each story contained one transitive event, described in sentence three. Sentence one of each story introduced two animate NPs who were the agent and patient or theme of this event. In half the stories, the agent was mentioned first, as in (4) above, and in half the stories the patient or theme was mentioned first. Sentence two introduced the location in which the event took place. Sentence four served as a distractor sentence, typically describing the emotional state of both actors or some state of affairs resulting from the transitive event in sentence three. The stories were kept deliberately simple, with only four sentences and a single transitive event, to reduce working-memory burdens for aphasic participants.

Each story was followed by a comprehension probe. The only difference between experimental and filler items was in the comprehension probes following them. For the 30 experimental items, the comprehension probe asked about the transitive event introduced in sentence three. For 20 of the experimental items, the probe appeared in one of two forms, either an object wh- question or a yes–no question, as illustrated in (4a–b) above. The object wh- question contains an unambiguously transitive verb followed by a gap, in contrast to the temporarily ambiguous wh- questions used by Sussman and Sedivy (like "What did Jody squash the spider with?"). The reason for this choice is related to the predictions of the slowed-processing account. If automatic comprehension of wh- movement sentences is slowed in aphasia, having a disambiguating object immediately following the verb (as in Sussman and Sedivy's sentences) may affect aphasic individuals' comprehension of these items. Assuming aphasic individuals are extremely delayed in their gap-filling, they may well encounter the NP in temporarily ambiguous "What did Jody squash the spider with?" before they are able to initiate or complete operations linking the wh- element and the verb. This might well cause them to suspend or alter their gap-filling routines. In addition, little is known about how aphasic individuals respond to temporary syntactic ambiguities, with or without wh-movement. Therefore, the simpler, unambiguous structures illustrated in (4a) were used.

Participants responded to the comprehension probes by answering aloud. For the object wh- questions, the correct answer was always the object. For the yes/no questions, the correct answer was always “yes.” The other 10 experimental items participants heard were followed by an object cleft as in (4c) above. For these sentences, the correct response to the cleft sentence was “yes” or “true.” In all, each participant heard 10 experimental trials ending with an object wh-question and ten experimental trials ending with a yes–no question, and an additional ten experimental trials ending with an object cleft. All experimental stories along with their accompanying comprehension probes are listed in Appendix A.

For the 20 filler items, the comprehension probes appeared in one of four forms: a “where” wh- question, asking about the location in which the transitive event took place; a subject wh- question, asking about the subject of the transitive event; an object cleft; or a yes–no question. The correct response to the object-cleft and yes–no questions for filler trials was always “no” or “false.” These items were intended to prevent a possible response bias for object cleft and yes–no items in the experimental trials. In all, there were five filler trials ending with a location wh- question, five filler trials ending with a subject wh- question, five ending with a false object-cleft probe, and five ending with an incorrect yes/no question. It is worth noting that while there were subject-extracted wh- question distractors, to prevent participants from developing biased looking patterns for the experimental object wh- questions, there were no corresponding subject clefts to serve as distractors for the experimental object clefts. We will return to this issue in the discussion of the results for the object cleft trials.

The individual nouns and verbs used in the stimuli were controlled in a number of ways. First, all verbs used were obligatorily transitive, to ensure that the absence of a noun phrase following the verb would unambiguously signal a trace. Previous work using this methodology (Altmann & Kamide, 1999; Sussman & Sedivy, 2003) has shown that perceivers’ looking patterns are very sensitive to this kind of grammatical information. Second, the nouns used in each story as well as the name of an unmentioned distractor element presented in the accompanying panel were roughly matched for log frequency, as assessed by the CELEX database (Baayen, Piepenbrock, & van Rijn, 1993). This matching was done so that no noun would show a particular frequency advantage; such an advantage could in principle speed looks to the object corresponding to that noun and thereby affect overall looking patterns. Third, the nouns for each story did not overlap phonologically in their initial segments. Previous work using this methodology has shown that phonological overlap creates competition in looks to objects whose names share the same initial segments (Allopenna et al., 1998, among others). Avoiding phonological overlap ensured that there would be no confusion or competition among nouns. Fourth, the nouns were matched for length in syllables.

Fifth, the nouns were rated for semantic relatedness, to control for the possibility that closely semantically related nouns might interfere with one another, especially for aphasic participants. In addition, recent work using this paradigm has shown competition for fixations between semantically related objects in a display (Huettig & Altmann, 2005). The three nouns mentioned in the 50 stories were put in pairs, along with the unmentioned distractor depicted in the panel. Each noun in a story was paired with all the other nouns in the story, plus the distractor object, for a total of six pairs per story or 300 pairs in all. These pairs were presented in randomized order to six native English-speaking volunteers to rate for their semantic relatedness. The six volunteers were asked to rate the relatedness of each pair on a seven-point scale, where 1 represented “completely unrelated” and 7 represented “very strongly related.” Across all pairs, the mean relatedness rating was 2.37, indicating that the raters did not perceive the elements presented together in a story as being strongly semantically related. On average, the subject and object of the transitive event in the story were judged to be the most strongly semantically related (mean = 3.93), and the subject and location of the event were judged to be the least semantically related (mean = 1.41). The unmentioned distractor and the other three elements were consistently judged to have low semantic relatedness (subject and distractor, 2.87; object and distractor, 1.48; location and distractor, 1.63). These low relatedness scores suggest that looking patterns during the experiment were relatively unlikely to be affected by semantic relationships among the objects in the stories.

The 50 stories and the associated comprehension probes were recorded by a female speaker of American English, speaking at a slightly slower than normal rate (3.34 syllables per second for the comprehension probes) into a Sony Mini-Disc player.[5] The stories and comprehension probes were then transferred to digital form, and the resulting sound files were measured and edited by two trained native speakers using Sound Edit 16.

2.2.2. Visual stimuli

The visual stimuli consisted of 50 panels with four images arrayed around a central fixation cross. The panel of images for the sample item in (4) is in Fig. 1.

[5] It is possible in principle that a significantly slowed speaking rate could affect how aphasic individuals understand these sentences, since Love, Swinney and colleagues as well as Piñango and colleagues have found evidence of delayed reactivation of a moved element during sentence comprehension by aphasic individuals. If incoming material were presented slowly enough, it might provide aphasic individuals enough time to reactivate the moved material and successfully use it in comprehension. However, the presentation rate for the critical sentences in this experiment, 3.34 syllables per second, is well within the average speaking-rate range of 2.5–4.56 syllables per second (Fonagy & Magdics, 1960; Wilshire, 1999). It is therefore unlikely that this presentation rate was slow enough to be responsible for aphasic participants’ successful (or unsuccessful) comprehension of the sentences in this experiment.

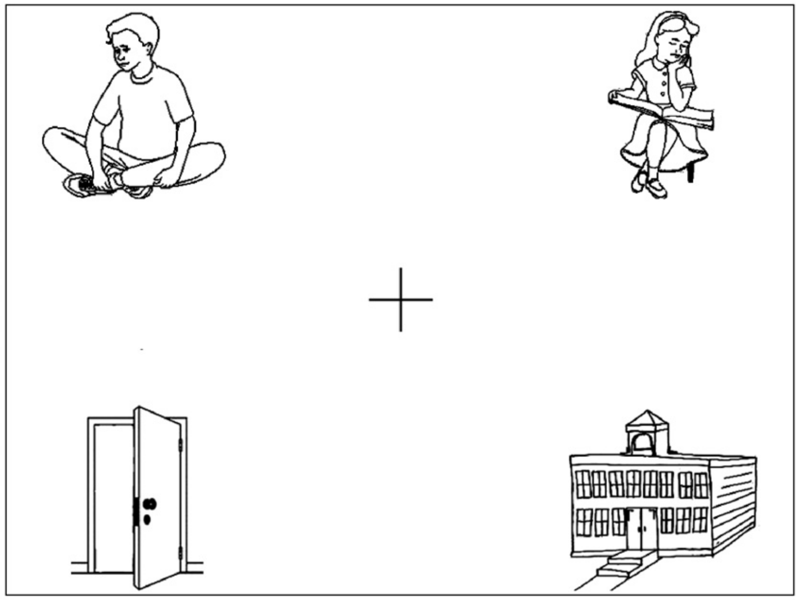


Fig. 1. Sample visual display.

The images in each panel corresponded to the subject and object of the transitive event in the accompanying story (the boy and the girl respectively in Fig. 1), the location in which the event took place (the school), and an unrelated distractor object (a door). The position in which each of these elements occurred in the panels was varied, such that the subject occurred in the upper left-hand position in roughly one-fourth of the panels, the upper righthand position in one-fourth of the panels, the lower lefthand position in one-fourth, and the lower righthand in one-fourth of the panels. The same distribution across panel positions was used for each of the other elements, in order to avoid any looking biases in the experiment due to the images' panel position. This balancing is described further in the description of the presentation lists below.

The images in the panels were all black-and-white line drawings, either obtained from public-domain sources on the internet or hand-drawn specifically for the experiment. In order to ensure that the images corresponded well to the objects in the story, the images were normed in a free-response object naming task. Five volunteers were presented with the 200 objects depicted in the panels and asked to name them. The criterion for successful identification was for at least four of the five participants to give the intended label for the object (i.e., 80% intended response or more). Synonyms (such as "woman" instead of "lady" or "forest" instead of "woods") were accepted as correct. Of the 200 objects, 160 were named correctly given the above criterion, for a success rate of 80%. The 40 pictures which did not meet the above criterion were grouped into 10 sets of four and presented to four additional volunteers in an object-label matching task. The volunteers were shown each set of four pictures and given a list of four object names. They were then asked to point to which picture corresponded to each object label. They were also told that they could respond by saying that no picture matched the label. Of the 40 pictures, 33 were matched with the intended label by all four volunteers. Seven were given a no-match response by at least two of the volunteers. These pictures were redrawn and presented to one of the four participants in the object-label matching task. This volunteer judged all of the new pictures to be reasonable matches for the intended labels.

The images of individual objects were assembled into panels using Adobe Photoshop 7.0. Three different versions of each panel were prepared in order to meet the criteria for the three different pseudo-randomized presentation lists, described below.

2.2.3. *Presentation lists*

Three pseudo-randomized lists were prepared for presentation of the stories. For the 30 experimental items, the three versions of the comprehension probe following the story were rotated across the lists using a Latin square design. Each subject heard each experimental story only once, followed by one version of the accompanying comprehension probe (wh- question, object cleft, or yes–no question).

The 20 filler items were interspersed among the experimental items so that no more than two experimental items appeared adjacent to one another in any list. The experimental items were also distributed evenly within each list, so that each experimental condition appeared roughly equally frequently in each half of a list. Participants were just as likely to encounter a story ending with a question or a cleft at the end of a list as at the beginning. Each list also began with a filler item.

The panels accompanying the stories were subjected to their own pseudo-randomization. The panels were distributed across the list so that panels in adjacent trials never had the image corresponding to the object (the critical element) appearing in the same position. Further, the panels were distributed across the trials so that the subject, object, location and distractor image appeared equally often in each position in the panel, as described above. This ensured that the object was equally likely to appear in any of the four positions on any given trial. Further, the position of the object in particular was evenly distributed across experimental conditions. Participants were just as likely to see the object in the upper lefthand position for stories followed by a wh- question probe as they were for stories followed by an object cleft.

These two pseudo-randomizations were joined in the final presentation lists. They ensured that any preferential looking patterns found in the experiment could not be due to biases built into the distribution of the stories or the pictures.

2.3. Procedure

After providing informed consent, participants were seated in a quiet, dimly lit room in front of a computer monitor. Beside the computer monitor was a loudspeaker and beneath the monitor was the remote camera for the eyetracker. In front of the monitor was a keyboard used to control the presentation of the stories. Participants were instructed to sit at a comfortable distance from the monitor and so that they could reach the keyboard. Two experimenters were also present in the room, one to control and monitor the eyetracking process via the eyetracking control computer and the other to assist the participants if necessary and to record their responses to the comprehension probes.

Participants' eye movements were monitored throughout the experiment using an Applied Science Laboratories (ASL) model 504 remote eyetracker. The position and direction of their gaze was sampled once every 16 ms by the remote camera mentioned above. The camera assessed eye position by monitoring the offset between two infrared light reflections, one reflection from the surface of the cornea and the other reflecting off the retina and passing through the pupil. This offset was calibrated for each participant at the beginning of the experimental session, and checked every 10 trials. Calibration involved having the participant look at each of nine numbers on the screen, with one of the experimenters pointing to the number to be looked at if necessary. Participants were told to move only their eyes, not their head, if possible.

Following the initial calibration and a brief verbal explanation of the procedure, participants performed a practice trial. This trial was one of the 20 filler trials described above. The calibration of their eyes was then checked and the experiment continued. An individual trial proceeded as follows. First, a blank white screen appeared on the computer monitor for 1500 ms. Then, the blank screen was replaced by a panel and an accompanying story began to play over the loudspeaker. Once the story was complete, there was a beep, followed after 300 ms by a comprehension probe. Participants then responded aloud to the comprehension probe while an experimenter recorded their answer. All aphasic participants except one (A4 in Table 1) were able to respond aloud; this participant indicated his responses by pointing or nodding and shaking his head. Once they had responded, participants either pressed the space bar on a keyboard in front of the monitor or the experimenter did it for them to advance to the next trial. The next trial then began with a blank screen, as described above.

The experiment terminated automatically after 50 trials with a message thanking the participant. The entire experiment, from obtaining consent to the last trial, lasted approximately 45 min.

2.4. Data analysis and reliability

Responses to comprehension probes were recorded online by the experimenter. For all aphasic participants, a second experimenter present during the experiment verified the first experimenter's recording of the responses. Reliability for these response checks was 95% or above for all aphasic participants. The responses were scored following the experiment, and the proportion of correct responses for each of the three experimental conditions (wh- question, object cleft, and yes–no question) was calculated. The scoring for each aphasic participant was checked by the first author. Either "yes," "correct," or "true" was counted as a correct response for the clefts and yes–no questions, while either the intended answer or a synonym was counted as correct for the wh- questions. All other responses, including "I don't know" and non-responses, were counted as incorrect.

Eye movement patterns are reported as proportions of fixations to different elements in the panel during the comprehension probe. The comprehension probe was divided into four different regions for analysis, as shown in Table 3.

Table 3
Sentence regions, comprehension probes

		Subject	Verb	Trace/object	Location
Wh - question	Who did …	the boy	kiss	that day at	school?
Object cleft	It was the girl that …	the boy	kissed	that day at	school.
Yes–no question	Did …	the boy	kiss	the girl at	school?

Fixations occurring prior to the subject of the verb were not included in the analysis. The most critical analysis regions for examining automatic processing of movement were the verb and trace regions. As can be seen in Table 3, the verb region included only the transitive verb, while the trace region extended from the offset of the verb to the onset of the noun describing the location of the event. Visual evidence of automatically associating the moved element with the verb or trace in the wh- movement sentences was expected to appear in these regions, in the form of more fixations to the object (the girl) compared to the subject (the boy) compared to other regions in the sentence (for example, the location). Intuitively, when participants hear "Who did the boy kiss that day at school," they should start looking at the girl (the person kissed) upon hearing the verb "kiss," which signals a trace and assigns a thematic role to the moved element "who," and stop looking at other elements in the display.

In addition to the main sentence regions described above, there was a further post-offset analysis region. This region comprised all fixations made between the offset of the comprehension probe and the participant's response, which signalled the trial's end. Any delayed looks (for example, due to delayed comprehension by aphasic participants) should appear here. Further, as is standard practice in studies of this kind, the temporal boundaries of each sentence region were shifted 200 ms downstream for the purposes of analysis. This practice compensates for the time required to program and execute a saccade in order to fixate on an object associated with a word.

These sentence regions were measured for each version (a–c) of the 30 experimental sentences, as described in Section 2.2. Thus, measurements were done on ninety sentences (30 experimental sentences appearing in each of three versions, wh- question, yes–no question, and object cleft). For each of these 90 sentences, the four segments described above were measured, for a total of 360 sets of measurements. All 360 of these measurements were reviewed by a native speaker who was linguistically trained. Intercoder reliability among this coder and the coders responsible for the original measurements was approximately 80%. In all cases of disagreement, the first author reviewed the measurement in question and resolved the conflict.

Fixation proportions were calculated for each participant individually and then averaged across participants. For each participant, fixation proportions were calculated separately for each sentence region. The proportion of fixations to each panel object out of the total fixations for each region was then calculated. This total included not only fixations to the subject, object, location and distractor elements on the screen, but also to the fixation cross in the center of the panel as well as fixations to elements outside the screen (since participants were not specifically instructed to look at the screen or at any particular elements on it). A participant had to fixate on the same position for four consecutive samples (or approximately 67 ms) for it to count as a fixation. This limit is above the 50-ms minimum needed to successfully fixate on an object (Rayner & Pollatsek, 1989) and is approximately twice as long as the sample used in other eyetracking while listening studies (e.g., Sussman & Sedivy, 2003). Fixations were calculated automatically for each participant by Eyenal 5.49 analysis software. The fixation proportions for each sentence region were calculated using Excel and were checked by hand for each participant by either the first or the second author.

3. Results: wh- and yes–no questions

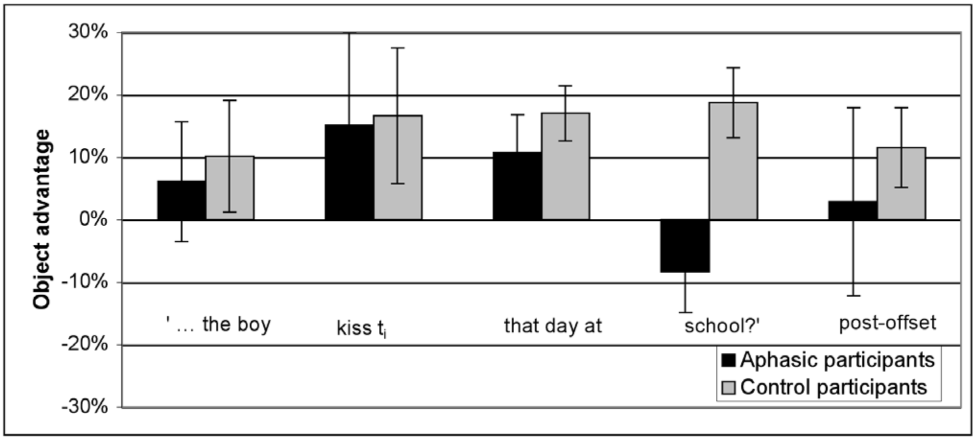
Results for wh- questions and yes–no questions are reported first, followed by results for object clefts, since the former results are most directly comparable to Sussman and Sedivy's results for young unimpaired participants. In all statistical analyses reported below, the fixation proportions and proportions of correct responses have been corrected using an arcsin transformation. This transform corrects for the non-normal properties of proportion data, which follow a binomial distribution. In addition, all t tests reported below are two-tailed unless otherwise noted.

3.1. Comprehension probes

Control participants exhibited good comprehension of both object wh- questions and yes–no questions. They were 95% accurate in their responses to yes–no questions (range: 80–100%) and 100% accurate in their answers to wh- questions (no variance). Overall, the aphasic participants' comprehension of the probes was very similar to what has been found in previous studies of aphasic individuals' off-line comprehension. Aphasic participants showed both higher accuracy and less variability in their responses to yes–no questions than in their responses to object wh- questions. Yes–no questions elicited a higher proportion of correct responses (86.7% correct, range: 60–100%) than wh- questions (70% correct, range: 0–100%). Aphasic participants' accuracy for yes–no questions was significantly better than chance ($t(11) = 5.92$, $p < 0.05$, $SE = 0.04$), while their accuracy for wh- questions was not ($t(11) = 1.29$, $p > 0.05$, $SE = 0.08$). Aphasic participants' performance for wh- questions was also significantly worse than controls' ($t(18) = 3.05$, $p < 0.05$, $SE = 0.10$), but their performance for yes–no questions did not differ from controls' performance ($t(18) = 1.83$, $p > 0.05$, $SE = 0.06$). Thus, aphasic participants had more difficulty understanding questions with wh- movement than yes–no questions without movement in this experiment.

3.2. Eye-movements

The first finding of note regarding the eye-movement data is related to the timing of the sentence regions used for analysis. Recall that the temporal boundaries of each sentence region were shifted 200 ms downstream for the purposes of analysis. Interestingly, this 200-ms offset appeared to be sufficient for not only the control participants but the



Subject region: "the boy"; Verb region: "kiss"; Trace region: "that day at"; Location region: "school?"

Fig. 2. Object advantage scores for wh- questions, by sentence region, aphasic vs. control participants.

aphasic participants. Thus, the aphasic participants also looked to the expected objects with roughly the same speed as the unimpaired control participants. This result is somewhat surprising if all processing, lexical and syntactic, is simply slowed in aphasia (cf. Yee, Blumstein, & Sedivy, 2004).

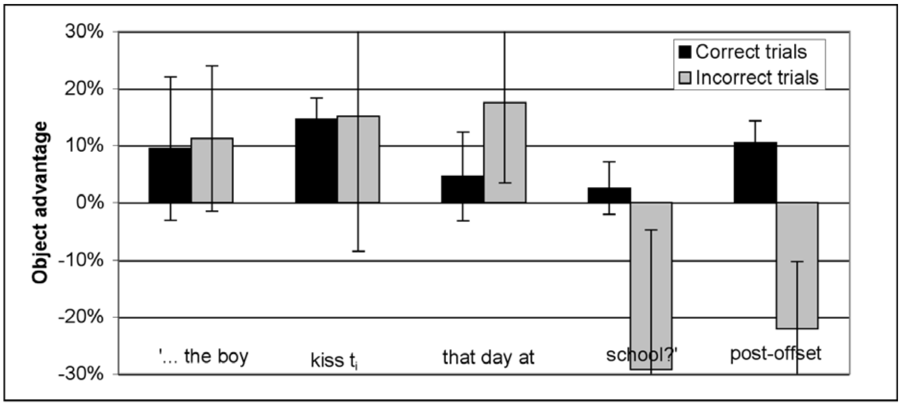
Below, only fixations on the subject and object (and in particular, the relative proportion of object fixations compared to subject fixations) are presented. This is because there were very few looks to the inanimate distractor (around 11% of fixations, across regions and trials) and even fewer looks to the location (around 6% of fixations, across regions and trials). This latter result is perhaps not surprising, given Boland's (2005) findings that non-argument prepositional phrases generally draw few looks from young unimpaired listeners. The former finding is perhaps not surprising either: since the distractor was never mentioned in any of the stories, participants likely came to ignore it over the course of the experiment.

The dependent variable plotted and used in the statistical analyses below is *object advantage*, the proportion of object fixations minus the proportion of subject fixations during a given region of a sentence. Since the object is the target picture in wh- questions—it corresponds to the moved wh- element, and fixations to it are expected to increase as a reflex of associating the wh- element with the verb—this measure corresponds directly to the target advantage measure used in many other eyetracking experiments (e.g., Arnold, Fangano, & Tanenhaus, 2003; Brown-Schmidt, Byron, & Tanenhus, 2005; cf. Sussman & Sedivy, 2003). Target advantage is simply the proportion of fixations to the target minus the proportion of fixations to a competitor. A positive object advantage in this experiment indicates that participants showed a preference for the object (target) over the subject (competitor) during a given region. A negative value indicates a corresponding subject preference.

3.3. *Wh- questions*

The object advantage for wh- questions is plotted by sentence region in Fig. 2. Aphasic participants' object-advantage scores are plotted in black, while control participants' object-advantage scores are plotted in grey. Error bars represent standard errors (*SE*s). Generally, both groups of participants looked roughly equally often at the subject picture (the boy) and the object picture (the girl) early in the sentence, and began to look more often at the object picture (the girl) starting at the verb (kiss). However, their fixation patterns differed in the latter region of the sentence, following the trace region.

Neither aphasic nor control participants showed a significant object preference during the subject region (one-sample *t*-tests vs. chance level of 0; aphasic participants: $t(11) = 0.72$, $p > 0.05$, $SE = 0.09$, control participants: $t(7) = 1.18$, $p > 0.05$, $SE = 0.07$). Object-advantage scores ranged from −19% to 35% for control participants, while they ranged from −50% to 52% for aphasic participants. However, both groups showed a significant object preference at the verb (aphasic participants: range = −18% to 49%, $t(11) = 3.37$, $p < 0.05$, $SE = 0.05$; control participants: range = −13.5% to 52.9%, $t(7) = 2.52$, $p < 0.05$, $SE = 0.07$).The aphasic participants did not show a significant object advantage at any other region of the sentence, but control participants showed a continuing significant object advantage during the post-verbal trace region and the location region (trace region: $t(7) = 4.65$, $p < 0.05$, $SE = 0.08$; location region: $t(7) = 2.94$, $p < 0.05$, $SE = 0.05$; post-offset region: $t(7) = 2.17$, $p > 0.05$, $SE = 0.04$). This pattern is very similar to the performance of Sussman and Sedivy's (2003) young unimpaired participants, who showed no fixation advantage for the object during the subject region but a significant preference to look at the object starting at the verb in wh- questions. This increase in object fixations at the verb for both groups is consistent with automatically associating the wh- element with the verb.



Subject region: "the boy"; Verb region: "kiss"; Trace region: "that day at"; Location region: "school?"

Fig. 3. Object advantage scores for correctly vs. incorrectly answered wh- questions, by sentence region, aphasic participants.

Aphasic and control participants also showed essentially identical performance in all regions of the sentence except the location region ("…school?"), where the difference was statistically significant (independent samples *t*-test: $t(18) = 2.62$, $p < 0.05$, $SE = 0.08$). Here, the aphasic participants exhibited a negative object-advantage score, indicating a preference to look at the subject during this region, while control participants showed a continuing preference for the object during the same region. This pattern indicates that aphasic participants experienced competition from the animate subject competitor during the latter part of the sentence on some trials, while their unimpaired counterparts did not.

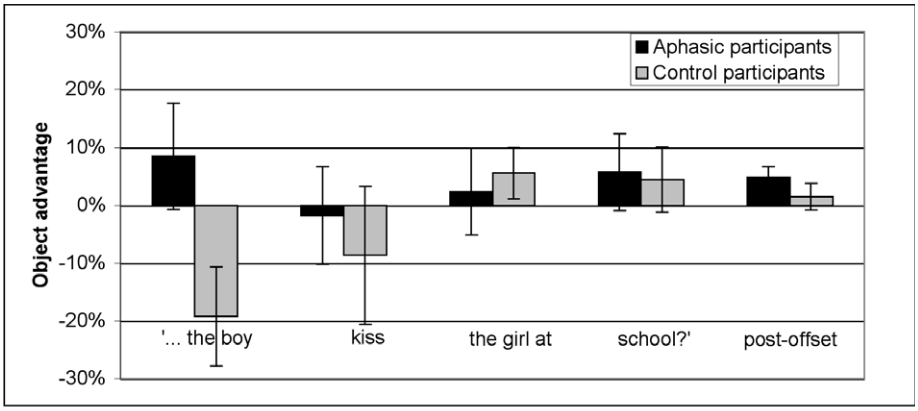
Separate analyses comparing trials eliciting incorrect responses by aphasic participants (30% of trials) to trials eliciting correct responses indicated that this pattern was due primarily to fixations in the incorrect trials, as shown in Fig. 3.[6] Statistical analyses directly comparing these groups are unlikely to be reliable, since there are relatively few incorrect-trial observations (and none at all for 4 of the 12 participants). Such comparisons should therefore be treated with caution. However, the fixation patterns seen in the early part of the sentence, the subject through trace regions, did not differ significantly for correct and incorrect trials (subject region: $t(17) = 0.12$, $p > 0.05$; verb region: $t(17) = 1.53$, $p > 0.05$; post-verbal trace region: $t(17) = 1.02$). The only clear differences between the two emerge in the location and post-offset regions, with incorrect trials showing a numerical subject preference in these regions. The only statistically significant difference between correct and incorrect trials appeared in the post-offset region, when participants gave their responses to the wh- question (independent-samples *t*-test: $t(17) = 2.55$, $p < 0.05$, $SE = 0.24$).

3.4. Yes–no questions

The object advantage for yes–no questions is plotted by sentence region in Fig. 4. Aphasic participants' object-advantage scores are plotted in black, while control participants' object-advantage scores are plotted in grey. Error bars represent standard errors (SEs). Both groups of participants exhibited a qualitatively different pattern when listening to yes–no questions like "Did the boy kiss the girl at school?" than when listening to wh- questions. They fixated on the subject (the boy) when hearing the subject, and they fixated on the subject and object roughly equally often during the remainder of the sentence. There was no increase in object fixations following the verb, as seen for the wh- question condition.

Control participants showed a marginally significant subject preference during the subject region (range = −45% to 10%, $t(7) = 2.29$, $p = 0.056$, $SE = 0.07$). There were no statistically significant differences at any other region (verb region: $t(7) = 1.10$, $p > 0.05$; object region: $t(7) = 0.91$, $p > 0.05$; location region: $t(7) = 1.02$, $p > 0.05$; post-offset region: $t(7) = 0.50$, $p > 0.05$). Aphasic participants did not show a significant object or subject preference during any part of the sentence; their object-advantage scores did not differ from chance during any sentence region. Furthermore, aphasic and control participants showed overall similar fixation patterns across the sentence. There were no statistically significant differences between control and

[6] As described above, both trials eliciting a response of "I don't know" and those receiving a subject answer (instead of a correct object answer) were counted as incorrect trials for the purposes of this analysis. An anonymous reviewer raises the interesting point that these two responses could reflect different processing: "I don't know" responses are suggestive of ambivalence and genuine competition between the object target and the subject competitor, while subject answers suggest simple incorrect selection of the ungrammatical subject answer. These differences might well be reflected in the fixation patterns, with different patterns for the "I don't know" and the truly incorrect subject-response trials. However, because of the relatively small numbers of incorrect wh- question trials (only 30% of trials), there are too few trials of each type to analyze them separately. We hope to address this question in future studies, ones which elicit greater numbers of incorrect responses.



Subject region: "the boy"; Verb region: "kiss"; Object region: "the girl at"; Location region: "school?"

Fig. 4. Object advantage scores for yes–no questions, by sentence region, aphasic vs. control participants.

aphasic participants during any region of the sentence (independent-samples *t*-tests, subject region: $t(18) = 1.84$, $p > 0.05$; verb region: $t(18) = 0.62$, $p > 0.05$; object region: $t(18) = 0.44$, $p > 0.05$; location region: $t(18) = 0.56$, $p > 0.05$; post-offset region: $t(18) = 0.49$, $p > 0.05$). Aphasic and control participants thus exhibited very similar fixation patterns throughout the sentence for yes–no questions, in contrast to wh- questions.

Replicating Sussman and Sedivy's (2003) findings for young normal comprehenders, there was no evidence of anticipatory looks to the object at the point the verb is heard. Both aphasic and control participants showed a numerical subject preference during the verb region for Yes–No questions (−3.2% object-advantage score for aphasic participants, range = −45% to 45%, and −10.5% for control participants, range = −55% to 20%), while both groups showed a reliable object preference during the verb in wh- questions (18.2% object advantage for aphasic participants, range = −18% to 49%,and 20.9% object advantage for controls, range = −14% to 53%). This difference resulted in a significant difference between wh- and yes–no questions during the verb region for both groups (aphasic participants: $t(18) = 3.18$, $p < 0.05$, $SE = .07$; control participants: $t(18) = 4.41$, $p < 0.05$, $SE = .07$). This effect replicates Sussman and Sedivy's central finding for young normals: both aphasic and control participants show increased looks to the object at the verb in an object wh- question, but not in a yes–no question. It is this effect which Sussman and Sedivy interpret as visual evidence of gap-filling, automatically associating a moved element with a verb or trace.

4. Result: Object clefts

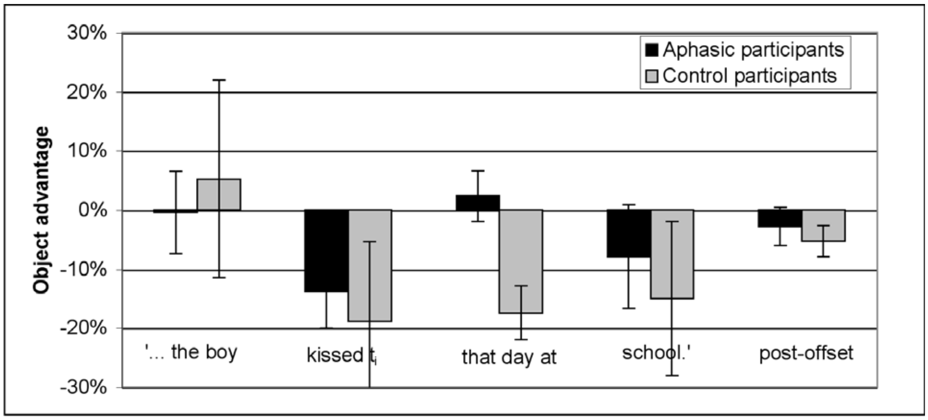
Next we turn to the results for object clefts. These sentences share a similar abstract structure with wh- questions, since they also involve wh- movement. We would therefore expect them to show similar visual evidence of rapid, automatic association of the moved element with the verb. Results for the comprehension probes are presented first, followed by results for eye-movements. In the statistical analyses reported below, all proportion data have been corrected using an arcsin transformation, as in the previous section.

4.1. Comprehension probes

Parallel to their performance with wh- questions, aphasic participants in this experiment were impaired in their comprehension of object clefts. While control participants were 94% accurate in their responses to object clefts (range = 90–100%), aphasic participants were only 67% accurate (range = 20–100%). Aphasic participants' performance did not differ statistically from chance ($t(11) = 1.26$, $p > 0.05$, $SE = 0.08$). Aphasic participants also performed significantly more poorly than controls ($t(18) = 2.447$, $p < 0.05$, $SE = .08$).

4.2. Eye-movements

The object advantage for object clefts is plotted by sentence region in Fig. 5. Aphasic participants' object-advantage scores are plotted in black, while control participants' object-advantage scores are plotted in grey. Error bars represent standard errors (SEs). Overall, both groups of participants fixated on the object (the girl) numerically more often than the subject (the boy) early in the sentence, during the subject region ("who the boy …"). For the remainder of the sentence, they showed a preference for the subject, reflected in their negative object-advantage scores during the remaining sentence regions. The aphasic participants' object-advantage scores did not differ significantly from chance during any region of the sentence (subject region: $t(11) = 0.21$, $p > 0.05$; verb region: $t(11) = 1.82$, $p > 0.05$; trace region: $t(11) = 0.51$, $p > 0.05$; location region: $t(11) = 0.63$, $p > 0.05$; post-offset region: $t(11) = 0.72$, $p > 0.05$). Control participants showed a reliable subject



Subject region: "the boy"; Verb region: "kissed"; Object region: "that day at"; Location region: "school."

Fig. 5. Object advantage scores for object clefts, by sentence region, aphasic vs. control participants.

preference during the post-verbal trace region (range = −35% to 0%; $t(7) = 3.20$, $p < 0.05$, $SE = 0.05$) but nowhere else in the sentence (subject region: $t(7) = 0.61$, $p > 0.05$; verb region: $t(7) = 1.10$, $p > 0.05$; location region: $t(7) = 1.29$, $p > 0.05$; post-offset region: $t(7) = 1.64$, $p > 0.05$).

Somewhat surprisingly, the aphasic participants showed a numerical increase in object fixations (higher object-advantage scores) during the post-verbal trace region compared to the preceding verb segment (−11% object-advantage score at the verb, 2% object-advantage score during the trace region). No such increase was seen for control participants (−14% object-advantage score at the verb, −15% object-advantage score during the trace region). Perhaps because of this increase in object fixations for the aphasic participants, there was a significant difference between aphasic and control participants at the post-verbal trace region ($t(18) = 2.87$, $p < 0.05$, $SE = 0.596$). There were no other significant differences between the groups' object-advantage scores elsewhere in the sentence.

5. Discussion

The data from the two different sets of items, the wh-questions and yes–no questions on the one hand and the object cleft sentences on the other, exhibit different patterns. We will discuss the patterns seen for the yes–no and wh- questions items first and then the patterns for object-clefts. We will then discuss some possible reasons for the discrepancies between the two sets of results.

In their responses to the comprehension probes, aphasic and control participants exhibited similar behavior for yes–no questions, both groups responding with above-chance accuracy. The two groups' automatic comprehension of yes–no questions, as reflected by their eye-movement patterns, was also very similar. There were no reliable differences between the two groups' object-advantage scores during any sentence region. In contrast, the two groups' performance on wh- questions was different. First, aphasic participants were significantly less accurate than control participants in their responses to the comprehension probes. Second, the two groups' eye-movements differed, but these differences only appeared in the later (post-verbal) regions of the sentence. Both groups showed visual evidence of rapidly associating a moved wh- element with a verb in object wh- questions, in the form of increased object-advantage scores emerging at the verb in object wh- questions. No such preference appeared in yes–no questions for either group, and there were no significant differences between the two groups during the subject, verb, or post-verbal trace regions of the wh- question. However, aphasic participants showed evidence of competition between the object and the animate subject competitor toward the end of wh- questions. In contrast, unimpaired control participants showed no evidence of such competition. Analyses comparing aphasic participants' correct and incorrect wh- question trials further provided suggestive evidence that the late-appearing subject fixations appeared primarily in incorrect trials. There was numerical evidence of this trend during the location region, with statistically significant evidence of more subject fixations in incorrect trials appearing in the post-offset region of the sentence. Further, there was no evidence of any differences between correct and incorrect wh- question trials for early sentence regions (subject, verb and trace regions). It is these regions where Sussman and Sedivy found visual evidence of automatically associating a moved element with a verb.

These results suggest that aphasic participants' on-line processing of the movement dependency in wh- questions was relatively unimpaired. If this is correct, these results are surprising under both impaired-representation and slowed-processing accounts of aphasic comprehension deficits. The index of automatic comprehension in wh- questions, increased looks to the object during the verb, appeared equally early for aphasic and control participants. This seems surprising even under slowed-processing accounts which restrict slowed processing in aphasia to long-distance grammatical dependencies such as wh- movement. In addition, there was no evidence that automatic processing was delayed in aphasic participants' incorrectly answered wh- questions compared to their correctly answered ones. Instead, the difference appeared as late-emerging competition between subject and object in incorrect trials. The wh- question data from this experiment do not support slowed-processing predictions: that automatic processing of a movement dependency should be slower in aphasic individuals than controls, and that automatic comprehension should be slower for cases of failed comprehension (in this case, incorrect trials) than for cases of successful comprehension.

These results also provide no support for an impaired-representation prediction: that automatic processing of wh- questions should be qualitatively different for aphasic and unimpaired individuals, since they are constructing qualitatively different syntactic representations. Aphasic and control participants did not differ in their eye-movement patterns early in the sentence. It was only in later segments, the sentence-final location region and the post-offset region, that looking patterns differed. Assuming that fixation patterns early in the sentence are indicative of automatic processing of the wh- question and the wh- movement dependency, aphasic and control participants processed these sentences quite similarly.[7]

However, there was little evidence of either aphasic participants or controls automatically associating the moved element (here, the wh- phrase coindexed with the clefted object argument "the girl") with the verb for object clefts. This contrasts with the eye-movement data for wh- questions, where there was a reliable increase in object fixations at the verb, consistent with automatic gap-filling. While the numerical increase in object fixations by aphasic participants following the verb in object clefts could be construed as evidence of such automatic processing, this difference is not reliable (in contrast to wh- questions) and it appears one sentence region downstream from where such fixation would be expected to occur (at the verb, as with wh- questions). The fixation patterns for object clefts thus differed qualitatively from the fixation patterns seen for the syntactically related object wh- questions.

One possible explanation of this difference in fixation patterns for object clefts is related to the distribution of filler and experimental materials, already alluded to in Section 2.2 above.[8] For the experimental object wh- questions, there were distractor subject wh- questions among the fillers, to prevent participants from developing any response biases. For the experimental object cleft items, however, there were no corresponding subject cleft distractors. This oversight may well have resulted in strategic looking patterns for cleft items, whose structure was always the same. Another possibility is that the object fixations seen for wh- questions were strategic "question-answering" looks, reflexes of a non-linguistic strategy of looking at the answer to the question at the earliest possible point in the sentence.

The notion that the fixations seen for the wh- questions were "question-answering" looks is countered by examining differences in fixation patterns for the correct and incorrect trials for the aphasic participants. Fixation patterns in the two cases did not differ during the subject, verb, or post-verbal trace regions, where we would expect to find evidence of automatic processing of the movement dependency. Instead, the pattern of early object fixations was similar regardless of the answer ultimately given to the question. If these fixations early in the sentence were truly "question-answering" looks, we would expect these patterns to differ for correctly and incorrectly answered wh- questions, since the correct and incorrect trials elicited different answers. Further, the appearance of a reliable object advantage at the verb is actually later than we would expect question-answering looks to begin. The wh- questions are unambiguously object questions, as marked by the inverted auxiliary before the subject ("Who did the boy kiss that day at school?"). Encountering this auxiliary is sufficient to determine that the sentence is questioning the object. If participants were looking to the answer as soon as they could determine that it was an object question, the object preference should have emerged at the subject region.

Further evidence is needed to ultimately determine whether the early fixation patterns found here for wh- questions are indices of the automatic processing of a wh- dependency. We will return to this issue in Section 6.

[7] The eye-movement evidence presented here could in principle be evidence of intact automatic semantic or thematic processing by both aphasic and control participants, as mentioned in Footnote 6 above and discussed further in Section 6. Perhaps the anticipatory looks to the object at the position of the verb in wh- questions are in fact evidence of rapid assignment of a Theme semantic role to the fronted element. (The eye-movement data suggest that this rapid thematic role assignment happens only in wh- questions, however, since no such anticipatory fixations were found in yes–no questions; viz. Sussman & Sedivy, 2003.) If so, the eye-movement patterns here would be consistent with models of aphasic comprehension in which fast and automatic thematic processing is intact in aphasia, but syntactic processing may still be impaired or delayed. However, it would be inconsistent with models in which thematic-role assignment is the locus of the deficit (such as Nakano & Blumstein, 2004; Myers & Blumstein, 2005). Interestingly, if this interpretation is correct, it indicates that both aphasic and unimpaired comprehenders may make use of non-syntactic computations to resolve syntactic dependencies on-line, as has independently been argued for typical comprehenders (Townsend & Bever, 2001; e.g.). This interpretation would also be at odds with the syntax-driven model of gap-filling assumed here, in which the syntactic constraints governing movement dependencies directly determine how they are computed during sentence comprehension. We are grateful to an anonymous reviewer for pointing out the importance of this alternative interpretation.

[8] There is at least one other possible explanation of this different pattern: that the syntactic structure of clefts is sufficiently different for the automatic processing routines used to comprehend them to be qualitatively different from those for wh- questions. Perhaps the same "active filler" strategy which applies to the comprehension of wh- questions does not apply to clefts. However, given that these sentence types appear to be functionally related in aphasia, becoming impaired and recovering together (viz. Thompson et al., 2003), and have traditionally been assumed to be similar in structure (Chomsky, 1986), we reject this possibility.

However, even if these fixations are simply a reflex of a "question-answering" strategy or some other extralinguistic heurisitic (viz. Grodzinsky, 1990, 2000), the current results indicate that such strategies can apply with surprising speed. Aphasic individuals were guessing at/fixating on the correct answer at the same point in the sentence as unimpaired controls. Further, it appears that such rapidly employed "question-answering" strategies do not necessarily correspond to (or constrain) the answer that participants ultimately provide. Participants were just as likely to fixate on the target object early in object wh- questions which they ultimately answered incorrectly.

With respect to the differing patterns found for wh-questions and object clefts, there are three pieces of evidence that the object-cleft fixation data were spurious. First, unlike in the wh- and yes–no question conditions, there is a mismatch between the eye-movement data and the off-line responses for object clefts. The poorer off-line comprehension of object clefts seen for aphasic participants was not reflected in their eye-movement patterns as it was for wh- questions. The aphasic participants' eye-movement patterns were also quite similar to control participants' patterns, even though their responses to the comprehension probes were not. Second, following the experiment, all of the control participants reported that they noticed early on that the cleft sentences were always the same, and that the response to these items was usually "yes." Many reported that they quickly stopped listening closely to these items as a result. Third, consistent with this observation, the raw numbers of fixations for object clefts were lower than for wh- questions. For example, participants fixated on the subject and object elements in a display an average of 70 times while listening to a wh- question, in which only the subject was overtly mentioned. In contrast, they fixated on the subject and object only 55 times while listening to an object cleft (in which both these elements were directly mentioned). Participants simply attended to the elements in the display less when listening to object clefts than when listening to wh- questions. These observations suggest that the eye-movement data in the object-cleft condition did not reflect participants' on-line sentence processing routines.

6. Conclusions

This study examined the automatic processing of wh-movement sentences by people with aphasia using a novel experimental technique, eyetracking while listening. In doing so, it tested the predictions of two competing explanations of aphasic individuals' comprehension difficulty with movement sentences, slowed-processing and impaired-representation accounts. The results, while preliminary, do not appear to be consistent with the predictions of either account. They suggest that when listening to yes–no questions and wh- questions, people with aphasia engage in the same rapid, automatic processing as unimpaired controls, from early on in the sentence. Further, the data suggest that for wh- questions, people with aphasia experience late-emerging competition from an ungrammatical competitor answer to the object wh- question, which unimpaired listeners do not. This competition emerges after normal-like processing early in the sentence, and it may be the source of their comprehension failure (since fixations to the animate subject competitor appear primarily in trials which elicited incorrect responses). There was no evidence that people with aphasia were slow in their on-line processing of the wh- dependency, as would be expected under slowed-processing accounts, or that their early automatic processing of the wh- questions was different from unimpaired controls, as would be expected under impaired-representation accounts.

The different eye-movement patterns for object clefts make the ultimate interpretation of the wh- question eye-movement data uncertain. There are a number of reasons to think that the fixations seen for object clefts are not indicative of participants' automatic processing, particularly since they do not show the strong match between eye-movement patterns and off-line responses found for both yes–no and wh- questions. However, even if the early fixation patterns seen for wh- questions are the result of extra-linguistic heuristics or guessing strategies rather than automatic processing of linguistic structure, these results clearly indicate that such strategies can apply very quickly. Further, they indicate that such strategies appear to be used not only by people with aphasia but by typical comprehenders as well.

Nevertheless, further evidence is needed to pin down the nature of the anticipatory eye-movements seen for wh-questions. One important piece of evidence would be to know whether these fixation patterns are affected by linguistic constraints on wh- movement. This is a crucial prediction of the syntax-driven model of automatic comprehension of movement dependencies assumed here. For example, would comprehenders be tempted to associate a wh- element with a verb which was in a grammatically inaccessible position, showing increased target fixations upon hearing a tempting verb inside an island (cf. McElree & Griffith, 1998; Traxler & Pickering, 1996)? In the case of a sentence like "Point to who the teacher that lectured about Napoleon bored to tears," would listeners look at a picture of some students when hearing the inaccessible verb "lectured," which lies inside a subject relative-clause island? Previous research using other paradigms has indicated that typical comprehenders are sensitive to such constraints, and do not try to associate moved elements with grammatically inaccessible verbs. Converging evidence from eyetracking (and for aphasic comprehenders) for these cases would be welcome. Similarly, further research is needed to determine whether these early fixations in wh- questions are due to a syntactic processing strategy of rapidly associating a moved element with a trace, or whether they reflect a semantic strategy of associating a moved element with the first element which can assign it a semantic role (cf. Pickering & Barry, 1991). Since the element which signals a trace in the current study (the verb) also assigns the moved element's semantic-role, further research is needed to tease these possibilities apart.[9,10]

Perhaps the most striking result from the current study is the late-emerging subject competition found for wh- questions. This result must be replicated and extended before we can confidently assign an interpretation to it. Nevertheless, its appearance highlights the particular usefulness of the eyetracking paradigm. Since eyetracking allows experimenters to track and analyze comprehension of multiple elements, patterns such as this are fairly easily observable. Methods such as CMLP and auditory anomaly detection only track activation of one element, or computation of one dependency, and consequently can obscure these sorts of multiple-activation effects. For example, a CMLP study only probing activation of the object (the moved element) could not reveal the reactivation of the subject seen in the eye-movement patterns for wh- questions.

Also striking are the similar early fixation patterns seen for correct and incorrect trials in the wh- question conditions. What distinguished questions eliciting correct and incorrect responses was not their initial processing (as indexed by eye movements early in the sentence) but the fixations seen later in the sentence. It is worth stressing that this pattern is suggestive—it is based on only a small set of trials and is fully reliable only in the post-offset region—and it must be replicated and extended before we can assign a final interpretation to it. However, parallel eye-tracking results have been found for a different class of grammatical dependencies, anaphor-antecedent relations for pronouns and reflexives (Choy & Thompson, 2005). In that study, trials eliciting correct and incorrect responses also showed similar early processing, with incorrect trials showing late-emerging competition from another antecedent for the pronoun or reflexive.

There are two more outstanding questions regarding the current results and how they fit with the previous results on comprehension of wh- movement by people with aphasia. The first question is theoretical. If the current results do not appear consistent with existing slowed-processing or impaired-representation accounts, what sort of account of aphasic language deficits are they consistent with? One possibility is that syntactic computations are not fundamentally altered or pathologically slowed in agrammatic aphasia, but are instead *weakened*, to the point that other factors may intervene to determine the sentence's ultimate interpretation (cf. Avrutin, 2006). Under such a view, the effect of damage to cortical tissue involved in building syntactic structure is not to fundamentally change the kinds of syntactic computations that are carried out, but instead to weaken the output of those computations. People with aphasia are carrying out the same operations with the same speed as people without brain damage in order to construct the same abstract representations, but the cortical representations associated with these syntactic structures are no longer strong enough to inhibit competition from other sources, such as competing extralinguistic heuristics (such as an Agent-first heuristic; Bever, 1970; Grodzinsky, 1990, 2000; Townsend & Bever, 2001) or independently generated lexical-semantic entailments (Piñango, 2000).[11] The late-emerging fixations to the subject competitor found in the current study may be visual evidence of just these competing influences. These sorts of competing heuristics have been shown to occasionally affect comprehension of non-canonical sentences even in typical individuals (Ferreira, 2003); under a weakened-syntax approach, aphasic individuals are simply more vulnerable to such influences. If this view of syntactic computation in aphasia is correct, it also provides a natural framework for understanding the treatment effects resulting from explicit training of abstract linguistic structure (TUF; Thompson, 2001). The effect of such training is to strengthen existing but radically weakened syntactic computations, which can then be employed in both comprehension (Dickey & Thompson, 2004) and production (Thompson, 2001; Thompson et al., 2003).

A second question raised by the current results is methodological. As discussed in Section 1, previous results from techniques such as CMLP and auditory anomaly detection have suggested that comprehension of wh-movement, even successful comprehension of wh- move-

[9] There is at least one additional possible source for the object fixations seen for wh- questions: the discourse or pragmatic prominence of the fronted wh- element. Discourse prominence has been shown to strongly affect eye-movements in other studies using this paradigm (e.g., Brown-Schmidt et al., 2005; among others). However, this explanation seems unlikely. The clefted object in object clefts (the girl in "It was the girl who the boy kissed that day at school") elicited consistently fewer looks than the subject, even though it is the focused element in the sentence (Rochemont, 1986; Kiss, 1998; among many others) and previous psycholinguistic work has shown that clefted elements are more salient that other elements in the sentence (Birch & Rayner, 1997; e.g.). In addition, the subject in yes–no questions, which is likely the default topic and center of attention in these sentences (Reinhart, 1981; Grosz & Sidner, 1986), did not elicit comparatively more fixations across the sentence than the less discourse-prominent object. Discourse prominence thus appears unlikely to be the motivation for fixations in this experiment.

[10] As discussed in Footnote 7 above, this possibility would in principle be consistent with approaches in which automatic semantic-role assignment processes are intact in aphasia (giving rise to the anticipatory fixations seen for wh- questions) but automatic computation of syntactic dependencies is disrupted. However, under this account of the eye-movement data presented here, additional hypotheses are needed to explain the late-emerging competition from the subject. For example, perhaps the extralinguistic heuristics which are claimed to guide aphasic comprehenders' understanding of non-canonical movement sentences (Grodzinsky, 1990, 2000) apply only after intact semantic-role assignment processes have had a chance to do their work. See below in the Conclusions for some discussion of such a possibility.

[11] This characterization of weakened syntactic computation is somewhat different from that of Avrutin (2006): that characterization focuses on competition between syntactic computations and other linguistic representations (such as information structure), and it also explicitly claims that the result of weakening the cortical representation of syntactic computations is to slow them. However, the two approaches do appear to share the same spirit.

ment, is slowed in aphasia. However, the current results from eyetracking while listening make it appear that people with aphasia are no slower than unimpaired individuals in their automatic comprehension. Interestingly, parallel eyetracking results from Yee et al. (2004) in the lexical domain point to the same conclusion. What is the source of this difference? A likely possibility is that it lies with the methodologies used. As discussed in Section 1, techniques such as CMLP and anomaly detection (as well as self-paced listening techniques, cf. Caplan & Waters, 2003) are mediated by consciously controlled responses such as a button press. In addition, they often involve a secondary cognitive task, such as a decision regarding whether a letter string is a word or not. Either of these operations may be impaired in aphasia. The response times in these tasks thus represent not only the time it takes aphasic participants to perform the linguistic operation being investigated, but also these secondary cognitive and motor operations. It is plausible that at least some portion of the delay seen in these tasks is due to precisely these task-specific additional processes.

The eyetracking methodology avoids these potential methodological pitfalls by using an unconscious and most likely unimpaired mechanism, eye-gaze, as an index of automatic processing. As the current study's results preliminarily suggest, this methodological advantage can bear significant theoretical dividends, allowing us to directly test fine-grained predictions of current theories regarding real-time language comprehension in aphasia.

Appendix A

Linguistic stimuli used in the experiment. Story contexts are provided followed by comprehension probes (A = wh-question, B = Yes–No question, C = Object cleft).

1. This story is about a girl and a boy.
One day, they were playing at school.
The girl was pretty, so the boy kissed the girl.
They were both embarrassed after the kiss.

A. Who did the boy kiss that day at school?
B. Did the boy kiss the girl that day at school?
C. It was the girl that the boy kissed that day at school.

2. This story is about a fish and a bird.
One day, they were at sea.
The bird was hungry and swallowed the fish.
He was full afterwards.

A. Who did the bird swallow that day at sea?
B. Did the bird swallow the fish that day at sea?
C. It was the fish that the bird swallowed that day at sea.

3. This story is about a ghost and a clerk.
One morning, they were both in a store.
The ghost was mischievous and scared the clerk.
Rumors spread that the place was haunted.

A. Who did the ghost scare that morning in the store?
B. Did the ghost scare the clerk that morning in the store?
C. It was the clerk that the ghost scared that morning in the store.

4. This story is about a duck and a shark.
One day, they were both swimming along the beach.
The shark was hungry and attacked the duck.
No one came to help out.

A. Who did the shark attack that day on the beach?
B. Did the shark attack the duck that day on the beach?
C. It was the duck that the shark attacked that day on the beach.

5. This story is about a grandma and a preacher.
One day, they were by the tombstone.
The grandma cried and so the preacher comforted the grandma.
They felt closer than ever.

A. Who did the preacher comfort that day by the tombstone?
B. Did the preacher comfort the grandma that day by the tombstone?
C. It was the grandma that the preacher comforted that day by the tombstone.

6. This story is about a woman and a student.
One day, they were both visiting London.
The woman had a camera, so the woman photographed the student.
The pictures all turned out well.

A. Who did the woman photograph that day in London?
B. Did the woman photograph the student that day in London?
C. It was the student that the woman photographed that day in London.

7. This story is about a lady and a soldier.
One evening, they were walking along the river.
The lady was flirtatious so the soldier embraced the lady.
They were attracted to each other.

A. Who did the soldier embrace that evening along the river?
B. Did the soldier embrace the lady that evening along the river?
C. It was the lady that the soldier embraced that evening along the river.

8. This story is about a dove and an owl.
One day, they were sitting on a branch.
The dove sang and the owl imitated the dove.
Their singing was unbearable to hear.

A. Who did the owl imitate that day on the branch?
B. Did the owl imitate the dove that day on the branch?
C. It was the dove that the owl imitated that day on the branch.

9. This story is about a princess and a singer.
One morning, they were sitting in a café.
The singer was lovestruck and approached the princess.
They both fell in love.

A. Who did the singer approach that morning in the café?
B. Did the singer approach the princess that morning in the café?
C. It was the princess that the singer approached that morning in the café.

10. This story is about a zebra and a giraffe.
One day, they were both in the open desert.
The giraffe was faster but the zebra challenged the giraffe.
They were out of breath after the race.

A. Who did the giraffe challenge that day in the desert?
B. Did the giraffe challenge the zebra that day in the desert?
C. It was the zebra that the giraffe challenged that day in the desert.

11. This story is about a man and a child.
One day, they were playing in the house.
The child was being naughty, so the man spanked the child.
They stopped playing after the spanking.

A. Who did the man spank that day in the house?
B. Did the man spank the child that day in the house?
C. It was the child that the man spanked that day in the house.

12. This story is about a pig and a cow.
One day, they were walking in the woods.
The pig fell behind so the cow pushed the pig.
They both were really exhausted that day.

A. Who did the cow push that day in the woods?
B. Did the cow push the pig that day in the woods?
C. It was the pig that the cow pushed that day in the woods.

13. This story is about a sheep and a bull.
One day, they were arguing on the farm.
The sheep got angry and kicked the bull.
They were both sorry afterwards.

A. Who did the sheep kick that day on the farm?
B. Did the sheep kick the bull that day on the farm?
C. It was the bull that the sheep kicked that day on the farm.

14. This story is about a snake and a rat.
One evening, they were playing together in the park.
The snake was sly and tricked the rat.
They never played together again.

A. Who did the snake trick that evening in the park?
B. Did the snake trick the rat that evening in the park?
C. It was the rat that the snake tricked that evening in the park.

15. This story is about a drummer and an actress.
One night, they were at a party.
The drummer got drunk and teased the actress.
They both went home early that night.

A. Who did the drummer tease that night at the party?
B. Did the drummer tease the actress that night at the party?
C. It was the actress that the drummer teased that night at the party.

16. This story is about a baby and a doctor.
One morning, they were both in the city.
The baby had a fever and so the doctor examined the baby.
They went to the hospital afterwards.

A. Who did the doctor examine that morning in the city?
B. Did the doctor examine the baby that morning in the city?
C. It was the baby that the doctor examined that morning in the city.

17. This story is about a model and an artist.
One evening, they were in the bedroom.
The model was beautiful, so the artist sketched the model.
The sketches became very famous.

A. Who did the artist sketch that evening in the bedroom?
B. Did the artist sketch the model that evening in the bedroom?
C. It was the model that the artist sketched that evening in the bedroom.

18. This story is about a sailor and a maiden.
One night, they both went to a dance at the castle.
The sailor was clumsy, so the maiden avoided the sailor.
They didn't dance that evening.

A. Who did the maiden avoid that night at the castle?
B. Did the maiden avoid the sailor that night at the castle?

C. It was the sailor that the maiden avoided that night at the castle.

19. This story is about a robin and a tiger.
One day, they were in the forest.
The tiger became hungry, and trapped the robin.
All the other animals ran away.

A. Who did the tiger trap that day in the forest?
B. Did the tiger trap the robin that day in the forest?
C. It was the robin that the tiger trapped that day in the forest.

20. This story is about a kitten and a puppy.
One day, they were playing in the fountain.
The puppy was being playful and drenched the kitten.
They had a lot of fun.

A. Who did the puppy drench that day in the fountain?
B. Did the puppy drench the kitten that day in the fountain?
C. It was the kitten that the puppy drenched that day in the fountain.

21. This story is about a horse and a dog.
One morning, they were walking along the street.
The horse was clumsy and accidentally kicked the dog.
They both got bruises.

A. Who did the horse kick that morning in the street?
B. Did the horse kick the dog that morning in the street?
C. It was the dog that the horse kicked that morning in the street.

22. This story is about a queen and a nurse.
One day, they were in church.
The queen became sick, so the nurse assisted the queen.
They became friends after that day.

A. Who did the nurse assist that day in church?
B. Did the nurse assist the queen that day in church?
C. It was the queen that the nurse assisted that day in church.

23. This story is about a prince and a witch.
One day, they were arguing on a hill.
The witch was angry and transformed the prince.
Everyone was amazed.

A. Who did the witch transform that day on the hill?
B. Did the witch transform the prince that day on the hill?
C. It was the prince that the witch transformed that day on the hill.

24. This story is about a kid and his dad.
One day, they were in the pool.
The kid was drowning but the dad saved the kid.
They were relieved to be safe.

A. Who did the dad save that day in the pool?
B. Did the dad save the kid that day in the pool?
C. It was the kid that the dad saved that day in the pool.

25. This story is about a bride and a groom.
On the wedding day, they were on the stairs.
The bride slipped and crushed the groom.
The wedding was delayed.

A. Who did the bride crush that day on the stairs?
B. Did the bride crush the groom that day on the stairs?
C. It was the groom that the bride crushed that day on the stairs?

26. This story is about a teacher and the police.
One morning, they were at the market.
The teacher shoplifted, so the police arrested the teacher.
A crowd gathered to watch.

A. Who did the police arrest that morning at the market?
B. Did the police arrest the teacher that morning at the market?
C. It was the teacher that the police arrested that morning at the market?

27. This story is about a monkey and a lion.
One day, they were in the jungle.
The lion was hungry and captured the monkey.
The other animals watched in fear.

A. Who did the lion capture that day in the jungle?
B. Did the lion capture the monkey that day in the jungle?
C. It was the monkey that the lion captured that day in the jungle.

28. This story is about a dancer and a fairy.
One night, they were in a palace.
The dancer performed and entertained the fairy.
Everyone had fun that night.

A. Who did the dancer entertain that night in the palace?
B. Did the dancer entertain the fairy that night in the palace?
C. It was the fairy that the dancer entertained that night in the palace.

29. This story is about a waitress and the fireman.
One day, they were in the diner.
The fireman was hungry and so the waitress served the fireman.
The meal was very tasty.

A. Who did the waitress serve that day in the diner?
B. Did the waitress serve the fireman that day in the diner?

C. It was the fireman that the waitress served that day in the diner.

30. This story is about an athlete and a scholar.
One day, they were sailing on the ocean.
The scholar was seasick so the athlete assisted the scholar.
They sailed for a week.

A. Who did the athlete assist that day on the ocean?
B. Did the athlete assist the scholar that day on the ocean?
C. It was the scholar that the athlete assisted that day on the ocean?

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