INTRODUCTION

Much of the research about sentence comprehension impairments in aphasia has focused on syntactic factors such as word order, but work in the area of non-disordered sentence processing highlights the importance of other information sources, such as lexical-pragmatic and prosodic cues (e.g., Blodgett, 2002; DeDe, Caplan, & Waters, 2005). For example, DeDe et al. (2005) showed that prosodic cues interacted with a combination of two lexical-pragmatic cues, verb transitivity bias and plausibility, during younger adults' on-line processing of sentences containing early closure ambiguities (e.g., Table 1, # 1 & 2). The present study extends DeDe et al.'s (2005) work by asking if individuals with aphasia access and integrate lexical-pragmatic and prosodic cues in the same way as age- and education- matched controls.

Table 1. Example Sentences and Summary of Experimental Conditions

#	Condition Name & Example Sentence*	At Ambiguous NP			
		Consistent Cues?	Cue Bias**		
			Pros	Trans	Plaus
1a	*Cooperating-Transitive-Plausible* While the parents / ***watched*** / the child / sang / a song / in the kitchen.	No	Subj	Obj	Obj
1b	*Neutral-Transitive-Plausible* While the parents / watched / the child / sang / a song / in the kitchen.	Yes	Obj	Obj	Obj
2a	*Cooperating-Intransitive-Implausible* While the parents / ***danced*** / the child / sang / a song / in the kitchen.	Yes	Subj	Subj	Subj
2b	*Neutral-Intransitive-Implausible* While the parents / danced / the child / sang / a song / in the kitchen.	No	Obj	Subj	Subj
3	*Late closure* While the parents / watched / a movie / the child / sang / a song / in the kitchen.	N/A			

*Slashes depict segmentation for self-paced listening. Bolded italic font indicates location of critical prosodic boundary in cooperating prosodic conditions. ** Cue Bias: Subj indicates bias towards subject interpretation of the ambiguous NP, and the early closure interpretation of the sentence. Obj indicates bias towards object interpretation of the ambiguous NP, and the late closure interpretation of the sentence.

METHODS

Participants

Twelve aphasic individuals (minimum six months post-onset of a single left-hemisphere stroke) and 12 non-brain damaged older (age- and education- matched) adults participated in the study. Participant characteristics are given in Table 2. The aphasic group completed background testing to ensure adequate single word comprehension to complete the tasks and to characterize their aphasic symptoms.

Table 2. Participant Information

	N	Age	Education
People with aphasia	12	Mean: 63.1 Range: 54-81	Mean: 16.9 Range: 12-20
Control	12	Mean: 65.6 Range: 56-75	Mean: 16.4 Range: 12-20

Procedures & Stimuli

The stimuli were identical to those described by DeDe et al. (2005). There were 15 sentence pairs containing early closure (EC) syntax. In EC sentences (e.g., Table 1, # 1 & 2), the second noun phrase (*the child*) is temporarily ambiguous. It may be the subject of a new clause, as is the case in EC sentences, but it may also be the direct object of the subordinate verb (*danced/watched*), as is the case in late closure sentences (LC; e.g., Table 1, #3). One member of each pair belonged to the *transitive-plausible* condition, in which the lexical-pragmatic cues were biased toward the LC interpretation and contained transitively biased subordinate verbs followed by plausible direct objects (Table 1, #1). The other member belonged to the *intransitive-implausible* condition, in which the lexical-pragmatic cues were biased toward the EC interpretation and contained intransitively biased subordinate verbs followed by implausible direct objects (Table 1, #2). The sentence pairs were identical except for the subordinate verbs, which were matched for frequency using Francis and Kuçera (1980). All stimuli were followed by true/false comprehension questions.

This lexical-pragmatic condition was crossed with two prosodic conditions. In the *cooperating* prosodic condition, the intonational contour increased expectations of EC structure by prosodically marking the clause boundary after the subordinate verb (Table 1, #1a & 2a; cf. Kjelgaard & Speer, 1999). In the *neutral* prosodic condition, neither of the possible clause boundaries was marked (Table 1, #1b & 2b), which increases expectations of LC structure.

The stimuli were recorded by a female speaker and then broken into segments consisting of short phrases using SoundEdit (Dunn, 1994) and entered into PsyScope (Cohen, MacWhinney, Flatt, & Provost, 1993) to create the self-paced listening (SPL) experiment. In SPL, participants paced themselves through each sentence one phrase at a time by pressing a button interfaced with a computer. The button box collected response accuracy and reaction times for each button press.

The stimuli were randomly assigned to four lists such that each version appeared in only one list. These were combined with filler sentences (15 of which had LC syntax) so that the experimental items comprised less than 20% of the items in each list. All participants completed all four lists in separate testing sessions, with order of list presentation counterbalanced across participants. Table 1 summarizes the experimental conditions.

RESULTS

Comprehension Questions

Table 3 presents the accuracy and response time data for each condition and group. The control group answered the comprehension questions more accurately than the aphasic group, $F1(1,22)=14.54$, $p<.001$. The control group also responded more quickly than the aphasic group, but the effect only reached the level of a trend, $F1(1,22)=3.81$, $p=.06$. No other effects were significant.

Table 3. Mean (and Std Dev) Proportion Correct and Response Times (msec) for Comprehension Questions

		Cooperating		Neutral	
		Intran-Implaus	Trans-Plaus	Intran-Implaus	Trans-Plaus
Older Adults	Accuracy	.91 (.10)	.87 (.17)	.88 (.13)	.89 (.14)
	Response Time	1757.5 (1354.7)	1831.4 (1781.3)	2091.5 (1634.5)	1942.2 (1453.1)
Aphasic Adults	Accuracy	.67 (.21)	.73 (.17)	.67 (.15)	.69 (.12)
	Response Time	3196.0 (1426.5)	3195.0 (1370.5)	2436.8 (962.1)	2877.0 (1505.3)

Listening times (LTs)

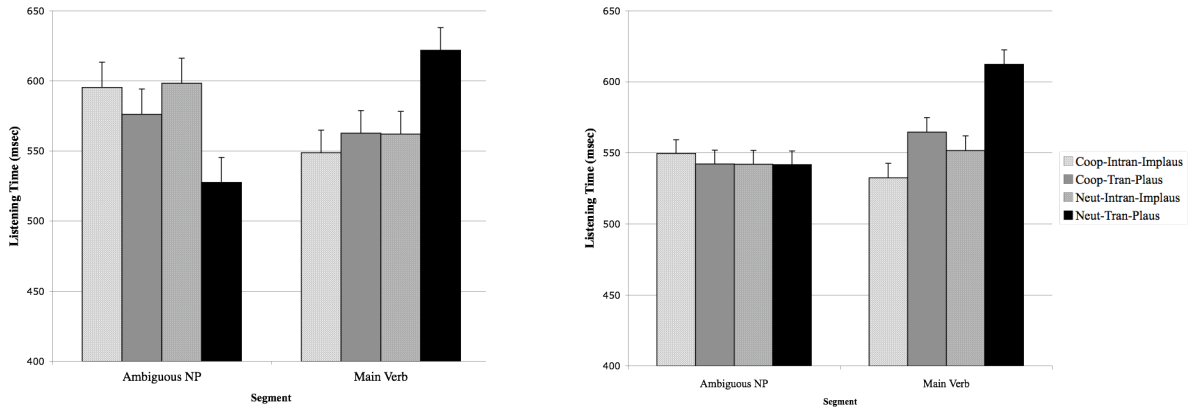
LTs for the ambiguous NP and the main verb were analyzed in separate 3-way ANOVAS (group x lexical-pragmatic condition x prosody). Figure 1 presents the LT data for each condition and group.

Ambiguous NP. The interaction of group, lexical-pragmatic condition, and prosodic contour was significant, $F1(1,22)=4.66$, $p<.05$. T-tests were used to examine predicted effects. The aphasic adults listened to the ambiguous NP for longer in the Neutral-Intransitive-Implausible condition than in the Neutral-Transitive-Plausible condition, $t(11)=2.57$, $p<.05$. LTs in the Cooperating-Transitive-Plausible condition were longer than those in the Neutral-Transitive-Plausible condition, $t(11)=2.17$, $p<.05$. LTs in the Cooperating-Intransitive-Implausible condition did not differ from those in the Neutral-Intransitive-Implausible or Cooperating-Transitive-Plausible conditions (t's ≤ 1.39). There were no significant differences in older adults' LTs for the ambiguous NP (all t's ≤ 1.46).

Main Verb. The main effect of lexical-pragmatic condition was significant, $F1(1,22)= 10.22$, $p<.001$, with longer LTs for sentences with transitively than intransitively biased subordinate verbs. This effect was qualified by the interaction between the conditions, $F1(1, 22)=8.03$, $p<.01$. LTs were significantly longer in the Neutral-Transitive-Plausible condition than any other condition. There were no other significant effects (no effects of group).

Figure 1. Self-Paced Listening Times for Aphasic and Control Groups

A. Aphasic Group **B. Control Group**



DISCUSSION

The results suggest that both aphasic and older adults are sensitive to lexical-pragmatic and prosodic cues during on-line syntactic ambiguity resolution. Both groups showed relatively long LTs for the main verb in the Neutral-Transitive-Plausible condition, suggesting they pursued the DO interpretation of the ambiguous NP when all of the cues were consistent with that interpretation, and were forced to reanalyze when the sentence was disambiguated. Only the aphasic group showed sensitivity to the presence of conflicting cues at the ambiguous NP. Note that DeDe et al. (2005) found that non-brain damaged younger adults were sensitive to the presence of conflicting cues at the ambiguous NP. This is important because it indicates that the

materials and paradigm were sensitive to the on-line processes of syntactic ambiguity resolution in non-disordered populations.

The findings that older adults did not show evidence of being slowed down by conflicting cues at the ambiguous NP but did show evidence of reanalysis at the main verb suggest that this group was also sensitive to the lexical-pragmatic and prosodic cues in the present experiment. These data are suggestive of interesting changes in syntactic ambiguity resolution as a function of normal aging. One possibility is that they relied on the cues available earlier in the sentence (e.g., at the subordinate verb) to avoid the conflict at the ambiguous NP.

Unlike the older adults (but like the younger adults), the aphasic adults' LTs for the ambiguous NP were longer in conditions with conflicting cues than in the Neutral-Transitive-Plausible condition. The aphasic group's LTs for the ambiguous NP in the Cooperating-Intransitive-Implausible condition were also relatively long and did not significantly differ from the conditions with conflicting cues. If the older adults' pattern of LTs relied on their ability to use the cues available at the subordinate verb, then the aphasic group's data may reflect an inability to integrate the cues on the same time course. Thus, even though the aphasic and younger (reported by DeDe et al., 2005) groups' data were similar in some ways, the aphasic group's data may reflect slowed integration of the probabilistic cues. In sum, the data suggest that aphasic adults are sensitive to the presence of lexical-pragmatic and prosodic cues, but integrate the cues more slowly during on-line syntactic structure-building operations.