Aging, Auditory Distraction, and Grammaticality Judgment

Background

The cognitive, syntactic and semantic influences in the task of sentence processing by normal individuals or in patients with brain damage are not well understood. Grammaticality judgment is a unique method of examining sentence processing. It has been shown that many patients with aphasia are able to judge grammaticality of sentences that they are unable to comprehend, suggesting that there are several levels of processing involved in interpreting sentences (Linebarger, Schwartz & Saffran, 1983; Wulfeck, 1988; Wilson & Saygin, 2004). Factors affecting normal subjects' abilities to complete cognitive linguistic tasks in the face of various types of distraction have been a subject of ongoing study (Jones, 1999; Goff et al., 2006). The purpose of this study was to examine the effects of auditory distraction on older and younger subjects' speed of grammaticality judgment of visually presented sentences varied by reversibility and short term memory requirements.

It is known that patients with aphasia have more difficulty comprehending reversible sentences than nonreversible sentences (Caramazza & Zurif, 1976); however, there have been no studies to date examining the influence of this reversibility variable on processing time for normal individuals in a visually presented grammaticality judgment task.

Short term memory variables have been studied in patients with aphasia in reaction time tasks where subjects monitored for words in sentences with extraneous words added to sentences to increase the memory load (Baum, 1989). However, there have been no studies to examine the impact of extraneous words ("padding") on the processing time for a visually presented grammaticality judgment task with normal individuals.

There have been several studies examining the grammaticality judgment performance of patients with aphasia (Linebarger et al., 1983; Wulfeck, 1988; Wilson & Saygin, 2004). Few data exist on the ability of normal adult subjects to judge grammaticality (Schutze, 1996; Breedin & Saffran, 1999), and none known that vary the semantic, attentional and memory requirements as in this study. Through analysis of reaction times to correct judgments of grammaticality, this study examines variables affecting processing performance for participants who are easily able to judge grammaticality across the stimuli.

Method

Development of stimuli: Consider the following sentence pair (nonreversible, passive):

1a. The cheese was eaten by the mouse.
1b. *The cheese was eaten the mouse.

In order to increase the demand on the subject's short term memory, extraneous words (6-8 total syllables) were placed outside the grammatical constraint; that is, outside the words which could theoretically constitute an error. Extra words (6-8 syllables) were similarly placed between the constraint and the error (or potential error) (the outside condition), as follows.

1a1. *In the corner of the kitchen*, the cheese was eaten by the mouse. (outside, good)
1a2. The cheese was *silently but still quite quickly* eaten by the mouse. (inside, good)

1b1. **In the corner of the kitchen*, the cheese was eaten the mouse. (outside, bad)
1b2. *The cheese was *silently but still quite quickly* eaten the mouse. (inside, bad)

Sets of reversible sentences were also constructed:

2a. The dog was chased by the cat.
2b. *The dog was chased the cat.

2a1. *In the middle of the field*, the dog was chased by the cat.
2a2. The dog was *awkwardly but happily* chased the cat.

2b1. **In the middle of the field*, the dog was chased the cat.
2b2. *The dog was *awkwardly but happily* chased the cat.

For each base sentence, then, four stimulus sentences were constructed, half grammatical, half ungrammatical; half with padding inside the grammatical constraint and half with padding outside the constraint. This resulted in 40 stimulus sentences, plus the 20 base sentences which were used for a separate analysis. Sixty other sentences from another experiment were included as filler sentences, for a total of 120 items.

Subjects: Thirty students in an undergraduate class in Psycholinguistics participated in the experimental task as a class assignment. An additional 15 subjects in the older age group completed the task as outlined. All subjects had normal or corrected hearing and passed a computerized reading screening prior to the experiment.

Task: Subjects were asked to silently read sentences presented on a computer screen and indicate as quickly as possible if each sentence was good (grammatical, permissible in English) or bad (ungrammatical, not permissible in English) by pressing a key on the keypad. Participants completed the task in quiet (no distraction) or in one of two types of auditory distraction (cafeteria noise or narrative [Anne of Green Gables, downloaded from Gutenberg.org).

Apparatus: Participants completed the experiment on either a Gateway or a Dell computer running Windows XP using SuperLab experimental software. Sentences were presented in black font on a white background and were randomized for presentation with a break given after every 40 presentations. Distraction was presented via iTunes using ancillary speakers at an intensity of approximately 70dB measured with a sound level meter. Reaction times (RTs) were measured by SuperLab.

Results

For this preliminary analysis, only correct responses were analyzed. Outliers were replaced with the value of two standard deviations from the mean. Data were analyzed using an analysis of variance using SPSS

Significant main effects were noted for Age, Attention, Grammaticality, and Reversibility; these are shown in Table 1. Reaction times were slower for the older age group, and for the good sentences. Reaction times were also slower for nonreversible sentences. There was a significant interaction effect for Age x Attention, illustrated in Figure 1. Younger subjects showed slowest reaction time in the Quiet and Noise conditions, with the fastest RTs in the Talk condition. The older group showed no significant difference between the Noise and Talk conditions, but were slower in the Quiet condition. Older participants were similarly distracted by the Noise and Talk conditions, while the younger subjects completed the task similarly in the Noise and Quiet conditions. There was also a significant Age x Grammaticality interaction (Figure 2). Younger participants showed a greater difference in RTs between good/bad sentences than did the older participants.

Preliminary analyses suggest that linguistic distraction increased speed of performance in the experimental task across all ages (consistent with Goff et al., 2006), but that the older subjects were similarly affected by the Noise and Talk distraction conditions. Younger subjects responded with comparable RTs to the Noise and Quiet conditions, suggesting that with normal aging, there may be increased sensitivity to distraction. Further data analysis will compare error rates in the different age groups and distraction conditions. Additional study has commenced examing the contribution of the aforementioned variables in a self-paced reading task.

References

Baum, S (1989) On-line sensitivity to local and long-distance syntactic dependencies in Broca's aphasia. *Brain and Language*, 37 (2), 327-38;

Breedin, S. & Saffran, E.M. (1999) Sentence processing in the face of semantic loss: a case study. *Journal of Experimental Psychology - General* 128 (4), 547-62

Caramazza A, & Zurif, E (1976) Dissociation of algorithmic and heuristic processes in language comprehension: Evidence from aphasia. *Brain and Language*, 3, 572-582.

Goff R, LaPointe L, Hancock A, Stierwalt J, Heald G (2006) *Quality and intensity of cognitive distraction: cafeteria noise and babble in younger vs. older adults*. Annual convention of the American Speech-Language-Hearing Association, Boston, MA.

Jones D. (1999) The cognitive psychology of auditory distraction: The 1997 BPS Broadbent Lecture. *British Journal of Psychology.* 90:2, 167-187

Linebarger M.C., Schwartz M.F., & Saffran E.M. (1983) Sensitivity to grammatical structure in so-called agrammatic aphasics. *Cognition*, 13:361-92

Schütze, C. T. (1996). *The empirical base of linguistics: Grammaticality judgments and linguistic methodology*. Chicago: University of Chicago Press.

Wilson, S. M. & Saygın, A. P. 2004. Grammaticality judgment in aphasia: Deficits are not specific to syntactic structures, aphasic syndromes, or lesion sites. *Journal of Cognitive Neuroscience* 16, 2 (Mar. 2004), 238-252.

Wulfeck, B (1988) Grammaticality judgments and sentence comprehension in agrammatic aphasia. *Journal of Speech and Hearing Research*, 31, 72-81.

Table 1. Mean reaction times in grammaticality judgment task

Variable		Mean (ms)	SEM
Age	Older	2790	15.586
	Younger	2346	13.238
Attention	Quiet	2679	18.374
	Noise	2694	16.586
	Talk	2422	18.115
Grammaticality	Good	2640	14.423
	Bad	2497	14.497
Reversibility	Reversible	2704	14.460
	Nonreversible	2432	14.459

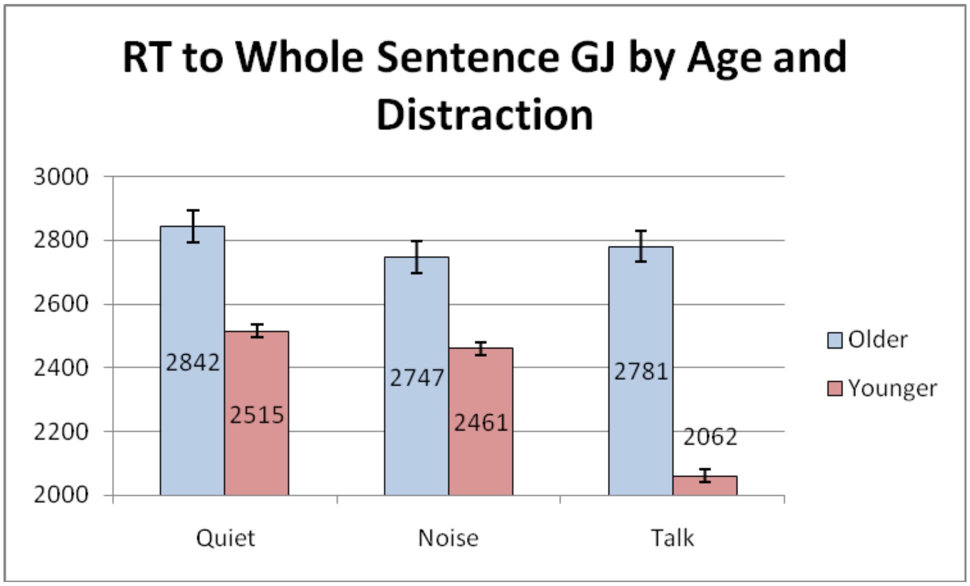

Figure 1. Reaction time to whole sentence grammaticality judgment task by age and distraction.

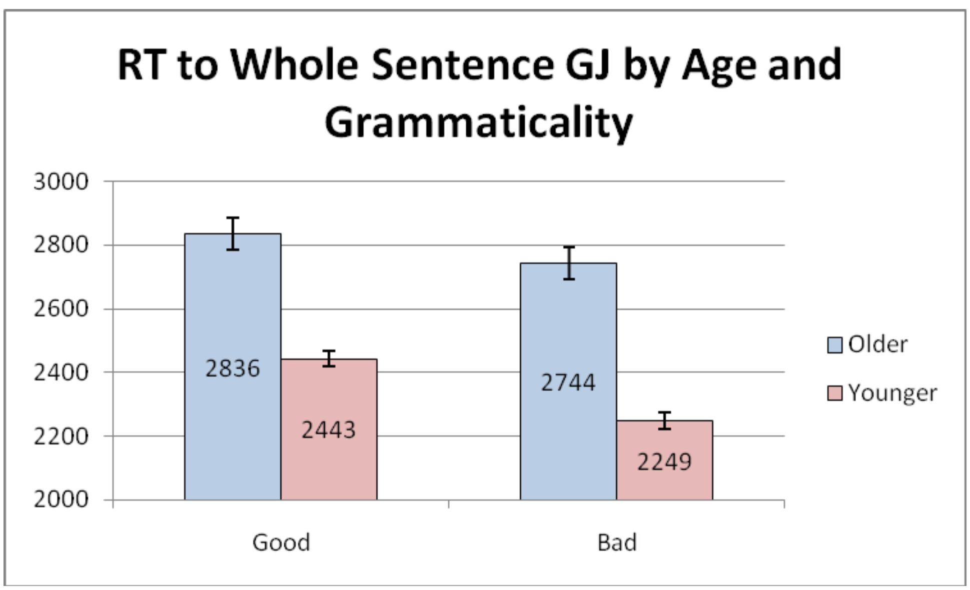

Figure 2. Reaction time to whole sentence grammaticality judgment task by age and grammaticality