Introduction

Verbs are central to the semantics and syntax of a sentence via their relationship with their arguments/thematics. Online priming studies have found that verb-specific information activates thematic role knowledge during sentence processing (e.g., McRae, Spivey-Knowlton, & Tannenhaus, 1998, Nakano and Blumstein, 2004; Trueswell & Kim, 1998) and that verbs provide immediate access to typical agents, patients, instruments, and locations outside of a sentence context by generating expectancies from a verb and its related thematic roles (Ferretti, et al., 2001) and vice versa (McRae, et. al., 2005). The specific aims of the current investigation are 1) to replicate the findings of McRae et. al. (2005) in young adults, and 2) to demonstrate that older adults exhibit agent and patient to verb priming patterns similar to those observed in young adults.

Methods

Younger Participants. Twenty-one younger adults (YA) (*M* = 21.5 years, range = 18-23 years) and 15 older adults (OA) (*M* = 72.5 years, range = 62 to 86 years) participated. Participants were right-handed native English speakers with normal or corrected vision and hearing with at least a high school education. Exclusionary criteria included neurological disorders or injury. OA participants received additional screening for cognitive and linguistic disorders (*Cognitive Linguistic Quick Test,* Helm-Estabrooks, 2001) and semantic processing impairment in nouns (*Pyramids and Palmtrees,* Howard & Patterson, 1992) and verbs (*Kissing and Dancing,* Bak & Hodges, 2003). All participants scored within normal limits.

Stimuli. Two sets of noun-verb pairs were developed for the priming tasks. One set included animate agent-verb pairs, the other primarily inanimate patient-verb pairs. To determine relatedness of agents and patients, a group of 13 neurologically normal undergraduates

completed two questionnaires (protocol similar to Ferretti et al., 2001). For the agent questionnaire, forty verbs were paired with a variety of agents. The participants rated agent-verb pairs by answering the question: "How common is it for the following people to (verb (e.g., *steal)*) something or someone?" on a scale of 1 (not common) to 7 (very common). Thirty-one agent-related verb pairs with relatedness ratings between 6.31 and 7.0 (M = 6.73, SD = 0.14) were chosen. The agent-verb pairs were then shuffled to form the unrelated pairs (*thief/winning*). (See Appendix A). Thirty-one agent-unrelated verb pairs (e.g., *barber/writing*) and 62 agent-nonwords with present progressive inflection (e.g., *barber/prafing*) were also developed.

A similar process was followed with the patient questionnaire. Twenty-six patient-related verb pairs with ratings ranging from 6.31 to 7.0 (M = 6.67, SD = 0.19) were chosen (e.g., *coffee/brewing*). (See Appendix B). Twenty-six unrelated pairs were created by shuffling the related pairs (e.g., *pizza/brewing*). Twenty-six pairs of unrelated fillers (e.g., *trophy/folding*) and 52 patient/nonword pairs (e.g., *trophy/jilding*) were also created.

The experiment was developed on DirectRT software (Empirisoft, 2004) and run on a Dell computer with 17-inch monitor. All trials were presented in random order. Each trial consisted of 1) a focal point (#) presented in the center of the screen for 500 ms, 2) the prime (e.g., *thief*) for 200 ms, 3) a mask (&&&&&&&&&) for 50 ms, and 4) the target (e.g., *stealing*) until the participant made a decision as to whether the word was a word or a non-word. The inter-stimulis interval (ISI) was 250 ms, and the intertrial interval (ITI) was 1500 ms.

Procedure. Modifications to the procedure of McRae et al were made in anticipation of running this experiment with persons with aphasia. Modifications included use of the left hand instead of the right (since persons with aphasia often have right hemiparesis) and performing a

lexical decision task rather than reading the target aloud. These modifications were not expected to affect the results (see Kiran & Thompson, 2003).

Participants sat at the computer with their nondominant hand on the keyboard. Instructions were as follows: "You will see a number of words and symbols. Please look at everything. When you seen a word in black, read it silently to yourself. When you see a word in blue, you must decide whether the word is a word or not a word. If the word is a real word, press the button the 'y' on the computer. If the word is not a real word, press 'n.' Please make your decisions as quickly and accurately as possible."

"Yes" and "no" options were indicated with a "y" and a "n" taped onto the letters "z" and "x" on the keyboard. Participants completed practice sessions with 20 trials before the agent and patient conditions before beginning the experiment.

All participants completed the same experiment under two conditions (agent and patient) within one session. A 5 to 10 minute break was given between conditions with conversation elicited by the examiner. Order of presentation was counterbalanced across participants.

Results

Reaction times (RT) for the related (e.g., *thief/stealing*) and unrelated pairs (e.g., *scholar/stealing*) were analyzed by paired t-test. Response latencies greater than 3 standard deviations were replaced by the upper limit value. Less than 1% of all responses for both groups were more than 3 SD's from the mean. Incorrect responses were replaced by the average reaction time (RT) for that participant. (See Figure 1 for graph of all RT results.)

Younger adults. Lexical decision accuracy was high across participants for related (M = 98.62%, SD = 1.93) and unrelated (M = 99.62%, SD = 1.74) items in the agent condition. RT's across participants were significantly shorter for related animate agent-verb pairs (M = 642.37

ms , SD = 226.33) than for the unrelated verb-animate agent pairs (M = 683.07, SD = 235.51, t(650) = -3.596, p = .000).

In the patient condition, lexical decision accuracy was high for related (M = 99.63%, SD = 1.16) and unrelated (M = 98.17%, SD = 1.97) items. RT's across participants were significantly shorter for related inanimate patient-verb pairs (M = 645.6 ms , SD = 223.03) than for the unrelated verb-animate agent pairs (M = 690.26, SD = 248.22, t(545) = -3.997, p = .000).

Older adults. Lexical decision accuracy was high across participants for related (M = 99.35%, SD = 2.41) and unrelated (M = 99.14%, SD = 1.43) items in the agent condition. RT's across participants were significantly shorter for related animate agent-verb pairs (M = 954.28 ms , SD = 364.07) than for the unrelated verb-animate agent pairs (M = 996.58, SD = 418.34, t(464) = -1.876, p = .03).

In the patient condition, lexical decision accuracy was high across participants for related (M = 98.97%, SD = 1.7) and unrelated (M = 98.72%, SD = 2.29) items. RT's across participants were significantly shorter for related inanimate patient-verb pairs (M = 901.54 ms , SD = 269.31) than for the unrelated inanimate patient-verb pairs (M = 981.52, SD = 389.51, t(389) = -3.975, p = .000).

Discussion

The results of this study replicate previous findings in younger adults (McRae et. al., 2005) showing that agents and patients generate expectancies for (prime) related verbs but not for unrelated verbs. These expectancies indicate an automatic co-activation of related verbs when typical agents or patients are activated since the prime-target stimulus-onset asynchrony (SOA) was only 250 ms. As observed in previous priming studies (e.g., Myerson, Hale, Jing, & Lawrence, 1997), reaction times for older adults were slower than those of young adults.

However, the OA group exhibited a similar priming pattern for both agents and patients as the YA group, indicating maintenance of verb-thematic processing in older adults. This work provides a paradigm for testing automatic processing of verb-thematic processing in single words in persons with aphasia.

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Figure 1. Reaction times for related and unrelated agents and patients for young adults (YA) and older adults (OA)