

## Thematic Role Priming of Related Verbs: Effects of Multiple Primes

### INTRODUCTION

Extensive evidence has shown that presentation of a word (target) following a related word (prime) results in faster reaction times (RTs) compared to unrelated primes. Thematic role relationships such as agent, patient, and action have been used to explore functional components of the semantic meaning of familiar words (Edmonds & Mizrahi, submitted; Ferretti, McRae, & Hatherell, 2001; Hare, Jones, Thomson, Kelly, & McRae, 2009; McRae, Hare, Elman, & Ferretti, 2005; Moss, Ostrin, Tyler, & Marslen-Wilson, 1995). Evidence from priming studies using two primes before a target (prime-prime-target priming) has been used to examine the effects of multiple influences on processing of target words (Balota & Paul, 1996; Khader, Scherag, Streb, & Rösler, 2003).

Khader et al. (2003) demonstrated an additive priming effect of two related noun primes on a target verb using a relatedness-judgment task, compared to single related primes. However, task-specific attentional processing may have been a factor in additive facilitation. In this study, we evaluate priming of prime-prime-target triads, similar to Khader et al., but we used a continuous list paradigm where the participant responds to each word, so that the triads of interest are unknown (see Figure 1). **Our research questions are as follows:**

RQ1. Will related agent and patient nouns (*car*, *tourist*, RR condition) facilitate faster reaction times (prime) for related verbs (*renting*) as compared to two unrelated primes (*box*, *dentist* for *renting*, UU condition)?

Based on previous findings (Khader et al., 2003), we predict a priming effect across participants and items.

RQ2. Will RTs for the RR condition be faster than the reaction times for the UR condition, where a related prime is preceded by an unrelated prime (*box-tourist* for *renting*)?

RQ3. Will RTs for the RR condition be faster than the reaction times for the RU condition, where a related prime is followed by an unrelated prime (*car-dentist* for *renting*)?

No specific predictions were made for RQ2 or RQ3, since previous findings indicating an additive effect for RR conditions were the result of different priming paradigms. If RR RT's are faster than those in both the UR and RU conditions, then it would indicate an additive effect.. RTs are likely to be faster in the UR than in the RU condition.

### METHODS

#### *Participants*

Forty-five participants completed the priming study, and 15 completed a survey to assist in stimuli development. All participants were right-handed, monolingual English speakers, age 18-30, with no negative neurological histories.

#### *Stimuli development*

Stimuli consisted of prime-prime-target triads in which all primes were nouns and all targets were transitive verbs in the present progressive (-ing) form (e.g. *renting*). Each verb appeared in every condition, and primes varied depending on condition. In the related condition one prime was a typical agent (e.g. *thief*), and the other a typical patient (e.g. *money*), of the target verb (e.g. *stealing*). The stimuli were well-controlled to reduce confounding factors. Primes were matched for animacy, length in letters, phonemes, and syllables, and attempts were

made to match as closely as possible psycholinguistic variables of frequency, age of acquisition, concreteness, familiarity, and imageability. See Table 2.

Potential related stimuli were drawn from a questionnaire developed for this study and by combining semantically-related agent-verb and patient-verb dyads identified in earlier research (Edmonds & Mizrahi, submitted, McRae et al., 2005). Participants rated 152 triads for semantic relatedness on a 7-point ordinal scale. Based on the results, 120 triads (30 verbs) composed four experimental conditions; related-related (RR), unrelated-related (UR), related-unrelated (RU), and unrelated-unrelated primes (UU). Repeated-measures ANOVA with a Huynh-Feldt correction showed a significant effect of relatedness ( $F(3) = 491.982, p = .000$ ), indicating that the prime stimuli across conditions were in fact different in relatedness (see Table 1).

#### *Continuous List Lexical Decision Task*

Experimental triads were embedded in a presentation list in random order. Participants were instructed to read and respond to every letter string presented on a screen by pressing a 'yes' or 'no' key to indicate whether it was a real English word. Participants were given no information about which items were of experimental interest. Letter strings remained on the screen until a response was given, followed by a response-stimulus interval [RSI] of 100ms (See McNamara & Altarriba, 1988, experiment 2) before the next item in the list appeared. See Figure 1 for a schematic of the task presentation.

Participants completed a practice section of 29 letter strings and conveyed understanding of the task. Participants saw 1000 trials with a word-nonword ratio of 0.5. Filler words were added to separate the experimental triads and to keep the related-unrelated ratio low (.18) (Ferretti et al. 2001; McRae et al, 2005). To reduce fatigue, participants were given two 5 minute breaks, and the experiment was completed in less than 30 minutes.

#### *Design and Analyses*

A repeated-measures design with four relatedness conditions was used to evaluate participant and item RT's. Participant results were initially analyzed for overall accuracy of lexical decisions. A minimum of 95% accuracy was required for inclusion in further analysis. RTs that fell greater than two standard deviations above or below the mean for each condition, or for which an error was made on either prime or the target, were excluded from further analysis. Effects of relatedness were examined using repeated measures ANOVA. Then Sidak post-hoc analyses with a Holm's (1979) correction were performed to evaluate potential differences that corresponded to our research questions (RR v UU [RQ1], RR v UR [RQ2] and RR v RU [RQ3]).

## RESULTS

Five participants had lower than 95% accuracy on the lexical decision task and were excluded from further analysis. The remaining 40 participants had an average accuracy of 97.8%. See Table 2 for mean RTs. A Repeated-measures ANOVA showed a significant effect of relatedness across participants ( $F(3) = 4.623, p = .004$ ) and items ( $F(3) = 3.667, p = .015$ ). Post-hoc analyses showed significant differences for participant and item comparisons between RR-UU ( $p=.021/p=.011$ ) and RR-RU ( $p=.012/p=.006$ ), with no significant difference between RR-UR ( $p=.570/p=.107$ ) (see Table 3).

## DISCUSSION

Paired agent and patient nouns primed related verbs compared to unrelated primes, replicating a facilitation effect of paired nouns on related verbs (Khader et al., 2003). However, different from Khader et al., our findings do not suggest an additive effect for two nouns versus

one noun. Comparison of RR to UR and RU conditions demonstrates that a single noun prime is sufficient to account for the observed facilitation in healthy young adults, while activation decays too rapidly to facilitate a related verb in the presence of an intervening unrelated noun. The absence of additive facilitation compared to single related primes suggests that attentional strategic processes may have been a component of more robust effects in previous research, as compared to the continuous priming paradigm used in the current study. These findings also replicate single word priming between related verbs and thematic roles (Edmonds & Mizrahi, submitted; Ferretti et al., 2001; McRae et al., 2005). More research is needed to better understand the implications of the current findings with respect to our understanding of the semantic relationships of verbs and their thematic roles, which are important to the assessment and treatment of sentence production deficits in aphasia (e.g., Edmonds, Nadeau, & Kiran, 2009).

## REFERENCES

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Figure 1 Single Word Presentation (Continuous List) Lexical Decision Task schematic

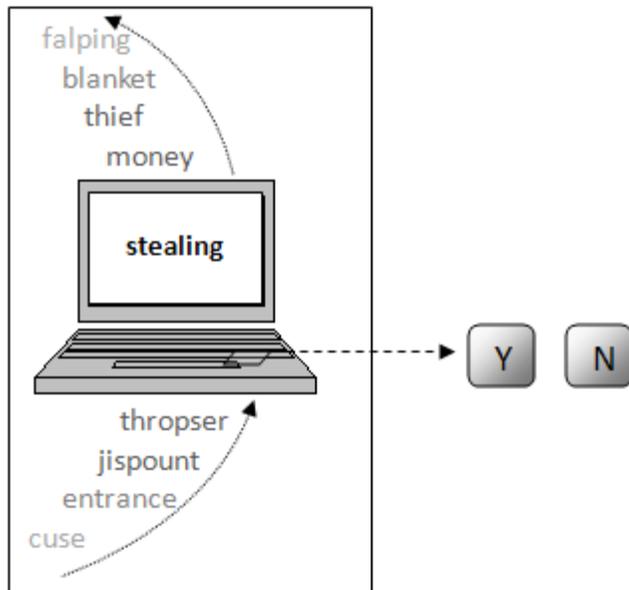


Table 1 Mean relatedness judgment ratings for each thematic role condition

Condition	Mean	SD	N
Related agent + related patient [AP]	6.66	0.20	30
Related agent + unrelated patient [AU]	2.56	0.88	30
Unrelated agent + related patient [UP]	2.35	0.72	30
Unrelated agent + unrelated patient [UU]	1.64	0.40	30

Table 2 Mean RTs with sample stimuli for participant (part.) and item results for each experimental condition

Priming Condition	Sample Stimuli			Part. mean (N=40)	SD	Item mean (N=30)	SD
	Prime 1	Prime 2	Target				
Related+related [RR]	<i>car</i>	<i>tourist</i>	<i>renting</i>	557.51	66.94	555.88	32.71
Unrelated+related [UR]	<i>box</i>	<i>tourist</i>	<i>renting</i>	560.70	70.81	564.61	44.45
Related+unrelated [RU]	<i>car</i>	<i>dentist</i>	<i>renting</i>	573.84	82.60	573.39	47.44
Unrelated+unrelated [UU]	<i>box</i>	<i>dentist</i>	<i>renting</i>	574.24	80.37	572.75	51.17

Table 3 Participant and item results for priming condition comparisons

Comparisons	Participants (N=40)		Items (N=30)		Required p-values to achieve significance*	Significance
	Mean Difference	Actual p-values	Mean Difference	Actual p-values		
RR v UU (RQ1)	-16.729	.021	-16.862	.011	.025	sig
RR v UR (RQ2)	-3.197	.570	-8.728	.107	.05	ns
RR v RU (RQ3)	-16.338	.012	-17.506	.006	.0125	sig

\*Adjusted for multiple comparisons based on Holm (1979).