

# Expectancy for the Morphological Form of Verbs During Semantic Priming

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## Abstract

We examined whether event knowledge about the roles that nouns play in specific events interacts with the morphological form of active and passive verbs during short SOA (250 ms), noun-verb semantic priming. In Experiment 1, we investigated how quickly participants pronounce verbs inflected with -ing or -ed (*arresting* vs. *arrested*) when preceded by primes consisting of a good-agent or a good-patient and the auxiliary *was* (*cop was* vs. *crook was*). In Experiment 2, the primes included the determiner *The*, and participants made lexical decisions to the same target verbs. In both experiments, participants responded more quickly to active verbs, and made more pronunciation errors in Experiment 1, when preceded by good-agent, rather than good-patient noun primes. Alternatively, response latencies and errors for passive verbs were similar regardless of noun type.

Keywords: semantic priming, morphology, thematic roles

## Introduction

The majority of past research investigating semantic priming between words has investigated nouns. However, researchers have recently investigated semantic priming from nouns to verbs (e.g., McRae, Hare, Elman, & Ferretti, in press), and from verbs to nouns (Ferretti, Kutas, & McRae, 2004; Ferretti, McRae, & Hatherell, 2001). Investigating semantic priming between nouns and verbs is important because successful language comprehension involves deriving the appropriate conceptual and syntactic relationships between entities and events mentioned in discourse. Semantic priming methodology is useful in this regard because it provides insight into *how* and *when* semantic and syntactic information becomes available from words to influence the comprehension process.

The results from semantic priming research indicate that event information becomes activated by noun and verb primes to influence priming in word-word semantic priming tasks. For example, Ferretti et al. (2001)

demonstrated using a short SOA (250 ms) priming paradigm that verbs such as *arrest* prime nouns that are common fillers of the verb's thematic roles (e.g., *agent - cop*, *patient - crook*, and *instrument - gun*). These results suggest that detailed conceptual information about events becomes activated very quickly from verbs.

More recently, McRae, Hare, Elman, and Ferretti (in press) have demonstrated that nouns which are common fillers of a verb's thematic roles, such as agent (*hero-rescuing*), patient (*movie-rented*), instrument (*crutches-walking*) and location (*sandbox-digging*), prime those verbs in short SOA (250 ms) and long SOA (500 ms) word-word priming tasks. These results suggest that not only can semantic priming occur through relational information such as thematic roles, but that this information becomes available very quickly from words presented in isolation. Because short SOAs of 250 ms or less are commonly viewed as capturing the "automatic" activation of information from words, the observed priming effects cannot be due to explicit strategic expectancy generation that is thought to occur at longer SOAs (e.g., Becker, 1980). Furthermore, previous research (Kahen, Neely, & Forsythe, 1999) has demonstrated that backward priming between words can occur at short, but not long SOAs. Because McRae et al. observed the same pattern of priming at a long SOA, their results cannot be due to backward priming from the verbs to the nouns.

## Accounting for Noun-Verb Semantic Priming

The most common explanation of short SOA (250 ms or less) word-word priming results is based on the notion of spreading activation and associative relatedness through co-occurrence. The original instantiations of semantic networks focused on noun representations (e.g., Collins & Loftus, 1975). Further extensions implemented verb meaning into this framework (e.g., Gentner, 1975). But these verb nodes included minimal semantic content.

The noun-verb priming results of McRae et al. (in press) could be accounted for by spreading activation if one were

willing to expand current semantic networks. For example, it could be assumed that nodes for common agents, patients, instruments, and locations in events become linked to verb nodes representing those events over time as a result of experience with situations to which the verb refers, and linguistic descriptions of them. If all words or concepts that tend to co-occur frequently in situations are linked in semantics, and/or orthography and phonology via an associative relation, then priming from typical role fillers to specific events might occur. McRae et al. point out, however, that typical measures of associative relatedness such as word-association norms, do not reveal associative relatedness between verbs and nouns that are related through thematic relations. Rather, people generally recall words from the same grammatical category as the stimulus. One might still argue, however, that the common noun fillers and their corresponding verbs are associated through co-occurrence in the real world and in linguistic descriptions, regardless if they are not shown to be associated through typical association norms. Indeed, the nouns and the participants and locations that they denote along with their corresponding events are associated in this manner.

In contrast to spreading activation and accounts based on simple co-occurrence, McRae et al. (in press) propose that their results are best accounted for by a prospective expectancy generation mechanism. According to this approach, reading a noun prime leads to activation of detailed well-learned event knowledge, which predicatively activates verbs that correspond to these events. However, unlike strategic expectancy models which suggest that people generate expectations for specific words (e.g., Becker, 1980), McRae and colleagues' approach (Ferretti et al. 2001; McRae, Ferretti, & Amyote, 1997; McRae et al., in press) holds that a concept or class of concepts is activated. Priming between noun and verbs occurs when the verb's representation overlaps with the predicted event space generated from nouns.

### **Event-Knowledge and Grammatical Morphemes**

In the following research, we extend McRae et al.'s (in press) results in two ways that contribute to this debate. First, we examine whether the predicted event space generated from nouns is specific to the thematic roles that these nouns play in those events, or whether it is only for the events in general. This is an important issue because a spreading activation account would hold that priming should be found for the events in general. That is, the good-agent and good-patient nouns should become linked to the *same* verb node and, therefore, priming should be found between these nouns and the verbs that denote those events. Alternatively, an account based on event memory would hold that the expectancy generated from the nouns should include information about the specific role that those nouns play in those events.

Second, we manipulated the morphological form of the verb targets so that they were presented in either active (*was arresting*) or passive voice (*was arrested*). This

manipulation enabled us to investigate whether the event expectations generated from nouns is for their specific roles in events (*cop was arresting/arrested*, *crook was arresting/arrested*), and provides insight into how world knowledge of events interacts with grammatical morphemes during on-line sentence comprehension.

Recent psycholinguistic research has shown that the activation of event knowledge is influenced by voice (Ferretti et al., 2001) and verb aspect (Ferretti et al., 2004; Madden & Zwaan, 2003). For example, Ferretti et al. (2001) presented verbs as part of short auditorally-presented active (*She arrested the*) and passive sentence fragments (*She was arrested by the*), and participants named a visual target (*cop*) presented at their offset. Agents and patients were presented in their congruent role (*She was arrested by the / cop*) and their incongruent role (*She arrested the / cop*). Priming was found only when nouns were in their congruent roles. Ferretti et al. (2004) have extended these results by showing how imperfective (*was skating*) and perfect verb aspect (*had skated*) influence the activation of location knowledge (*arena*) using Short SOA priming. They found that common locations in which specific events occur are primed when they are preceded by imperfective verbs, but not when preceded by the same verbs in their perfect form. Thus, the current experiments add to research examining the interplay between event knowledge and grammatical morphemes by examining if voice interacts with people's event knowledge about common agents and patients in events during short SOA semantic priming.

### **Experiment 1**

In Experiment 1, we used a naming task to examine how grammatical inflections associated with the active and passive forms of verbs interact with people's event knowledge about the roles that nouns play in specific events. If people do generate expectancies from nouns about the events that they typically play a role in, and if these expectancies are specific to the thematic roles that the nouns typically play in those events, then active verbs should be responded to more quickly after the presentation of good-agents than good-patients, and passive verbs should be facilitated after the presentation of good-patients than good-agents. Alternatively, if short SOA semantic priming between nouns and verbs occurs through spreading activation or an associative relatedness mechanism based on co-occurrence, then we would expect no difference between how quickly people respond to active and passive verbs when they are preceded by good-agents and good-patients.

Another prediction that follows from an event-based expectancy account, is that people may make more pronunciation errors when the thematic role of the noun primes and the morphological form of the verb primes mismatch (*cop was - arrested / crook was arresting*) compared to when they match (*cop was - arresting / crook was - arrested*). The rationale is that if people are generating expectancies for the morphological form of the verbs, then they may sometimes mispronounce those words

when the inflections (-ing, -ed) turn out to be inconsistent with these expectations.

## Method

**Participants.** Fifty-two undergraduate students from Wilfrid Laurier University participated for course credit. Participants all had normal or corrected-to-normal visual acuity and all were native speakers of English.

**Materials.** The noun-verb combinations were selected from a previous norming study by McRae et al. (1997). In this study, participants rated the agenthood (How common is it for a/an \_\_\_\_\_ to arrest someone?) and patienthood (How common is it for a/an \_\_\_\_\_ to be arrested by someone) of each noun-verb combination on a 7-point scale, where 1 corresponded to very uncommon and 7 to very common. Thirty-six verbs were chosen from this study on the basis that a good-agent and good-patient noun could be found for each of the verb's agent and patient roles. All nouns were animate and referred to different kinds of human beings (cop, crook, prosecutor, etc). The 36 good-agent nouns and their corresponding verbs were rated higher for agenthood ( $M = 6.4$ , range = 4.4 - 7.0) than patienthood ( $M = 2.2$ , range = 1.2 - 4.0),  $t_2(35) = 18.61$ ,  $p < .01$ . Alternatively the good-patient nouns were rated higher for patienthood ( $M = 5.8$ , range = 3.0 - 7.0) than agenthood ( $M = 2.5$ , range = 1.2 - 5.7),  $t_2(35) = 13.99$ ,  $p < .01$ .

Four lists were constructed and each contained 9 good-agent active pairs (*doctor was - curing*), 9 good-agent passive pairs (*doctor was - cured*), 9 good-patient active pairs (*thief was - chasing*), and 9 good-patient passive pairs (*thief was - chased*). Across the four lists, each item appeared in each of the 4 conditions, and no participant saw any noun or verb more than once. Another 144 unrelated noun-verb combinations (*dispatcher was - swimming*) were added that served as filler trials. These filler items allowed us to keep the relatedness proportion low (36/180 or 0.2). Across all 180 trials, half of the verbs appeared in active form and the other half in passive form. Finally, 10 unrelated practice trials were used for each participant's practice session.

**Procedure.** Stimuli were displayed on a 17-inch Sony Trinitron monitor controlled by a Macintosh G4. Each trial consisted of the following events: a focal point (+) in the center of the screen for 250 ms; the prime for 250 ms, and the target until the participant pronounced it into a microphone. The intertrial interval was 1500 ms. Response latencies were recorded with ms accuracy via a CMU button box. Participants were instructed to read the two-word phrase silently (e.g., *doctor was*) and pronounce the subsequent verb (*curing*) into the microphone as quickly and accurately as possible. The order of the four lists was counter balanced across participants. The entire task took approximately 15 minutes to complete.

**Design.** Naming latency and squared root of the number of errors were analyzed using separate three-way analyses of variance. The factors of interest were the thematic role of the noun primes (agent versus patient), which was within participants and items, and voice of the verb targets (active, passive), which also was within participants and items. Planned comparisons investigated the effect of thematic role separately for active and passive voice. List was included as a between-participants dummy variable and item rotation group as a between-items dummy variable to stabilize variance that may result from rotating participants and items over the two lists.

## Results and Discussion

Mean response times and percentage of pronunciation errors for each condition are presented in Table 1. Response latencies greater than 3 standard deviations from the mean were replaced by that value (less than 1% of the target trials). Overall, 6.4% of the target trials were removed from the response time analysis due to microphone malfunction (3.6%) and pronunciation errors (2.8%).

**Naming Latency.** The interaction between voice and thematic role was only marginally significant in the participant analysis,  $F_1(1, 48) = 3.36$ ,  $p < .08$ ,  $F_2(1, 32) = 2.33$ ,  $p > .13$ . Planned comparisons revealed that active verbs were pronounced more quickly when preceded by good-agents than good-patients,  $F_1(1, 48) = 5.26$ ,  $p < .03$ ,  $F_2(1, 32) = 4.13$ ,  $p = .05$ . Alternatively, passive verbs were pronounced at a similar rate regardless of the thematic role of the noun primes, both  $F_s < 1$ . Overall, passive verbs ( $M = 626$  ms) were responded to marginally more quickly than active verbs ( $M = 633$  ms),  $F_1(1, 48) = 3.28$ ,  $p < .08$ ,  $F_2(1, 32) = 3.53$ ,  $p < .07$ . Finally, there was no main effect of thematic role,  $F_1(1, 48) = 1.82$ ,  $p > .18$ ,  $F_2(1, 32) = 1.92$ ,  $p > .17$ .

**Pronunciation Error Analysis.** The interaction between voice and thematic role was not significant,  $F_1 < 1$ ,  $F_2(1, 32) = 1.63$ ,  $p > .20$ . However, planned comparisons demonstrated that people made more pronunciation errors for active verbs preceded by good-patient nouns than good-agent nouns,  $F_1(1, 48) = 3.44$ ,  $p < .07$ ,  $F_2(1, 32) = 5.29$ ,  $p < .03$ . Alternatively, people made a similar amount of errors to passive verbs when they were preceded by good-agent and good-patient nouns, both  $F_s < 1$ . Overall, people made more pronunciation errors to active verbs ( $M = 1.8\%$ ) than to passive verbs ( $M = 1\%$ ),  $F_1(1, 48) = 10.06$ ,  $p < .01$ ,  $F_2(1, 32) = 4.92$ ,  $p < .04$ , suggesting that people had more difficulty pronouncing the longer and less frequent form of these verbs. People also made more pronunciation errors to the targets when they were preceded by good-patient nouns ( $M = 1.7\%$ ) than good-agent nouns ( $M = 1.1\%$ ), but this effect only reached significance in the item analysis,  $F_1(1, 48) = 1.90$ ,  $p > .17$ ,  $F_2(1, 32) = 4.36$ ,  $p < .05$ .

Table 1: Mean Response times (ms) and Percentage of Errors for Experiment 1 and Experiment 2.

Experiment	Active Voice		Passive Voice	
	<i>Response Times</i>	<i>Errors</i>	<i>Response Times</i>	<i>Errors</i>
Experiment 1 (Naming)				
Good-agent	626	.7%	627	.4%
Good-patient	641	1.2%	625	.5%
Difference	15*	.5%*	-2	.1%
Experiment 2 (Lexical Decision)				
Good-agent	870	1.4%	831	.7%
Good-patient	907	1.5%	826	1.3%
Difference	37*	.1%	-5	.6%

\* Significant at  $p < .05$

The results of Experiment 1 provide support for the prediction that the thematic role of the noun primes and the morphological form of the target verbs should interact during semantic priming. People pronounced active verbs more quickly when they were preceded by good-agent than good-patient nouns, and they also made more pronunciation errors to those verbs when they were preceded by good-patient nouns than good-agent nouns. This pattern is what would be expected on an account based on the assumption that people quickly generate expectations about specific events when they read nouns that are common participants in those events. These results also suggest that these expectations are more detailed than a general activation of the related event. Specifically, the interaction with grammatical morpheme shows that the expectancy generated from the nouns was for specific roles in the events.

The pattern of results for the passive verbs was not as predicted, however. People were expected to respond more quickly to passive verbs preceded by good-patients than by good-agents. The lack of a difference between the two different types of nouns could be a result of a number of possible factors. We discuss some possibilities after we present a replication of the current experiment.

## Experiment 2

In Experiment 2, we replicate and extend the present results by 1) using a different task, in this case Lexical Decision, and 2) to increase the contextual information provided in the primes by adding the determiner *The*. The main motivation for changing tasks was to generalize the findings across tasks, and to use a task that ensures that on each trial people read the entire word before responding. In a naming task, it is possible that people may start pronouncing the target words before they have completely identified the word. This would be more likely to happen if people are generating expectancies for the target events/verbs from the nouns. For example, if reading *cop* leads to expectancy for the verb *arresting*, then people may be more likely to start pronouncing arrest after seeing just

the first few letters of the word. Given that the critical target manipulation was an inflection at the end of the verbs, it is possible that the results of Experiment 1 were not as strong because on some trials response time was not influenced by the suffixes. This possibility is supported by the fact that in Experiment 1 people made significantly more pronunciation errors to active verbs preceded by good-patient than good-agent nouns. With a lexical decision task, however, people must read the entire word before they respond, otherwise they would not be performing the task correctly. Finally, adding the determiner at the beginning of the primes created prime - target combinations that capture the beginning of the main clause (NP-V-NP) in English sentences, which is the most frequent form of sentences in the language. This increase in prime context provides a closer approximation to how active and passive verbs normally appear in text while maintaining the basic parameters of a short SOA priming paradigm.

## Method

**Participants.** Fifty-two undergraduate students from Wilfrid Laurier University participated for course credit. Participants all had normal or corrected-to-normal visual acuity and all were native speakers of English.

**Materials.** The same primes, targets, and filler items used in Experiment 1 were used in Experiment 2, with two exceptions. First, 90 of the 144 filler items were pronounceable nonword verb targets (e.g., *explained*). Second, the determiner *The* was added to the primes so that they formed three word phrases such as *The doctor was*.

**Procedure.** The procedure was identical to Experiment 1 except that participants made lexical decisions to the target words instead of naming them.

**Design.** The design was identical to Experiment 1.

**Results and Discussion.** Mean response times and percentage of errors for each condition are presented in Table 1. Response latencies greater than 3 standard

deviations from the mean were replaced by that value (less than 1% of the scores). In total, people made lexical decision errors to 4.9% of the target trials, and these trials were excluded from the response time analysis presented below.

**Decision Latency Analysis.** Voice and thematic role interacted,  $F_1(1, 48) = 4.18, p < .05, F_2(1, 32) = 4.62, p < .05$ . Planned comparisons demonstrated that active verbs were responded to more quickly when preceded by good-agent nouns than good-patient nouns,  $F_1(1, 48) = 6.35, p < .02, F_2(1, 32) = 6.16, p < .02$ . Alternatively, passive verbs were responded to at a similar rate regardless of the thematic role of the noun primes, both  $F_s < 1$ . Collapsed across thematic role, passive verbs ( $M = 829$  ms) were responded to more quickly than active verbs ( $M = 889$  ms),  $F_1(1, 48) = 30.89, p < .01, F_2(1, 32) = 15.15, p < .01$ . Finally, there was no main effect of thematic role,  $F_1(1, 48) = 2.24, p > .14, F_2(1, 32) = 1.13, p > .29$ .

**Lexical Decision Error Analysis.** Voice and thematic role did not interact,  $F_1 < 1, F_2(1, 32) = 2.55, p > .12$ . Planned comparisons indicated that active verbs were responded to correctly equally often when preceded by good-agent nouns and good-patient nouns, both  $F_s < 1$ . Although there was a trend for passive verbs to be responded to correctly more frequently when preceded by good-agent than good-patient nouns, this trend did not reach statistical significance,  $F_1(1, 48) = 1.74, p > .19, F_2(1, 32) = 3.01, p < .10$ . Collapsed across thematic role, active verbs ( $M = 2.9\%$ ) were responded to incorrectly more often than passive verbs ( $M = 2\%$  ms), but this trend was only marginally significant in the analysis by participants,  $F_1(1, 48) = 3.51, p < .07, F_2(1, 32) = 1.70, p > .2$ . Finally, there was no main effect of thematic role, both  $F_s < 1$ .

The same pattern of response time results found in Experiment 1 was replicated in Experiment 2 using a different task and primes that included the determiner *The*. The changes in the procedure also had the desired effect of strengthening the response time analysis as the interaction between thematic role of noun and voice was significant in both analysis by participants and items. Another difference between the two experiments was the differences in overall response time. Lexical decision latencies are normally longer than naming latencies, but in the current experiment the lexical decision latencies seem considerably longer than normally found with word-word priming tasks. One possibility for the increase in response times is that the determiner *The* added to the each of the primes may have caused people to take longer to process the primes and, therefore, longer to respond to the targets. Another possibility is that people may find it relatively difficult to make lexical decisions to verbs in general because of the morphological complexity of verbs relative to nouns. Finally, the error data again demonstrated that people tend to make more errors to active than passive verbs. However, unlike Experiment 1 there was no significant differences in errors when active verbs were preceded by good-agent than

good-patient nouns. This latter finding is not that surprising though, as the lexical decision task ensured that individuals read the inflections on target verb before making their response.

Regardless of the differences in overall response times and error rates, the results of Experiment 2 again demonstrated that peoples' expectancies about the roles nouns play in specific events interacted with the different morphological forms of verbs denoting identical events.

## General Discussion

The main goal of this research was to investigate an Prospective Expectancy account of noun-verb semantic priming. On this account, we expected that people should respond more quickly in both types of semantic priming tasks when the morphological form of the verb and the thematic role type of the nouns matched (i.e., *The cop was – arresting, The crook was – arrested*) than when they mismatched (*The cop was – arrested / The crook was – arresting*). The results for the active verbs did show that they were responded to more quickly when they were preceded by their congruent role filler compared to incongruent filler, but there were no differences found when passive verbs were preceded by good-agents and good-patients. Therefore, the results are consistent with the overall prediction that noun type and voice should interact, but the form of this interaction was not entirely consistent with all of our predictions.

We suggest that there may be a couple of reasons why passive verbs were not responded to differently when preceded by good-agent and good-patient nouns. First, previous research by McRae et al. (1997) has demonstrated that for many transitive verbs, the agent role is often more constrained in the range of possible noun fillers that can be acceptable relative to the patient role of the same verbs. For example, many nouns denoting humans can be *arrested*, including *cops* and other kinds of common *arrestors*. However, the same cannot be said for the nouns that denote good-patients of *arrest*. *Crooks, thieves, murderers* and so on are generally not capable of being an agent of an arresting event. Of course, there are cases in which *cops* are also *crooks* and *murderers*, but this not very common in general. Because we investigated events that involve very specific kind of human agents (doctors, lawyers, judges, etc) we may have also selected events that cannot be conducted by the patients of those events (patients, defendants, convicts, etc).

Another possibility is that our response times could have been influenced by English word order constraints. The most common sentence type in English are active sentences in which the initial NP is the agent of the main verb. Passive sentences that begin with an initial NP that is a patient of the subsequent verb are much less common. It could be the case that this initial agent-verb frequency advantage for active sentences in English is having an influence in the semantic priming tasks. Specifically, people may have a general bias to evaluate the initial noun

for the agent role rather than patient role of the subsequent verb.

Differentiating between alternative accounts of these results is difficult without further experimentation. We are currently extending these results by conducting a similar lexical decision experiment that includes an unrelated baseline condition. By adding an unrelated condition, we will get a better understanding as to whether the lack of difference in response times for the passive verbs is due to facilitation to both good-agent and good-patient nouns or perhaps not due to priming at all. Similarly, we can also gain insight into whether the differences found for active verbs is due to priming for the good agents, no priming for good-patients, or perhaps even inhibition to the good patients.

The results reported above have important implications for models of semantic memory. Because we used short SOA priming, the results cannot be attributed to retrospective or strategic processes, such as Becker's (1980) verification model. Furthermore, prospective models based on associative relatedness or spreading activation (e.g., Collins & Loftus, 1975), cannot account for the observed interaction between nouns that are *both* commonly involved in the same events, and verbs that refer to those events with different morphological forms. If verbs were linked through undifferentiated links to their typical agents and patients, one would have expected equal response times, regardless of the voice of the verb. Our results suggest that this fundamental assumption of an undifferentiated spread of activation in semantic memory must be modified so that it can be constrained by syntactic information such as grammatical inflections on verbs. Thus, spreading activation networks could incorporate ad hoc assumptions well outside the scope of current versions to account for the present data, but they would no longer be in the same spirit upon which the notion of spreading activation was based. Similarly, because of the overlap between the good agent and patients with events, it is difficult to see how an account based on strict co-occurrence can account for our results - both nouns do appear with the verb frequently in language, and the entities referred to by the nouns appear frequently together in real world events.

In conclusion, we present evidence that when people read nouns it leads to the generation of expectancies for the specific roles that those nouns play in specific events, which in turn leads to expectations for specific morphological form of verbs. Although more research is needed to clarify differences between agent and patient roles in this research, our initial results are most consistent with a prospective expectancy account of noun-verb semantic priming.

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