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Thematic Role Focusing by Participle Inflections: Evidence From Conceptual Combination

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The authors examined how people integrate knowledge of agents and patients of events with the temporal and causal properties of present and past participles to constrain interpretation of isolated participle–noun phrases like *arresting cop* and *arrested crook*. Good-agent head nouns were more easily combined with present participles (e.g., *arresting cop*) than with past participles (e.g., *arrested cop*), and the reverse was true for good patients. Furthermore, present-participle good-patient phrases (e.g., *serving customer*) were often interpreted as verb phrases. This research provides further evidence of the interaction between morphosyntactic cues and world knowledge of events in language comprehension.

Language comprehension involves quickly integrating various types of semantic and syntactic knowledge (Pickering & Traxler, 1998; Spivey & Tanenhaus, 1998; Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995). Understanding the representations and mechanisms underlying people's ability to combine these types of information is a central component of the study of language comprehension (and production). One important type of semantic information is conceptual knowledge concerning events and their common participants (Altmann & Kamide, 1999; Ferretti, McRae, & Hatherell, 2001; McRae, Spivey-Knowlton, & Tanenhaus, 1998). Furthermore, verb morphology, as a syntactic cue, has been central to various theories of sentence and discourse processing (Garnsey, Pearlmutter, Meyers, & Lotocky, 1997; Givón, 1995; MacDonald, Pearlmutter, & Seidenberg, 1994; Morrow, 1986; Trueswell, Tanenhaus, & Garnsey, 1994). These information types may interact in interesting ways. For example, grammatical morphemes signaling voice, tense, and aspect may influence the foregrounding and backgrounding of explicitly mentioned entities and events (Carreiras, Carriedo, Alonso, & Fernandez, 1997; Ferretti et al., 2001; Magliano & Schleich, 2000; Morrow, 1986) and may modulate the activation of background knowledge about common instruments used in events when they are not explicitly mentioned (Truitt & Zwaan, 1997).

The influences of grammatical and thematic role knowledge typically have been studied using sentence comprehension tasks by investigating their combined influences on structural ambiguity resolution or by analyzing eye-movement patterns recorded while people listen to unambiguous sentences (Altmann & Kamide, 1999; Garnsey et al., 1997). However, people's interpretation of participle–noun phrases such as *arrested crook* might also provide a tool for investigating how situation and grammatical knowledge are represented, computed, and integrated. In this article, we examine how grammatical morphemes and thematic-role conceptual knowledge combine to influence the ease with which participle–noun phrases are interpreted. To focus on the temporal and causal properties of events, our experiments used adjectival participles as modifiers (e.g., *arresting cop, arrested cop, arresting crook, arrested crook*). The conceptual and syntactic properties of present- and past-adjectival participles make them ideal for studying the interaction between syntactic and conceptual knowledge during thematic-role assignment because adjectival participles have properties consistent with both verbs and adjectives. For example, they inherit the argument structures and thematic roles of the verbs from which they are derived, suggesting that participles derived from transitive verbs can be biased toward either the agent or patient role. Like adjectives in a modifying relation, only one thematic role of an adjectival participle is assigned a filler. To investigate the influence of thematic role knowledge, we used participles derived from verbs for which good agents and good patients can be identified for the class of event denoted by the verb (e.g., cops and crooks for arresting events; Ferretti et al., 2001; McRae, Ferretti, & Amyote, 1997). We used one offline and two online experiments to examine the interaction between event-specific thematic fit of head nouns (the fit between the head noun and the thematic role concepts for a specific verb) and the

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focusing properties of adjectival participles (i.e., present vs. past participles).

Event Structure

People's knowledge of dynamic events may influence thematic-role assignment and thus participle–noun phrase interpretation for two reasons. First, agents and patients are associated with different parts of dynamic events. In general, dynamic events are viewed as involving a period that leads up to the actual change of state, a period in which the change(s) of state occur, and a period that follows. The period preceding the change of state captures the preparatory or initiating processes by which the event is accomplished, and the period following the event captures the consequent or resultant states (Moens & Steedman, 1988). As illustrated in Figure 1, entities and artifacts are more or less salient during various event components. Agents typically are associated with the initiating conditions (and the ongoing event) because they tend to cause the event to occur, whereas patients typically are associated with the resultant states (and the ongoing event) because they often undergo a change of state. However, although this is generally the case, it is not true of all events; patients can cause an event to occur, and agents may undergo a change of state.

A second reason for predicting that event knowledge influences thematic role assignment is that the grammatical inflection of an adjectival participle can be biased toward particular roles (Haspelmath, 1994). Present (active) participles such as *arresting* in *arresting cop* are biased toward the actual or ongoing event and thus the agent role, whereas past (passive or resultative) participles (*arrested cop*) are biased toward the resultant state and thus the patient role (see Figure 1).[1] The approach taken here, following Haspelmath's (1994) study, is that the focusing properties are derived from the fact that adjectives describing events tend to be more time stable (i.e., more stative) than the same events described by verbs. This focusing property should hold for the participles used in the present experiments because they were derived from transitive verbs.

We also examined head noun typicality as a filler for the participle's agent and patient roles. For example, *arrest* often takes both an agent and a patient, as in *The cop arrested the crook*. Here, *cop* is the agent and *crook* is the patient. Although the fillers for these roles can vary, some are more typical than others. In the case of *arrest, cop* is a typical filler for the agent role, whereas *teacher* is an atypical filler.

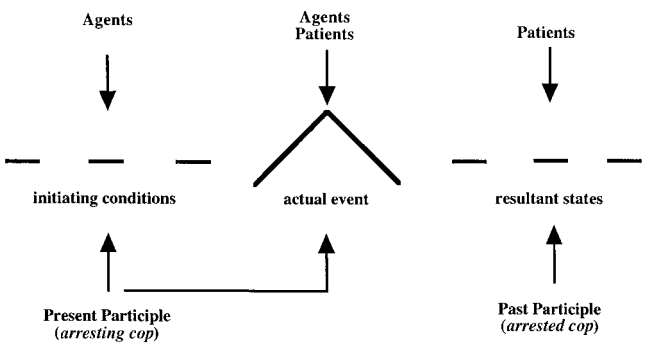

Figure 1. Agents and patients, present and past participles, and their relation to the temporal and causal structure of events.

Recently, McRae et al. (1997) extended previous work (e.g., Dowty, 1991) to construct a theory of thematic roles that incorporates event-specific information. They postulated that an important aspect of verb meaning and event structure concerns common participants, instruments, and locations, and that this knowledge might be viewed as instantiated in schemas, at least in those that emphasize dynamic, context-dependent event structures (Hintzman, 1986; McClelland & Rumelhart, 1985). In their view, a thematic role of a specific verb is a concept formed through everyday experiences during which people learn about who and what play specific roles in specific situations. This knowledge is computed immediately as a consequence of hearing or reading the verb and thus is a key factor in driving online thematic assignment (Altmann & Kamide, 1999; Fernald, 2001; Ferretti et al., 2001; McRae et al., 1998). The agent and patient roles are advantageous for our purposes because human empirical studies and computational models suggest that participant information is salient in situations (Kolodner, 1983; Lancaster & Barsalou, 1997). Furthermore, agent and patient roles are by far the ones that are most frequently assigned to core arguments of transitive verbs (subject and object, respectively). Consequently, the well-defined lexical–conceptual nature of transitive verbs makes them ideal for examining the influence of grammatical morphemes on constraining the activation of world knowledge about participants in events.

Models of Conceptual Combination and Participle–Noun Phrase Interpretation

The time course of the activation and use of various types of world knowledge has played an important part in theories of conceptual combination. Recent theories of conceptual combination appear to differ slightly on whether world knowledge is used immediately either to comprehend a combination or to elaborate the representation of a combined concept. For example, the competition among relations in nominals (CARIN) model includes the claim that world knowledge concerning the relations that are typically used with the modifier concept in conceptual combinations is brought to bear immediately as part of the interpretation process (Gagné, 2000, 2001; Gagné & Shoben, 1997). Furthermore, Wisniewski's (1997) dual-process approach allows for the use of world knowledge in comprehending relational combinations. In contrast, in the selection-modification model of Smith, Osherson, Rips, and Keane (1988), world knowledge does not strongly influence conceptual combination. Similarly, Murphy (1990) implicated the use of world knowledge in the elaboration process, which may be considered as occurring somewhat later than the initial interpretation process. However, Murphy has also implicated world knowledge in initial stages of processing, in terms of selecting the dimension of the head noun that is altered when it is placed in a combination. In sum, all approaches to conceptual combination hold that world knowledge associated with both modifiers and head nouns play a crucial role in determining the meaning of combined concepts, but they vary on when and how world knowledge influences interpretation.

The vast majority of psychological research on conceptual combination has focused on adjective–noun or noun–noun combina-

[1] Depending on the event denoted by the participle and the head noun, other roles could compete for assignment, such as instrument (e.g., *sewing machine*) and location (*parking garage*).

tions. Thus, the part played by grammatical inflections in conjunction with event knowledge has not been scrutinized, and conceptual combination research has not contrasted directly, for example, present versus past participles. Although research on conceptual combination has not directly focused on grammatical inflection and event knowledge, there has been some research that is relevant to these issues. For example, the comprehension of phrases like *peeled apple* or *burning house* has been studied and this research indicates that people are sensitive to these inflections (Gagné & Murphy, 1996; Potter & Faulconer, 1979; Springer & Murphy, 1992). Thus, *peeled apple* is understood as *an apple that has been peeled,* and *burning house* as *a house that is burning* (see also Lees, 1963; Levi, 1978). The research presented in the current article extends research on participle–noun phrases by examining directly how grammatical inflections interact with event knowledge to constrain interpretation.

How might these factors combine to influence the comprehension of participle–noun phrases? For phrases with present-participle modifiers, there should be a bias toward assigning the head noun to the agent role and, conversely, for past participles, there should be a bias toward the patient role. When the head noun is typical for the role that is consistent with the focus of the participle, and atypical for the alternative role (e.g., *arresting cop, arrested crook*), interpretation should be relatively consistent and fast. In contrast, when a head noun is atypical for the role that is consistent with the participle's inflection, and typical for the alternative role (e.g., *arresting crook, arrested cop*), interpretation should be more difficult and might vary over items and participants. Of course, these are the two ends of the continuum. In our experiments, each head noun varies in its typicality for the alternative roles of the participles, and thus there should be intermediate cases. Consequently, ease of interpretation should vary as a function of head noun typicality.

Experiment 1

We investigated people's interpretations of participle–noun phrases in an offline task. The main goal was to establish that the phrases are interpreted primarily by combining the focusing properties of the morphemes with event-specific knowledge of typical agents and patients.

Method

Participants. Forty-eight native English-speaking psychology undergraduates from the University of Western Ontario, London, Ontario, Canada, participated for course credit.

Materials and Procedure. Thematic fit of each head noun for the participles' agent and patient roles was measured by means of a role–filler typicality norming study reported in McRae et al. (1997). This norming method indexes the plausibility of entities or artifacts denoted by nouns as fillers for specific thematic roles by capturing participants' intuitions regarding how typically the denoted situation occurs in the world. Role–filler typicality was measured by having participants rate agenthood ("How common is it for a_____to arrest someone?") or patienthood ("How common is it for a_____to be arrested by someone?") of particular nouns in specific situations on a 7-point scale ranging from 1 (*very uncommon*) to 7 (*very common*).

The verb–noun pairs selected from McRae et al.'s (1997) norming study contained nouns rated as a typical filler for one role and less typical for the other, although thematic fit of the less typical role varied widely (see the Appendix). If a head noun was more typical for the agent role, it was called a *good-agent* phrase. The agenthood ratings of the 64 participle good-agent pairs were significantly higher (M = 6.5, range = 5.7–6.9) than their patienthood ratings (M = 2.9, range = 1.3–6.6), $t_2(62) = 18.96$, $p < .01$.[2] If the head noun was more typical of the patient role, it was called a *good-patient* phrase. The patienthood ratings of the 56 participle good-patient pairs were significantly higher (M = 6.0, range = 5.1–7.0) than their agenthood ratings, (M = 2.7, range = 1.0–6.6), $t_2(54) = 16.39$, $p < .01$. One should note that although these differences are reliable, the ranges overlapped.[3]

Four lists were created, two containing good-agent phrases and two containing good-patient phrases. Items were rotated through lists so that no participle or noun appeared more than once in each. That is, if *arresting cop* appeared in one good-agent list, *arrested cop* appeared in the other, so that each list contained half of the good agents with a present participle and the opposing half with a past participle. The same was true of the good-patient items, yielding four lists. Four additional lists were created identical to the first four except that the items appeared in reversed order.

Participants were given one booklet and were provided with the following instructions: This experiment investigates how people interpret noun phrases. In this study, you will be presented with many phrases. Your task is to read each phrase and think of a likely meaning for it. Pretend that you just heard the phrase in a conversation. What would be the meaning of the phrase that seems most natural to you? For each phrase, write the meaning that seems most natural to you. Please avoid vague interpretations. For some of the phrases, it may be difficult to come up with a meaning. Just do the best that you can. These instructions are similar to those used to examine how people define noun phrases in a nonspeeded task (e.g., Wisniewski, 1996). Each booklet took approximately 30 min to complete.

Design. The percentage of patient interpretations for each condition was analyzed by a two-way analysis of variance (ANOVA). The factors were grammatical marking (present vs. past participle), which was within items (F_2), and thematic fit (good agent vs. good patient), which was between items.

Results and Discussion

Each response was coded as an *agent, patient,* or *other* interpretation. Agent interpretations described the head noun as being the agent in the event denoted by the participle (e.g., *a cop who is arresting someone* for *arresting cop*). Alternatively, a definition such as a crook who was arrested for *arrested crook* was scored as a patient interpretation. The *other* category included responses that clearly failed to fit either category. Participants sometimes failed to provide sufficient detail (e.g., a single-word description or associate, such as *school* for *graded student*), or otherwise failed to distinguish between possible interpretations (e.g., *army at war* for *attacked infantry*). Some definitions implied that the head noun was an agent or patient for a specific event without being explicit. In these cases, Todd R. Ferretti's intuition was used. For example, *frightened and took off* was coded as a patient interpretation for *startled bird* because it strongly implied that the bird had been startled. Such examples were coded as agent or patient interpreta-

[2] F_1 refers to analyses by participants, whereas F_2 and t_2 refer to analyses by items.

[3] It was discovered following the completion of all experiments that one good agent and one good patient were rated equally as agents and patients to one decimal point. Because they had been inappropriately labeled as good agent and good patient, they were omitted from all analyses.

tions only when they were strongly implied; otherwise, they were coded as *other*.[4]

Agent and patient interpretations constituted 90% of the definitions. Because of the infrequent occurrence of *other* interpretations, they were removed from the analyses, and the proportions of agent and patient interpretations were normalized (see Table 1). Analyses including the *other* category did not differ in any significant way from those reported below.

Grammatical marking and thematic fit interacted, $F_2(1, 116) = 84.41$, $p < .01$. This occurred because the participle's influence for good-agent phrases (74% more agent interpretations for present vs. past), $F_2(1, 116) = 479.15$, $p < .01$, was much greater than for good-patient phrases (28%), $F_2(1, 116) = 119.78$, $p < .01$. Overall, there was a greater percentage of patient interpretations for good-patient phrases ($M = 83\%$, $SE = 2\%$) than for good-agent phrases ($M = 46\%$, $SE = 4\%$), $F_2(1, 116) = 215.76$, $p < .01$. Finally, there was a greater percentage of patient interpretations for phrases with past participles ($M = 90\%$, $SE = 2\%$) versus present participles ($M = 37\%$, $SE = 3\%$), $F_2(1, 116) = 436.53$, $p < .01$.

For past-participle phrases, participants consistently produced patient interpretations regardless of thematic fit. The past participle strongly focused participants on the resultant state (Haspelmath, 1994) and thus highly constrained them toward the patient role. In contrast, the present participle was less constraining. This result is consistent with Haspelmath's (1994) suggestion that present participles provide a weaker bias because they can focus on an ongoing event, making them less time stable than past participles. This naturally explains why participants often generated patient interpretations for head nouns with high patienthood and low agenthood ratings; they interpreted the participle as a finite verb and the head noun as a patient (direct object). The 45 present-participle good-patient phrases given finite verb interpretations by at least 50% of the participants were more heavily biased toward patienthood (patienthood: $M = 6.0$, $SE = 0.1$; agenthood: $M = 2.3$, $SE = 0.2$) than were the remaining 10 phrases of this type (patienthood: $M = 6.0$, $SE = 0.2$; agenthood: $M = 4.6$, $SE = 0.4$). Thus, participants produced definitions such as *a cop arresting a crook,* or *a crook arrested by someone* for phrases such as *arresting crook*. By interpreting the participles as finite verbs, participants reconfigured the phrases' syntactic structures.

There are three further possible reasons why participants may be more willing to construct verb-phrase interpretations for present-participle phrases than for past-participle phrases. First, the production of finite-verb interpretations might have been influenced by word-order constraints in that the most common structure in English is the subject–verb–object main clause, which typically corresponds to agent–verb–patient. Second, there is a greater degree of ambiguity in present participles than in past participles. For example, Lees (1963) suggested that people interpret phrases such as *eating apples* by using a *for* relation (*apples for eating*). Although some definitions were consistent with this suggestion (e.g., *slaughtering pig* as *a pig for slaughtering*) there were very few (less than 0.5%). In addition, although there are examples such as *arresting cop* that could mean *a cop who arrests others* or *a cop who is stunningly good looking,* such alternative definitions occurred extremely rarely. Thus, definitions corresponded primarily to the intended meaning of the phrases, and this occurred even though the phrases were presented in isolation (i.e., without a constraining sentential context that could reduce their ambiguity). In summary, because the participles were derived from transitive verbs and the head nouns were typical for the class of events denoted by the verb, participants provided a narrow range of definitions.

Finally, McRae et al. (1997) found that the agent roles for the transitive verbs used in their study (which are similar in nature to those of the present study) tended to be more well defined than the patient roles; that is, the verbs generally admit a narrower range of fillers for the agent role than for the patient role. For example, a limited number of people can arrest others (not likely a crook), whereas almost anyone can be arrested (including cops). Thus, if the agent roles in the present experiment generally admit a narrow range of fillers, then it may be difficult to compute an agent interpretation for *arresting crook* phrases. Thus participants may have been biased toward a finite-verb patient interpretation, particularly when the head noun was a highly typical patient. Alternatively, if the patient role admits a wide range of plausible fillers, a patient interpretation is generated easily for *arrested cop* phrases.

Table 1
Percentage of Head Nouns Interpreted as Agents and Patients in Experiment 1

	Interpretation type			
	Agent		Patient	
Phrase type	%	*SE*	%	*SE*
Good agent				
Present participle	91	2	9	2
Past participle	17	2	83	2
Good patient				
Present participle	31	3	69	3
Past participle	3	2	97	2

Experiment 2

The goal of Experiment 2 was to determine whether grammatical morphemes interact with event knowledge to constrain online interpretation of participle–noun phrases. We used a sense–nonsense task in which participants indicated whether each phrase had a sensible interpretation (Gagné & Shoben, 1997; Murphy, 1988). If grammatical cues interact with event knowledge, then phrases should be more readily interpreted when participle inflection and thematic fit match (*arresting cop, arrested crook*) versus when they do not (*arresting crook, arrested cop*).

Method

Participants. Forty-four native English-speaking University of Western Ontario psychology undergraduates with normal or corrected-to-normal visual acuity participated for course credit.

[4] Interrater reliability was calculated by having the definitions scored for a randomly chosen half of the items in each of the four cells by a second rater, who was not one of the authors. The number of participants who were judged to provide agent and patient definitions for each item was correlated. This was not done for *other* interpretations because of the numerous scores of 0. Interrater reliability was high ($r = .99$, for agent interpretations; $r = .98$, for patient interpretations).

Materials. On the basis of the norms of McRae et al. (1997), the agenthood ratings of the 66 participle good-agent pairs were significantly greater (M = 6.5, range = 5.7–6.9) than their patienthood ratings (M = 2.9, range = 1.3–6.9), $t_2(65) = 18.32$, $p < .01$. In contrast, the patienthood ratings of the 56 participle good-patient pairs were significantly greater (M = 6.0, range = 5.1–7.0) than their agenthood ratings, (M = 2.8, range = 1.0–6.6), $t_2(55) = 15.71$, $p < .01$.

Four lists were constructed. Two consisted of good-agent phrases, and two consisted of good-patient phrases. Each good-agent list included 33 present-participle phrases, 33 past-participle phrases, and 66 nonsensical participle–noun filler trials (e.g., *brewed ant*). Each good-patient list contained 28 present-participle phrases, 28 past-participle phrases, and 56 nonsensical participle–noun filler trials. Across the lists, each participle appeared in both its present and past form and modified a related head noun. No participant saw any participle or head noun more than once. Finally, 20 practice trials were created, consisting of 5 present-participle sensible, 5 present-participle nonsensical, 5 past-participle sensible, and 5 past-participle nonsensical phrases. Each list was presented to 11 participants.

Procedure. Stimuli were displayed on a 14-in (21.56 cm) Sony Trinitron (New York) monitor controlled by a Macintosh LCIII (Cupertino, CA) using PsyScope (Cohen, MacWhinney, Flatt, & Provost, 1993). Each trial consisted of the following events: *Ready?* presented in the center of the screen until the participant pushed a button indicating he or she was ready, a 500-ms blank screen, and then a participle–noun phrase was presented until the participant responded. The intertrial interval was 1,500 ms. Participants were instructed to read the phrase and to decide as quickly and accurately as possible whether it had a sensible interpretation. The *yes* and *no* buttons were randomized across participants. Response latencies were recorded with millisecond accuracy by means of a Carnegie Mellon University (CMU) button box that measured the time between phrase onset and the button press. Testing sessions began with the practice trials and lasted about 20 min.

Design. Response latencies and percent-sensible response, were analyzed by three-way ANOVAs. The factors of interest were grammatical marking (present vs. past), which was within participants and items, and thematic fit (good agent vs. good patient), which was between participants and items. A trial was excluded from the latency analyses if participants indicated that it was a nonsense item. In the analyses, list and item rotation group were used as between-participants and between-items factors to stabilize variance due to rotating participants and items across lists (Pollatsek & Well, 1995).

Results and Discussion

Participants were faster and more likely to judge phrases as *makes sense* when thematic fit was consistent with the participle's inflection (see Table 2). Response latencies greater than 3 standard deviations from the mean were replaced by that value (less than 1% of the scores). Grammatical marking and thematic fit interacted, $F_1(1, 40) = 14.22$, $p < .01$; $F_2(1, 116) = 12.83$, $p < .01$. Planned comparisons revealed that good-agent present-participle phrases were judged more quickly than good-agent past-participle phrases, $F_1(1, 40) = 6.93$, $p < .02$; $F_2(1, 116) = 4.25$, $p < .05$. In contrast, good-patient past-participle phrases were judged more quickly than good-patient present-participle phrases, $F_1(1, 40) = 7.23$, $p < .02$; $F_2(1, 116) = 8.49$, $p < .01$. The main effects of thematic fit and grammatical marking were nonsignificant, all Fs < 1. Finally, response latencies were longer for nonsense judgments (M = 1,990 ms, SE = 18 ms) than for any of the four conditions of interest.

Grammatical marking and thematic fit also interacted in the percent-sensible-judgment data, $F_1(1, 40) = 48.21$, $p < .01$; $F_2(1, 116) = 133.41$, $p < .01$. Planned comparisons revealed a greater percentage of sensible responses for good-agent present-participle phrases than for good-agent past-participle phrases, $F_1(1, 40) = 42.31$, $p < .01$; $F_2(1, 116) = 128.22$, $p < .01$. In contrast, there was a greater percentage of sensible responses for good-patient past-participle phrases, $F_1(1, 40) = 10.44$, $p < .01$; $F_2(1, 116) = 27.12$, $p < .01$. Overall, good-patient phrases were judged sensible more often (M = 86%, SE = 1%) than were good-agent phrases (M = 77%, SE = 2%), $F_1(1, 40) = 6.08$, $p < .03$; $F_2(1, 116) = 17.26$, $p < .01$. In addition, present-participle phrases (M = 85%, SE = 1%) were judged sensible more often than past-participle phrases (M = 79%, SE = 2%); $F_1(1, 40) = 5.14$, $p < .05$; $F_2(1, 116) = 12.37$, $p < .01$. Both of these main effects occurred primarily because good-agent past-participle phrases were judged sensible only 65% of the time. Thus, Experiment 2 shows that people combine morphosyntactic information with knowledge of specific events to constrain thematic role assignment during participle–noun phrase interpretation.

Table 2
Response Latencies and Sensible Judgment Percentages for Experiment 2

	Response latencies		Sensible judgment	
Phrase type	ms	*SE*	%	*SE*
Good agent				
Present participle	1,623	37	89	2
Past participle	1,705	34	65	2
Difference	−82[a]		24[a]	
Good patient				
Present participle	1,688	44	80	2
Past participle	1,563	42	92	2
Difference	125[a]		−12[a]	

[a] Significant by participants and items.

Experiment 3

A number of researchers have claimed that a verb's argument structure includes only syntactically relevant selectional restrictions such as animacy (Caplan, Hildebrandt, & Waters, 1994; Chomsky, 1965). Given that there is a strong tendency for agents to be animate, whereas patients can be either animate or inanimate, the present experiments used transitive verbs that typically involve animate agents and patients, and all head nouns were animate. To ensure further that the interaction between the morphemes and thematic fit is due to event-specific knowledge, and thus not due to head nouns that are more likely to be agents versus patients across events in general, an unrelated control condition was added in Experiment 3 in which head nouns and participles were repaired to form unrelated sensible phrases (e.g., *kicked king*). If it is the case that our good agents are biased toward being good agents in general, then response latencies should be shorter when they are modified by unrelated present participles. Similarly, if our good patients are biased toward being good patients in general, then response latencies should be shorter when they are modified by unrelated past participles. However, if event-specific knowledge constrains thematic-role assignment, an interaction between mor-

pheme and phrase type should be obtained for the related phrases only.

Method

Participants. Eighty native English-speaking University of Western Ontario psychology undergraduates with normal or corrected-to-normal visual acuity participated for course credit.

Materials. Seventy-two participle good-agent pairs and 60 participle good-patient pairs were created. Although all of these items were presented to participants in Experiment 3, it was discovered later that the past tense form of the verb (*drove*), rather than the past participle (*driven*), was used for some items. These were omitted from all analyses, which then were based on 57 good agents and 52 good patients. The agenthood ratings for the 57 participle good-agent pairs (M = 6.5, range = 5.7–6.9) were significantly greater than their patienthood ratings (M = 2.9, range = 1.3–6.6), $t_2(56) = 18.65$, $p < .01$. In contrast, the patienthood ratings for the 52 participle good-patient pairs (M = 6.1, range = 5.1–7.0) were significantly greater than their agenthood ratings, (M = 2.6, range = 1.0–6.6), $t_2(51) = 16.96$, $p < .01$.

Eight lists were constructed, four good-agent lists and four good-patient lists. Each good-agent list contained 18 related present-participle phrases (*arresting cop*), 18 related past-participle phrases (*frightened monster*), 18 unrelated present-participle phrases (*punishing nurse*), and 18 unrelated past-participle phrases (*kicked king*). For the unrelated trials, we re-paired the head nouns with participles so that the phrases were plausible but not typical. Each list also included 72 nonsensical participle-noun filler trials (*brewed ant*). Each good-patient list contained 15 related present-participle phrases (*adopting baby*), 15 related past-participle phrases (*entertained audience*), 15 unrelated present-participle phrases (*interviewing princess*), 15 unrelated past-participle phrases (*worshipped applicant*), and 60 nonsensical participle–noun filler trials. Over the eight lists, for both good-agent and good-patient phrases, each participle appeared in its present and past form and modified both a related and unrelated but plausible head noun. Finally, there were 5 present-participle sensible, 5 present–participle nonsensical, 5 past-participle sensible, and 5 past-participle nonsensical practice trials. Each list was presented to 10 participants.

Procedure. The procedure was identical to Experiment 2.

Design. The design was identical to Experiment 2 except for the addition of the relatedness factor (related vs. unrelated), which was within participants and items.

Results and Discussion

As predicted by an account based on event-specific thematic knowledge, thematic fit interacted with grammatical marking for related phrases but not for unrelated phrases, both in the latency and percent-sensible data (see Table 3). Latencies greater than 3 standard deviations above the grand mean were replaced by that value (1% of the scores). The interaction among grammatical marking, thematic fit, and relatedness was significant by participants, $F_1(1, 72) = 8.22$, $p < .01$, and marginal by items, $F_2(1, 101) = 3.31$, $p < .08$. This interaction occurred because, as we predicted, grammatical marking and thematic fit interacted for related phrases, $F_1(1, 72) = 12.28$, $p < .01$; $F_2(1, 101) = 13.65$, $p < .01$, but not for unrelated phrases (both Fs < 1). Planned comparisons revealed that related good-agent present-participle phrases were judged more quickly than related good-agent past-participle phrases, $F_1(1, 72) = 3.92$, $p = .05$; $F_2(1, 101) = 6.14$, $p < .02$. In contrast, related good-patient past-participle phrases were judged more quickly than related good-patient present-participle phrases, $F_1(1, 72) = 14.21$, $p < .01$; $F_2(1, 101) = 5.25$, $p < .03$. For unrelated items, response latencies were similar regardless of grammatical marking, both for good-agent and good-patient phrases (all Fs < 1).

Collapsing across relatedness, grammatical marking and thematic fit interacted because response latencies were shorter for good-agent phrases with present participles versus past participles, whereas the opposite was true for good-patient phrases, $F_1(1, 72) = 5.73$, $p < .02$; $F_2(1, 101) = 5.71$, $p < .02$. Relatedness did not interact with thematic fit or grammatical marking (all Fs < 1). There was a main effect of relatedness; related items were judged more quickly, (M = 1,881 ms, SE = 28 ms) than unrelated items (M = 2,145 ms, SE = 36 ms), $F_1(1, 72) = 51.45$, $p < .01$; $F_2(1, 101) = 32.31$, $p < .01$. There were no main effects of thematic fit or grammatical marking (all Fs < 1). Finally, response latencies were slowest when phrases were judged to be nonsensical (M = 2,380 ms, SE = 18 ms).

Grammatical marking, thematic fit, and relatedness also interacted in the percent sensible data, $F_1(1, 72) = 10.44$, $p < .01$; $F_2(1, 101) = 5.66$, $p < .02$. This again occurred because grammatical marking and thematic fit interacted for related phrases, $F_1(1, 72) = 18.58$, $p < .01$; $F_2(1, 101) = 24.92$, $p < .01$, but not for unrelated phrases (both Fs < 1). Planned comparisons for related items revealed that good-agent phrases were judged as sensible more often when paired with present participles, $F_1(1, 72) = 10.14$, $p < .01$; $F_2(1, 101) = 10.85$, $p < .01$. In contrast, good-patient phrases were judged as sensible more often when

Table 3
Response Latencies and Sensible Judgment Percentages for Experiment 3

	Related				Unrelated			
	Latency		Sensible Judgment		Latency		Sensible Judgment	
Phrase type	ms	*SE*	%	*SE*	ms	*SE*	%	*SE*
Good agent								
Present participle	1,809	49	94	1	2,119	59	74	3
Past participle	1,996	64	85	2	2,179	91	76	3
Difference	−187[a]		9[a]		−60		−2	
Good patient								
Present participle	1,948	54	84	2	2,126	73	69	3
Past participle	1,767	49	92	2	2,153	59	73	3
Difference	181[a]		−8[a]		−27		−4	

[a] Significant by participants and items.

paired with past participles, $F_1(1, 72) = 9.02$, $p < .01$; $F_2(1, 101) = 7.85$, $p < .01$. For the unrelated items, percent sensible responses were similar regardless of grammatical marking, both for the good-patient phrases and good-agent phrases (all Fs < 1).

Collapsing across relatedness, grammatical marking and role interacted because good-agent phrases were judged as sensible more often when paired with present participles, whereas good-patient phrases were judged as sensible more often when paired with past participles, $F_1(1, 72) = 7.24$, $p < .01$; $F_2(1, 101) = 13.18$, $p < .01$. Relatedness did not interact with thematic fit, or marking (all Fs < 1.2). Finally, there was a main effect of relatedness in that related items ($M = 89\%$, $SE = 1\%$) were judged as sensible more often than unrelated items ($M = 73\%$, $SE = 1\%$); $F_1(1, 72) = 54.91$, $p < .01$; $F_2(1, 101) = 84.63$, $p < .01$. There were no main effects of thematic fit or grammatical marking (all Fs < 1).

The results of Experiment 3 replicate and extend the results of Experiment 2 in that grammatical marking and thematic fit interacted for related phrases in both Experiments but did not interact for unrelated phrases, which were included in Experiment 3 only. One possible explanation of the Experiment 2 results was that the event-specific good agents and patients may have been good agents and patients across events in general, and thus the Grammatical Marking × Thematic Fit interaction may solely have reflected such general biases of the nouns. However, the lack of a similar interaction for the unrelated trials in Experiment 3 shows that the information being tapped in the online experiments is indeed detailed world knowledge of events and that this information combines with morphosyntactic information to constrain thematic role assignment during phrase interpretation.

Further evidence of event-specific (verb-specific) thematic fit is evident in correlational analyses that were conducted separately for each type of phrase to investigate how agenthood and patienthood ratings correlate with response latencies for the related items of Experiments 2 and 3. As illustrated in Table 4, the correlations were consistent across Experiments 2 and 3, and the expected correlations were obtained. That is, agenthood ratings negatively correlated with response latencies for present-participle good-agent phrases; participants were faster to respond as agenthood rating increased. Similarly, participants responded more quickly to past-participle good-patient phrases as patienthood increased. The correlations also suggest that, as in Experiment 1, participants generated finite verb-phrase interpretations for present-participle good-patient items during online interpretation. The correlations between response latency and patienthood rating for these items demonstrate that response latency decreased as patienthood increased even though the presumably mismatched present participle had been used.

One discrepancy between Experiments 2 and 3 is the percentage of *arrested cop* phrases judged sensible (65% in Experiment 2 vs. 85% in Experiment 3). Experiment 2 did not include unrelated trials. Thus, half of the trials consisted of phrases in which the head noun was a good filler for one of the participle's thematic roles, and the other half included head nouns that were nonsensical for both roles (barring a metaphorical, effortful interpretation; e.g., *brewing ant*). This sharper contrast may have caused participants to be more sensitive to the match between the participle and thematic fit, leading them to judge fewer *arrested cop* phrases as sensible. Presumably, a similar result did not occur with *arresting crook* phrases because participants generated a finite verb-phrase interpretation for those items.

One possible concern with Experiments 2 and 3 is that good agents and patients were presented in separate lists. In the experiments, not all participles taken from McRae et al.'s (1997) norms appeared with both a good agent and good patient. Thus, the item rotation procedure in Experiments 2 and 3 was used to maximize the number of items available from the norms while avoiding repetition of particular nouns and participles within the experimental lists. However, the nouns varied widely on their role–filler typicality ratings for the lower-rated role, therefore participants were presented with a relatively heterogeneous set of items. In addition, we have replicated our results in an online experiment that included filler trials containing head nouns biased toward the opposite role. The good-agent lists included 20 good-patient filler trials, and the good-patient lists included 20 good-agent filler trials, half with present participles and half with past participles. The pattern of results reported herein was replicated.

Finally, recall that one alternative account of the large number of patient interpretations found for *arresting crook* phrases in Experiment 1 was that the participles' patient role may admit a greater range of concepts than their agent role, and thus participants could generate these interpretations easily for both present and past participles. One problem with this explanation is that it implies analogous effects in the unrelated trials of Experiment 3. That is, if it was easier to fill the patient roles for the participles in general because they admit a wider range of fillers, then participants should have interpreted the unrelated trials faster when the participles were in their past than in their present forms. However, there was no evidence of this in the data of Experiment 3.

Table 4
Correlations Between Agenthood and Patienthood and Response Latencies for Experiments 2 and 3

	Agenthood rating		Patienthood rating	
Phrase type	Exp 1	Exp 2	Exp 1	Exp 2
Good agent				
Present participle	−.36[a]	−.37[a]	−.01	.03
Past participle	−.10	−.13	−.13	−.05
Good patient				
Present participle	−.08	.10	−.32[a]	−.32[a]
Past participle	.09	.09	−.36[a]	−.30[a]

Note. Exp = experiment.
[a] Significant correlation at $p < .05$.

General Discussion

There are four contributions of this research. First, the experiments illustrate how people integrate world knowledge of agents and patients in specific events with the morphological properties of adjectival participles to constrain offline and online thematic role assignment during phrase interpretation. To our knowledge, these experiments are the first to investigate this combinatorial process in this paradigm. The second contribution is to linguistic and psycholinguistic studies of the influence of morphosyntactic information on the construction of situation models from events mentioned in text (Carreiras, Carriedo, Alonso, & Fernandez, 1997; Givón, 1995; Magliano & Schleich, 2000; Morrow, 1986; Truitt & Zwaan, 1997) and to recent research examining thematic role focusing following transitive verbs during online comprehension

(Stevenson, Crawley, & Kleinman, 1994; Stevenson, Knott, Oberlander, & McDonald, 2000). The current results suggest that grammatical morphemes modulate the activation or use of explicitly mentioned information and also assist in foregrounding and backgrounding world knowledge about the common properties of events. The profiling of world knowledge specific to the temporal and causal components of events makes this information useful for guiding expectations during language comprehension.

Third, as in a number of recent studies (Altmann & Kamide, 1999; Ferretti et al., 2001; McRae et al., 1998), one key type of information for driving processing was event-specific thematic fit, rather than a general notion of the likelihood of a concept being an agent versus a patient across all verbs. The current research provides further evidence for these claims. One should note that the relatively long response latencies in Experiments 2 and 3 make it difficult to conclude from these data alone that the participle inflections modulate the activation (vs. the eventual use) of event-specific thematic-role knowledge. Making strong conclusions regarding activation requires a task that better taps moment-by-moment processing, such as the head-mounted eyetracking, looking paradigm of Altmann and Kamide (1999). Because of the tight time lock between language comprehension and fixation of a scene, the locus of participants' fixations could be measured at various points of a spoken sentence that contains a participle–noun phrase. For example, it might be possible to use a picture of an arresting event that includes both a police officer and someone being arrested and to measure the probability with which participants fixate on the police officer versus other aspects of the scene at *arresting* in a sentence such as *The arresting officer pulled out her gun*.

Finally, the experiments have implications for theories of conceptual combination. This research directly examined event-based relations, which differentiates it from the vast majority of conceptual combination experiments that have investigated either adjective–noun or noun–noun combinations. Although the role of event relations during noun-phrase interpretation has been identified by others (Gagné & Shoben, 1997; Lees, 1963; Levi, 1978; Wisniewski, 1997), the present research is the first to provide direct support for the integration of event-specific relations and grammatical morphemes during noun phrase interpretation. Because current models of conceptual combination have not been aimed at accounting for participle–noun phrase interpretation, we do not comment in detail about the degree to which various models naturally account for our data or how they could be modified to do so.

In conclusion, knowledge about specific events and their participants and the focusing properties of grammatical morphemes combine to influence interpretation of participle–noun phrases in isolation. This study adds to a growing body of research indicating that morphosyntactic properties of verbs and participles play a crucial role in the construction of situation models.

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Appendix

Good-Agent and Good-Patient Pairs and Their Agenthood and Patienthood Rating

Participle	Agent	Agent-hood	Patient-hood	Experiment
dismiss	principal	6.3	2.0	1, 2, 3
kiss	lover	6.9	6.6	1, 2, 3
invite	host	6.5	2.2	1, 2, 3
instruct	coach	6.7	2.7	1, 2, 3
love	grandmother	6.6	6.6	1, 2, 3
sentence	judge	6.9	1.3	1, 2, 3
attack	troop	6.6	6.2	1, 2, 3
lift	worker	6.1	2.1	1, 2, 3
investigate	detective	6.4	1.9	1, 2, 3
carry	postman	6.8	1.6	1, 2, 3
terrorize	pirate	6.5	2.2	1, 2, 3
approve	committee	6.2	3.8	1, 2, 3
slaughter	butcher	6.2	1.4	1, 2, 3
pay (paid)	customer	6.5	1.6	1, 2, 3
grade	teacher	6.9	2.6	1, 2, 3
accuse	prosecutor	6.8	2.6	1, 2, 3
teach (taught)	professor	6.6	2.6	1, 2, 3
interview	reporter	6.8	2.7	1, 2, 3
capture	policeman	6.4	2.1	1, 2, 3
scrub	janitor	6.8	1.4	1, 2, 3
request	specialist	5.7	5.5	1, 2, 3
beat (beaten)	bully	6.5	1.9	1, 2, 3
search	patrolman	6.3	1.4	1, 2, 3
choose (chosen)	contestant	6.0	5.3	1, 2, 3
arrest	cop	6.7	1.6	1, 2, 3
read (read)	philosopher	6.5	3.0	1, 2, 3
serve	waitress	6.8	2.5	1, 2, 3
scratch	cat	6.9	4.1	1, 2, 3
record	singer	6.7	5.5	1, 2, 3
recognize	witness	6.1	3.9	1, 2, 3
shoot (shot)	hunter	6.9	2.8	1, 2, 3
throw (thrown)	pitcher	6.8	1.6	1, 2, 3
audit	accountant	6.0	4.0	1, 2, 3
torture	rapist	6.6	2.2	1, 2, 3
write (written)	author	6.7	1.8	1, 2, 3
visit	tourist	6.8	1.4	1, 2, 3
sketch	artist	6.5	2.5	1, 2, 3
show (shown)	salesman	6.6	1.6	1, 2, 3
stalk	prowler	6.4	2.1	1, 2, 3
study	scientist	6.6	2.4	1, 2, 3
stole (stolen)	criminal	6.7	1.4	1, 2, 3
question	lawyer	6.5	2.9	1, 2, 3
find (found)	archeologist	6.4	1.8	1, 2, 3
fire	employer	6.1	2.4	1, 2, 3
frighten	monster	6.4	1.8	1, 2, 3
devour	snake	6.2	3.9	1, 2, 3
govern	president	6.7	2.7	1, 2, 3
fight (fought)	boxer	6.8	6.1	1, 2, 3
disobey	brat	6.7	3.1	1, 2, 3
adopt	parent	5.8	1.7	1, 2, 3
entertain	comedian	6.9	2.7	1, 2, 3
execute	terrorist	6.1	4.0	1, 2, 3
evaluate	instructor	6.1	4.0	1, 2, 3
kick	donkey	6.1	3.4	1, 2, 3
convict	juror	6.6	1.3	1, 2, 3
accept	friend	6.1	5.8	1, 2, 3
cheer	spectator	6.7	1.3	1, 2, 3
conquer	king	6.1	3.8	1, 2, 3
cure	doctor	6.8	3.8	1, 2, 3
hire	boss	6.7	2.9	1, 2, 3
help	fireman	6.7	3.9	1, 2, 3
admire	fan	6.8	1.7	1, 2, 3
describe	person	6.5	6.3	1, 2, 3
interrogate	inspector	6.3	1.6	1, 2, 3
identify	nurse	5.3	4.2	2, 3
eat (eaten)	man	6.9	1.7	2, 3
convict	judge	6.4	1.5	3
punish	parent	6.5	1.5	3
shoot (shot)	assassin	6.9	2.2	3
fire	owner	6.3	1.9	3
consider	scientist	6.6	4.0	3
serve	butler	6.7	2.1	3

Appendix continued

Participle	Patient	Agent-hood	Patient-hood	Experiment	Participle	Patient	Agent-hood	Patient-hood	Experiment
invite	guest	1.9	6.4	1, 2, 3	lift	infant	2.5	5.9	1, 2, 3
torture	slave	1.3	5.6	1, 2, 3	cure	patient	1.4	6.1	1, 2, 3
startle	bird	3.2	6.0	1, 2, 3	love	husband	6.6	6.8	1, 2, 3
draw (drawn)	model	2.0	6.4	1, 2, 3	choose (chosen)	candidate	4.0	5.6	1, 2, 3
eat (eaten)	chicken	5.9	6.7	1, 2, 3	applaud	musician	2.9	6.8	1, 2, 3
transport	cattle	2.0	5.6	1, 2, 3	arrest	crook	1.2	5.9	1, 2, 3
question	witness	2.0	6.7	1, 2, 3	dismiss	pupil	1.5	5.5	1, 2, 3
rescue	hostage	1.4	5.2	1, 2, 3	convict	criminal	1.4	5.9	1, 2, 3
admire	athlete	4.8	6.4	1, 2, 3	terrorize	victim	1.4	6.6	1, 2, 3
entertain	audience	1.7	6.7	1, 2, 3	frighten	cat	3.1	5.5	1, 2, 3
overthrow (overthrown)	dictator	4.3	5.3	1, 2, 3	serve	customer	1.5	7.0	1, 2, 3
search	thief	5.7	6.1	1, 2, 3	scratch	gardener	3.4	5.7	1, 2, 3
adopt	baby	1.4	6.4	1, 2, 3	slaughter	pig	1.0	6.8	1, 2, 3
present	nominee	4.2	5.5	1, 2, 3	lecture	freshman	1.9	5.4	1, 2, 3
visit	family	6.4	6.6	1, 2, 3	govern	villager	3.2	6.5	1, 2, 3
evaluate	applicant	3.3	5.7	1, 2, 3	punish	child	1.5	5.8	1, 2, 3
carry	newborn	1.2	6.2	1, 2, 3	instruct	novice	1.6	5.3	1, 2, 3
attack	infantry	5.6	5.7	1, 2, 3	audit	taxpayer	2.7	6.2	1, 2, 3
shoot (shot)	deer	1.0	6.4	1, 2, 3	cheer	quarterback	3.8	5.2	1, 2, 3
hunt	rabbit	2.4	6.7	1, 2, 3	kiss	princess	5.9	5.9	1, 2, 3
recognize	celebrity	3.8	6.8	1, 2, 3	enslave	peasant	1.7	5.6	1, 2, 3
grade	student	2.4	6.8	1, 2, 3	stalk	prey	1.7	6.0	1, 2, 3
worship	king	2.6	6.2	1, 2, 3	capture	fugitive	2.6	5.1	1, 2, 3
kick	wimp	1.6	5.4	1, 2, 3	teach (taught)	trainee	1.6	6.3	1, 2, 3
investigate	suspect	2.4	6.4	1, 2, 3	pay (paid)	cashier	3.1	5.4	1, 2, 3
sketch	woman	4.3	5.3	1, 2, 3	chase	mouse	3.1	5.5	1, 2, 3
interrogate	culprit	2.0	5.4	1, 2, 3	investigate	gangster	3.5	6.4	3
release	inmate	1.5	5.9	1, 2, 3	interview	applicant	1.6	6.6	3
fire	employee	1.9	6.4	1, 2, 3	sentence	criminal	1.3	6.7	3
accuse	defendant	3.6	6.8	1, 2, 3	devour	rabbit	3.3	5.7	3

Note. The Experiment column indicates where each pair was used. The participles appeared in both their present-participle and past-participle forms. Irregular past participles are indicated in parentheses.

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