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Situation Models and Abstract Ownership Relations

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Six experiments used a fan-effect paradigm to test whether people can use the abstract relation of ownership to help integrate information into situation models. People studied sentences of the form *The [person] owns/is buying the [object]* for a later recognition test. The integration of sentences into a situation model (as evidenced by an attenuated or absent fan effect) was observed when the verb phrase referred to a specific event (*is buying*) and the objects could all be bought in the same place (e.g., a drugstore). This organization did not occur either when the verb phrase referred to general ownership (*owns*) or when the items were unlikely to be purchased in a single location (e.g., *television* and *car*). It was concluded that although abstract relations can be used to segregate information into sets that can be integrated into situation models, this integration is more likely when it can be embedded within a spatial–temporal framework.

People often understand statements by mentally creating models of the situations they describe (Johnson-Laird, 1983, 1989; Kintsch, 1988; Radvansky & Zacks, in press; van Dijk & Kintsch, 1983). These representations, which we refer to here as *situation models,* are mental simulations of the situations to which they refer. A situation model contains a set of tokens that represents the important entities of the situation as well as the functional relations among those entities. This article presents a view of how these representations have an influence on memory retrieval when they are created and how they are structured in cases in which the relations between entities are of a more abstract nature.

Before considering how abstract relations may play a role in the organization and retrieval of situation models, we briefly review what sorts of organizational aspects of situation models have been studied previously. Research on the concept of situation models has covered a wide range of topics, including text comprehension (Zwaan, 1996), logical reasoning (Schaeken, Johnson-Laird, & d'Ydewalle, 1996), memory retrieval (Radvansky, Zacks, & Hasher, 1996), spatial cognition (Taylor & Tversky, 1992), and the understanding of physical devices (Hegarty & Just, 1993). The bulk of this research has emphasized physical characteristics, such as spatial and temporal relations. This emphasis can be seen by considering a brief survey of some of the research that has been done on situation models over the past 15 years. Much of this research has had the primary aim of evaluating basic characteristics of situation models in terms of how they relate to cognitive processes such as memory retrieval or text comprehension.

Situation models are assumed to represent the situation described by a text rather than the text itself. Consistent with this claim, studies have shown that memory for previously heard sentences is guided by situation-based representations (Bransford, Barclay, & Franks, 1972; Garnham, 1981; Radvansky, Gerard, Zacks, & Hasher, 1990). In a study by Garnham (1981), more false alarms were made to a distractor sentence that referred to the same situation as the original sentence (e.g., *The hostess bought a mink coat* **from** *the furrier* vs. *The hostess bought a mink coat* **at** *the furrier's*) than to two sentences that referred to different situations (e.g., *The hostess received a telegram* **from** *the furrier* vs. *The hostess received a telegram* **at** *the furrier's*). In other words, memory confusions arose when both descriptions referred to the same spatial location or arrangement, but not when they referred to different spatial locations or arrangements.

Other studies have tested the accessibility of information contained in situation models by highlighting or foregrounding a portion of the situation described during narrative comprehension (Glenberg, Meyer, & Lindem, 1987; Morrow, Greenspan, & Bower, 1987; O'Brien & Albrecht, 1992;

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Rinck & Bower, 1995). For example, people in Morrow et al.'s (1987) experiments were able to verify that a pair of objects was in the same room of a memorized building layout more quickly when the story protagonist was in the same room in the building as the objects than when he or she was in a different room. Again, the evaluation of the situation-model view was based on an assessment of how spatial relations affect cognitive processing.

Although much of the research has emphasized spatial relations, there has been some consideration of temporal information and its relation to situation models (e.g., Anderson, Garrod, & Sanford, 1983; Schaeken et al., 1996; Zwaan, 1996). For example, in Zwaan's (1996) study, people read narratives in which there were time shifts that were short (e.g., *a moment later*), intermediate (e.g., *an hour later*), or long (e.g., *a day later*). What was found was that reading and responses times were faster for the short condition than for the intermediate and long conditions, which did not differ from one another. This suggests that actions or events within the same time frame are integrated into the same situation model, whereas events that move beyond a time frame are considered to be part of a different situation. Again, the evaluation of situation models is based on how physical properties affect their structure, in this case the physical property of time.

Finally, memorized facts are more easily retrieved if they can be integrated into a single situation model than if they cannot (Radvansky, 1992; Radvansky et al., 1996; Radvansky, Spieler, & Zacks, 1993; Radvansky & Zacks, 1991). For example, information about several objects being in the same location can be integrated into a single model because it refers to a common situation. In contrast, information about an object being in several locations is stored in separate situation models, each pertaining to a different location. Similarly, situation-model integration is also observed when information can be integrated or not on the basis of whether a common time frame is present (Radvansky, Zwaan, Federico, & Franklin, 1997). Again, the assessment of these differences calls attention to the spatial–temporal character of situation models.

Although physical characteristics have dominated most of these research efforts, other characteristics have been studied on occasion. For example, Gernsbacher, Goldsmith, and Robertson (1992) showed that when reading a narrative, people represent a character's emotional states in a situation model. Note, however, that the situations in Gernsbacher et al.'s study were not structured on the basis of such emotions. Instead, the emotional states were properties of the characters (see Radvansky & Zacks, in press). As such, this research does not address the central question here, which is how an abstract relation may play a role in organizing information into situation models. There is also evidence that causal relations are important in creating representations of a narrative (e.g., Graesser, Singer, & Trabasso, 1994). For example, information that is part of the causal structure of a narrative is easier to remember (e.g., Trabasso & van den Broek, 1985). Furthermore, goal information that is not completed is more available during reading than information that has either been successfully completed or is not part of the causal structure (Lutz & Radvansky, 1997; Suh & Trabasso, 1993). Still, to date there is no evidence that information is segregated into different situation models on the basis of causal relations. Much of the research on causal relations has shown that the internal structure of a situation model can be organized around causal information. Therefore, although these studies do show evidence of the use of abstract relations in situation models, it is not clear how this information can be used to segregate one situation model from another.

Although situation models represent situations in a real or possible world, it is not clear from a psychological point of view how a situation should be conceptualized and, therefore, how dependent these models are on the spatial–temporal factors so often studied in this research. From one perspective, situation models might represent only events that are located in time and space (e.g., *John is buying a bagel*). This is a view of situations as events. Alternatively, situation models might represent any general state of affairs that is not necessarily temporally or spatially localized (e.g., *John owns a bagel*). This is a view of situations as states of being. The current experiments sought to distinguish between these perspectives and to circumscribe the types of situations that are represented by situation models.

The present study examined the use of situation models involving the abstract relation of *ownership*.[1] Although it is abstract, ownership is a basic relational structure that is readily understood (e.g., Miller & Johnson-Laird, 1976). Two elements associated by an ownership relation can be conceived of as relating to a state of affairs that exists in the world. Ownership does not entail specific spatial–temporal relations (people can own a house no matter where they are or what time it is) and does not change an object's physical characteristics. Ownership is conceptually imposed on the world and is not a physical part of it. Miller and Johnson-Laird (1976; Johnson-Laird, 1983) described four characteristics of ownership, derived from Snare (1972). First, if a person owns an object, then that person can use it and no one should prevent him or her from doing so. Second, another person may use an object only if the owner gives permission. Third, an owner is capable of giving another person permission to use an object. Finally, ownership can be transferred from one person to another by actions of the original owner. These four characteristics can be distilled into the simple notion that ownership relations inform a person about who controls the use of the owned object as well as the transfer of that control.

[1] Miller and Johnson-Laird (1976) identified two types of ownership: *inalienable* and *alienable*. Inalienable ownership refers to relations, such as partynomic relations (e.g., *This is my arm*) and kinship relations (e.g., *This is my Uncle Jim*), that cannot be easily transferred away from the owner. Alienable ownership refers to the relations among entities that can be easily transferred (e.g., *This is my $5*). Only alienable relations are the concern of this article. Furthermore, we confine our discussion to concrete objects, such as people, cars, and radios, rather than to intangibles, such as ideas.

Current Experiments

Assessment of Mental Organization

A fan-effect paradigm (Anderson, 1974) was used in the current study. A *fan effect* is an increase in response time to a memory probe on a recognition test, accompanying an increase in the number of associations with a concept. This paradigm permits a test of the subjective organization of the facts with little conscious intrusion on the part of the participant. Furthermore, no external organization of the information (e.g., in a story or a structured list) is provided by the experimenter. As such, the integration of information into situation models is done spontaneously by the person during the course of the experiment.

Previous work has shown that the fan effect can be mediated by whether a set of facts, which shares a common concept, refers to a single situation or to multiple situations (Radvansky et al., 1993, 1996; Radvansky & Zacks, 1991). When a set of facts shares a common concept but refers to different situations, the information is stored in separate situation models. For example, the facts *The potted palm is in the hotel, The potted palm is in the public library,* and *The potted palm is in the city hall* share the concept *potted palm.* Because each fact describes a separate location, a different situation model is created for each. When any one of these facts is presented as a memory probe during a recognition test, not only will the situation model corresponding to the probe be activated, but so will the other models that contain elements of the probe (e.g., models containing *potted palm*). The activation of these irrelevant models will interfere with the retrieval of the appropriate one, increasing the time required to recognize it. The more irrelevant models there are, the greater the interference, and so a clear fan effect is observed.

In contrast, when the facts that concern a given concept all refer to the same situation, the information can be integrated into a single situation model. For example, the facts *The pay phone is in the airport, The wastebasket is in the airport,* and *The ceiling fan is in the airport* all share the concept *airport.* Because these facts concern a single situation, one situation model is created to represent the entire set. Thus, when any one of these facts is presented as a memory probe during a recognition test, only this model should be activated. As a result, there is little or no retrieval interference, and so the fan effect should be greatly attenuated if not eliminated.

This pattern of differential fan effects for multiple- and single-situation conditions has been demonstrated repeatedly with spatial materials (Radvansky, 1992; Radvansky et al., 1993, 1996; Radvansky & Zacks, 1991), as well as with temporal materials (Radvansky et al., 1997). This effect occurs despite instructions to organize by other means and with definite or indefinite articles (e.g., *the* vs. *a* or *an*), when the location serves as either the sentence subject or the predicate (e.g., *The potted palm is in the hotel* or *In the hotel is the potted palm*) and in both younger and older adults.

The reason that this pattern of response times was not observed in the original fan-effect study by Anderson (1974) was because those experiments used sentences such as *The hippie was in the park.* These sentences contain both person and large location concepts. Thus, it is possible to organize situation models either around a person concept (a person can travel from place to place as part of a course of events) or around a location concept (a large location can contain several people at once). Therefore, some interference would be expected from both the person and location concepts. Radvansky et al. (1993) were able to show that when the locations were small ones that typically contain only a single person, such as a phone booth, the location-based organization was no longer plausible, and so a person-based organization was observed with a fan effect occurring off of the location concept, but not off of the person concept. Therefore, we view the fan effect as a useful tool for assessing mental organization. Independently stored but related representations produce a substantial fan effect, whereas integrated representations do not (e.g., Moeser, 1979; Smith, Adams, & Schorr, 1978).

The current experiments extended this logic to abstract relations, with a particular focus on ownership. On the basis of previous semantic analyses of ownership (e.g., Miller & Johnson-Laird, 1976), we assumed that because people control the right to use an owned object, the facts would be organized around the owner rather than around the objects. In other words, any observed organization in the current experiments should be person based. Thus, no organization (and therefore a substantial fan effect) should occur when several people are associated with a single object, which should result in the creation of a separate situation model for each person. However, a person-based organization (an attenuated or eliminated fan effect) should occur when a single person is associated with several objects, because only one situation model should be formed. As such, the critical effect is the Condition × Fan interaction, where condition refers to the case in which there is a single person associated with multiple objects versus the case in which there are multiple people associated with a single object.

Current Hypotheses

The first four experiments investigated the extent to which the organization of information into situation models depends on the information's situation specificity. One factor we considered was the verb phrase used to describe the person–object relation. When the spatial–temporal context is ambiguous, such as when the verb phrase describes a person's possession of an object in general (e.g., *The banker owns the house*), the reader is less likely to identify this information as clearly referring to a specific situation in the world. In contrast, if the presence of a unique spatial–temporal context is more directly communicated, such as when the verb phrase refers to the person's act of acquiring an object (e.g., *The banker is buying the house*), a person can easily identify it as referring to a specific event. Thus, several pieces of information are less likely to be integrated into a situation model in the former case than in the latter.

The second factor we considered was the likelihood that the described objects would be encountered in a single situation. We assumed it would be easier to integrate information into a situation model when a person could interact with all of the objects in a spatially and temporally contiguous fashion. This factor was manipulated by using either objects that could be purchased in a drugstore (e.g., toothpaste, magazines, and candy) or objects that people typically own (Rudmin & Berry, 1987) but are not usually purchased in the same place (e.g., house, car, and computer). If a common spatial–temporal framework is important for people to establish whether information can be integrated into a situation model, then integration should be more evident in the first case with the drugstore objects than in the second with the unrelated objects.

These factors were varied across the first four experiments. Because these experiments were so similar, they are presented together. Experiment 1 used the *is buying* verb phrase and drugstore objects. Experiment 2 used the *is buying* verb phrase and unrelated objects. Experiment 3 used the *owns* verb phrase and drugstore objects. Experiment 4 used the *owns* verb phrase and unrelated objects. In Experiments 1 and 3, people were not told that the objects could be bought in a drugstore, but were simply asked to memorize the study facts as efficiently as possible.

By manipulating these factors, we were able to test four hypotheses. Although the first and the fourth hypotheses are more plausible, the second and the third are presented for completeness. First, the *spatial–temporal framework* hypothesis stipulates that several pieces of information are integrated into a single situation model only if the information clearly refers to specific events that can be plausibly tied together in time and space. This is consistent with the idea that situation models require a spatial–temporal framework in order to be constructed (e.g., Radvansky et al., 1997; Zwaan & Radvansky, 1996). If this is so, a person-based organization should be observed only in Experiment 1, in which the study facts pertained to the purchase of objects that are found in a single location (a drugstore), and should not occur when the facts either referred to objects that are typically bought in different locations at different times (as in Experiments 2 and 4) or referred to an abstract relation that is not localized in time and space (as in Experiments 3 and 4).

Second, the *verb-dependent* hypothesis assumes that a verb phrase that more clearly identifies a unique event (e.g., *is buying*) is sufficient for person-based organizations to be observed, and that whether people can easily interact with the objects in the same location is unimportant. If this is so, a person-based organization should be observed in Experiments 1 and 2, in which the verb phrase was *is buying,* but not in Experiments 3 and 4, in which the verb phrase was *owns.*

Third, the *interactability* hypothesis assumes that for person-based organizations to be observed, it is sufficient that the objects be ones that can potentially be interacted with in a given situation. Integration would not occur for objects that cannot be interacted with together. According to this view, a person-based organization should be observed in Experiments 1 and 3, in which the objects described could all be found in a drugstore, but not in Experiments 2 and 4, in which the objects were unlikely to be interacted with in close spatial and temporal proximity.

Fourth, the *semantics-of-ownership* hypothesis is that people always consider descriptions as referring to common states of affairs. Thus, because ownership conveys information about who controls the objects (Johnson-Laird, 1983; Miller & Johnson-Laird, 1976), situation models are always integrated and organized around the person concepts regardless of the nature of the verb phrase or the type of objects to which the information pertains. If this is the case, then a person-based organization should be observed in all four experiments.

The predictions of the four hypotheses across the four experiments are summarized in Table 1, where + and — denote the presence or absence of a person-based organization, respectively. (See Appendix A for examples of sentences from each experiment.) Again, person-based organization would be indicated by a larger fan effect for conditions in which a single object is associated with multiple people (multiple people/single object conditions) than for conditions where a single person is associated with multiple objects (single person/multiple objects conditions).

Experiments 1–4

Method

Participants. Seventy-two people were tested in each experiment. An additional 4 participants were replaced in Experiment 2, 3 for having more than 10% errors on the recognition test, and the 4th for having previously participated in a similar experiment. One additional participant each was replaced in Experiments 3 and 4 for not finishing the experiment. All participants were native English speakers and were given partial course credit for their participation.

Materials and procedure. Participants memorized a list of 18 sentences of the form *The [person] is buying/owns the [object].* The person concepts were frequently occurring occupation names drawn from Battig and Montague's (1969) category norms. The objects were either drawn from Rudmin and Berry's (1987) norms for owned objects (Experiments 2 and 4) or were items that could all be bought in a drugstore (Experiments 1 and 3). These latter items were selected on the basis of data obtained from 9 people who did not participate in the main experiments and who were

Table 1
Predictions for the Four Different Hypotheses in Experiments 1–4

Hypothesis	Experiment 1	2	3	4
Spatial–temporal framework	+	—	—	—
Verb dependent	+	+	—	—
Interactability	+	—	+	—
Semantics of ownership	+	+	+	+

Note. A plus sign indicates that the fan effect for the single person/multiple objects condition should be absent or at least smaller than the fan effect for the multiple people/single object condition. A dash indicates that there should be no evidence of such a pattern.

asked to list various objects that could be bought in a drugstore. Responses that referred explicitly to drugs, prescriptions, or medications were excluded, as were conceptual replications of more popular answers (e.g., *comb* and *hairbrush*). The selected objects were each mentioned by 5 to 9 participants ($M = 6.3$). The person and object concepts used in all of the experiments are listed in Appendix B.

Each person's study-list sentences were generated by randomly pairing people (e.g., *banker*) and objects (e.g., *house*) so that there were 1 to 3 associations between each person and each object concept (thus defining Fan Levels 1–3). For details, see Radvansky et al. (1993). An example of a structure of associations between the person and object concepts for the study list is presented in Figure 1. Note that the location of the person and object concepts within the associative structure was randomly determined for each participant.

The items of interest were those in which either a single person was associated with 1 to 3 objects (single person/multiple objects) or a single object was associated with 1 to 3 people (multiple people/single object). However, to have the correct number of associations for those critical items and to keep the number of memorized sentences to a minimum, the study lists also included six sentences in which multiple people were associated with multiple objects. These sentences were in the 2–3, 3–2, and 3–3 fan cells of the design (where the first number refers to the number of associations with the person concept and the second refers to the number of associations with the object concept). For example, in Figure 1, the sentence *The carpenter owns the stereo* would be an example of a 2–3 sentence; there are two associations with *carpenter* and three associations with *stereo*. There were four sentences in which both the person and object concepts had only 1 association each (1–1 fan). Two of these sentences were arbitrarily assigned to the single person/multiple objects condition and two to the multiple people/single object condition. Thus, different data were used to exemplify Fan Level 1 in both conditions. Finally, two study sentences in each of the 1–2, 1–3, and 2–1, 3–1 cells composed the multiple people/single object and single person/multiple objects conditions, respectively.

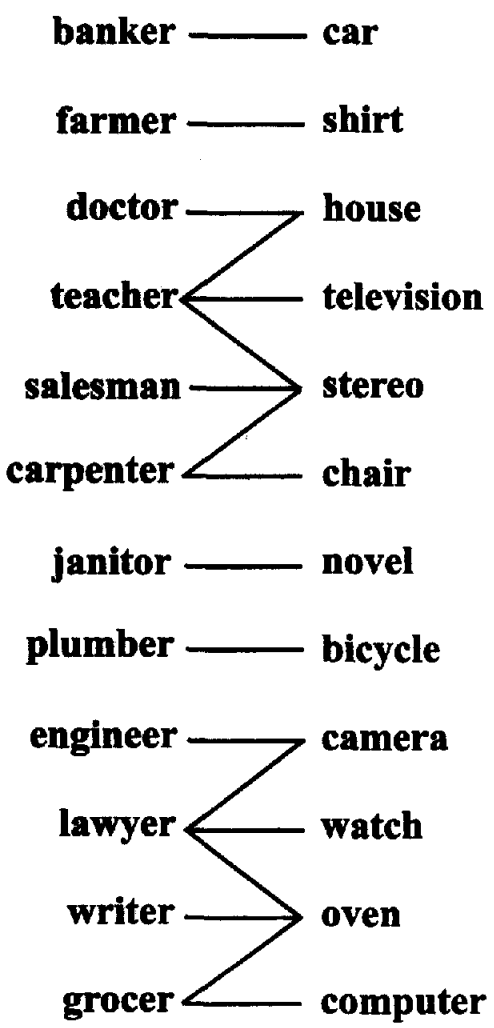

Figure 1. An example of the structure of person–object associations in the construction of the study lists for all six experiments. Note that the positions of the person and object concepts within this structure were randomized for each participant.

The study sentences were presented one at a time for 7 s each, in a random order, on an IBM-PC compatible computer in 40-column video mode. Sentences were presented halfway down and at the left edge of the computer screen. After all of the study sentences had been presented, people were given a series of test questions to see if they had memorized the sentences. The test questions were of the form *Who is buying/owns the [object]*? and *What is/does the [person] buying/own*? Participants responded by typing their answers into the computer. Because the number of answers to a question varied (from one to three), a number was presented beside each question to indicate how many answers to the question there were. If a person answered incorrectly, the computer gave the correct answer or answers. Depending on whether there were one, two, or three correct answers, each set of correct answers was presented for 3, 6, or 9 s, respectively. All responses to the test questions were recorded. After a person answered all of the test questions, the program returned to the study portion of the experiment. This study–test cycle continued until a person was able to answer all of the test questions correctly, twice in a row. Participants required an average of 5.0 ($SD = 1.5$), 5.1 ($SD = 1.5$), 4.8 ($SD = 1.3$), and 4.6 ($SD = 1.2$) cycles to memorize the study sentences in Experiments 1–4, respectively. After the sentences were memorized, the recognition test was given.

The recognition test was composed of 288 sentence probes presented in eight blocks of trials. Half of the probes were the study sentences. The rest were nonstudied sentences generated by recombining person and object concepts from within the same cell of the design. This was done to preserve the number of associations with each of the concept types. For example, on the basis of the sentences shown in Figure 1, if Sentences 1 and 2 were studied, then Sentences 3 and 4 would be the corresponding nonstudied sentences:

1. *The teacher owns the house.*
2. *The lawyer owns the camera.*
3. *The teacher owns the camera.*
4. *The lawyer owns the house.*

At the start of each trial, a fixation point (a plus sign) appeared halfway down the left edge of the computer screen for 500 ms. Then, a probe sentence was presented. The probe began at the location of the fixation point and remained on the screen until a response was made. A studied sentence was indicated by pressing the left button of a computer mouse, and a nonstudied sentence was indicated by pressing the right button. The mouse was held in the right hand and remained resting on the desktop. Each person was encouraged to respond as fast and as accurately as possible. If an error was made, feedback was given in the form of a tone that sounded and a line that appeared on the screen that read either

ERROR!! SENTENCE STUDIED!! or ***ERROR!! SENTENCE NOT STUDIED!!***, whichever was appropriate. This feedback remained on the screen for 1 s.

Prior to the recognition test, people were given 18 practice trials to familiarize themselves with using the mouse buttons to make their responses. On the practice trials, a line appeared that read either *SENTENCE STUDIED* or *SENTENCE NOT STUDIED*, and a person responded accordingly. Feedback for errors was provided.

Design and analysis. Only those trials that contributed to single person/multiple objects and multiple people/single object conditions were analyzed. Those trials in which there were multiple associations for both the owner and the object (i.e., 2–3, 3–2, and 3–3 sentences) were excluded because they could not be easily classified into either the single person/multiple objects or the multiple people/single object conditions. Trials on which an error occurred were not included in the response time (RT) analysis. Also, RTs faster than 500 ms or slower than 10 s were excluded as anticipations and lapses of attention, respectively, as were RTs that were greater than 2.5 *SD*s from the mean of a given cell for each person. These trials composed 3.6%, 3.5%, 3.5%, and 3.4% of the data in Experiments 1–4, respectively. These trials were not counted as errors. In each experiment, the RT data were submitted to a 2 (condition: person vs. object) × 3 (fan) repeated measures analysis of variance (ANOVA). Statistical tests are subscripted to indicate which experiment they are from (e.g., a subscript of 1 indicates Experiment 1). Unless otherwise mentioned, a rejection level of $p < .05$ was assumed.

Results

Participants made an average of 3.0%, 2.7%, 2.4%, and 2.3% errors in Experiments 1–4, respectively. Because these error rates were so low, the error data were not considered further.

Because the situation-model view more directly accounts for the pattern of RTs for studied probes, these data are considered in detail and are presented in Figure 2. The data from the nonstudied probes are less relevant, and so are presented in Appendix C; the data from the 2–3, 3–2, and 3–3 cells are presented in Appendix D for the same reason. The studied-probe data are generally consistent with the spatial–temporal framework hypothesis. There was a significant Condition × Fan interaction for Experiment 1, but not for Experiments 2, 3, or 4. For Experiment 1, where the objects could all be purchased in a drugstore and the verb phrase was *is buying*, a fan effect was not observed in the single person/multiple objects condition, where several objects were being bought by a single person. However, a fan effect was observed in the multiple people/single object condition, where an object was being bought by several people. For the other three experiments, a fan effect was observed in both conditions.

In reporting the results of the statistical analyses, we first report the results of the individual experiments, followed by an analysis of the combined data from the four experiments. Importantly, the Condition × Fan interaction was significant in Experiment 1, $F_1(2, 142) = 2.77$, $MSE = 81{,}427$, $p = .06$, but not in any of the other three experiments (all Fs < 1). Simple effects tests on the data from Experiment 1 showed that the fan effect was significant in the multiple people/single object condition, $F_1(2, 142) = 7.16$, $MSE = 89{,}248$, but not in the single person/multiple objects condition ($F_1 < 1$). This is consistent with the notion that the facts in the single person/multiple objects condition were integrated into a single situation model, thereby removing a source of retrieval interference. In contrast, the facts in the multiple people/single object condition were not integrated, and so, interference was observed. Referring back to Table 1, the presence of a person-based organization in Experiment 1 but not in the other three experiments is what was predicted by the spatial–temporal framework hypothesis. All of the other three views predicted that a person-based organization would have been observed in at least one other experiment. This was not the case.

In addition to the important Condition × Fan interaction, there was a significant main effect of condition in Experiments 1, 2, and 3, $F_1(1, 71) = 6.80$, $MSE = 67{,}307$; $F_2(1, 71) = 5.66$, $MSE = 46{,}161$; $F_3(1, 71) = 12.55$, $MSE = 61{,}144$; but not Experiment 4 ($F_4 < 1$). There was also a significant main effect of fan in all experiments, $F_1(2, 142) = 6.55$, $MSE = 65{,}870$; $F_2(2, 142) = 8.94$, $MSE = 38{,}482$; $F_3(2, 142) = 8.60$, $MSE = 72{,}465$; and $F_4(2, 142) = 8.00$, $MSE = 62{,}538$.

To verify that the pattern of data in Experiment 1 differed from those in Experiments 2, 3, and 4, the RT data were combined into a 4 (experiment) × 2 (condition) × 3 (fan) mixed ANOVA with the first variable as a between-subjects variable and with the rest as within-subjects variables. Unfortunately, the Experiment × Condition × Fan interaction was not significant, $F(6, 568) = 1.14$, $MSE = 60{,}352$, $p = .34$. However, there was not sufficient power to detect this three-way interaction, $\beta = .45$. Because the important comparison for the spatial–temporal framework hypothesis is with Experiment 1 relative to the other three experiments, the data were submitted to another analysis in which Experiment 1 was compared with the combination of Experiments 2, 3, and 4 in a 2 (experiment: 1 vs. 2, 3, and 4) × 2 (condition) × 3 (fan) ANOVA. This analysis did yield a significant three-way interaction, $F(2, 572) = 3.13$, $MSE = 60{,}352$, thus providing some further support for the spatial–temporal framework hypothesis.

Discussion

The purpose of these four experiments was to assess under what circumstances people would integrate information into a common situation model. The basis for assessing such integration was the presence or absence of a person-based organization. The clearest person-based organization was observed in Experiment 1. In particular, a fan effect was observed for the multiple people/single object condition. In contrast, a fan effect was not observed in the single person/multiple objects condition, in which several objects were bought by a single person. When a person could purchase several items in the same situation (i.e., in a drugstore), the information could be easily integrated in memory. However, when a single object was purchased by several people, the information was not integrated.

The data in Experiments 1–4 are most consistent with the spatial–temporal framework hypothesis. People integrate information into a situation model when it can be plausibly inferred that the information refers to events that occurred in

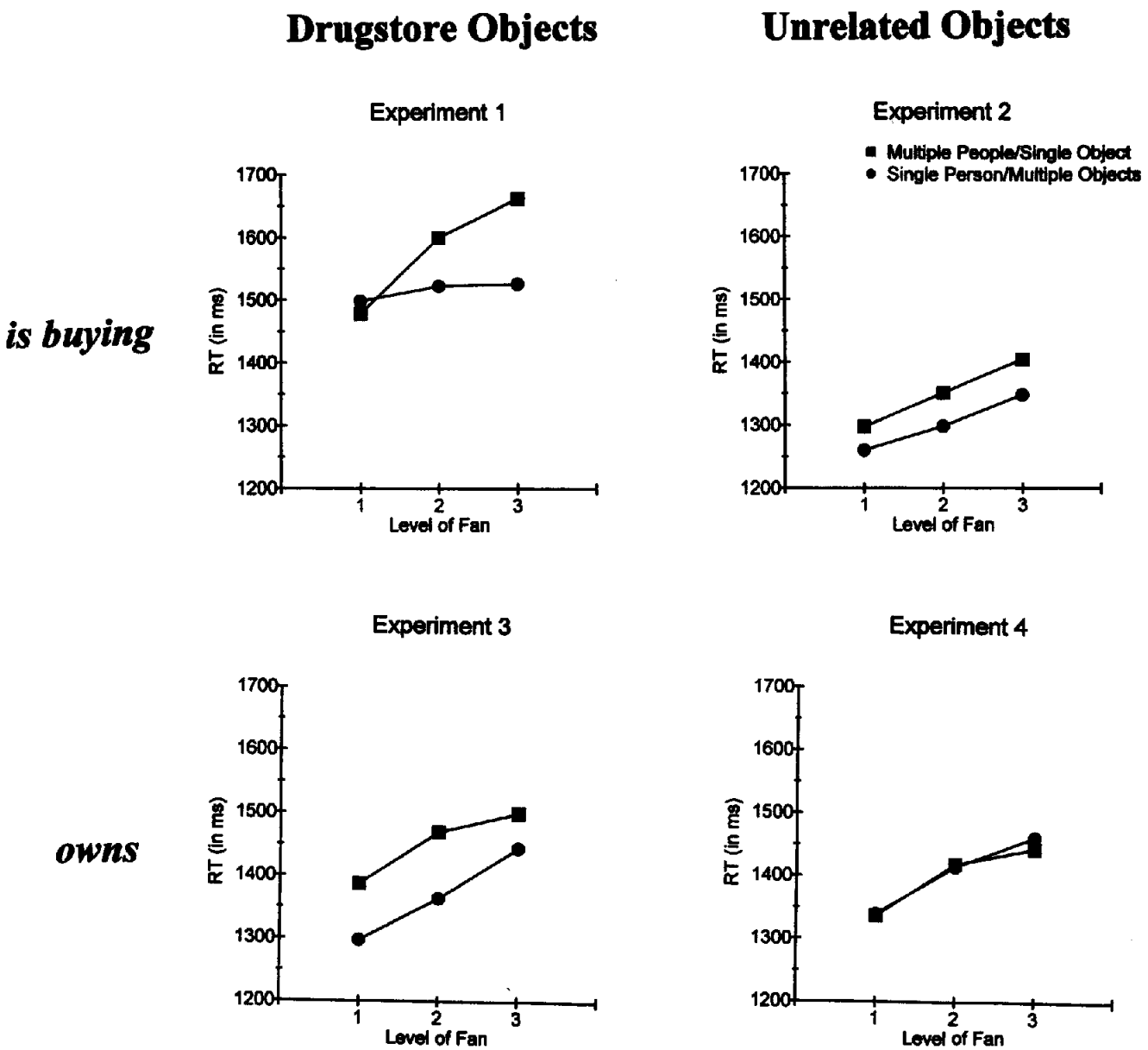

Figure 2. Studied response times (RTs) for Experiments 1, 2, 3, and 4.

the same place at the same time. We would like to point out that, although it appears that a spatial–temporal component is helpful in organizing situation models, these representations are not location based. In Experiment 1, a single location (the drugstore) applied across the whole stimulus set. Therefore, location per se did not serve as a useful guide for segregating the facts into different situation models. Instead, people appeared to rely on knowledge of situations they had experienced, such as the knowledge that people can buy several objects at once in a drugstore.

The results are inconsistent with the verb-dependent and interactability hypotheses. These views predicted a person-based organization for Experiments 2 and 3, respectively, which did not occur. However, it should be noted that in these two experiments, there was a significant main effect between the single person/multiple objects and multiple people/single object conditions, suggesting that each of these variables—the situation specificity of the verb phrase and the interactibility of the objects—although not strong enough to produce clear organization, did play some small role in differentiating the information in these two conditions.

Finally, these results are also inconsistent with the semantics-of-ownership hypothesis. This view suggests that all information is interpreted as referring to states of affairs regardless of any spatial–temporal contiguity, and that the integration of facts into situation models is based on the control of the owned objects. As such, person-based organi-

zations should have been observed in all experiments because in all of the experiments there was a clear state of affairs described and a clear ownership of the objects mentioned in the study sentences. However, no person-based organization was observed. In Experiment 4, in which there was neither a situation-specific verb phrase nor objects that could be easily interacted with together, there was no indication of a person-based organization.

Experiment 5

An alternative explanation of the results of Experiments 1–4 was considered. In particular, the objects used in the experiments were either related and small or were unrelated and large. This difference could have produced the observed pattern of data. Specifically, people may have found it easier to integrate facts about small objects than about large objects. As such, because the objects in Experiment 2 were large, although the *is buying* verb phrase was used, people may have found it more difficult to integrate information into situation models. There are two ways to address this issue: (a) to use materials with small objects that are unlikely to be purchased in the same situation to assess whether just having small objects would be sufficient for observing a person-based integration, and (b) to use materials with large objects that are likely to be purchased as part of the same situation to assess whether spatial–temporal contiguity is what is required for the possibility of integration to occur. Experiment 5 addressed this issue in the first way, and Experiment 6 addressed it in the second.

In Experiment 5, we had people memorize sentences in which the objects were small, like the drugstore objects, but in which the objects were unlikely to be bought in the same location, such as a toothbrush, a compact disc, and a diamond ring. Again, the *is buying* verb phrase was used to emphasize an interpretation of specific events. If the critical feature is that the objects should all be part of the same situation, then a person-based organization should not be observed with these materials. However, if the critical feature is the size of the objects, a person-based organization should be observed.[2]

Method

Participants. Forty-eight people were recruited from the participant pool at the University of Notre Dame and were given partial course credit. All were native English speakers.

Materials and procedure. The materials used in Experiment 5 were generated in the same way that those in Experiments 1–4 were, with the exception that the objects were small and are typically bought in different places. The *is buying* verb phrase was used, resulting in study sentences of the form *The [person] is buying the [object].* The same person concepts were used as in the previous experiments. Participants in Experiment 5 required an average of 5.0 (SD = 1.5) cycles to memorize the study sentences. The RT data were trimmed in the same fashion as in the earlier experiments. These trimmed trials composed 4.0% of the data.

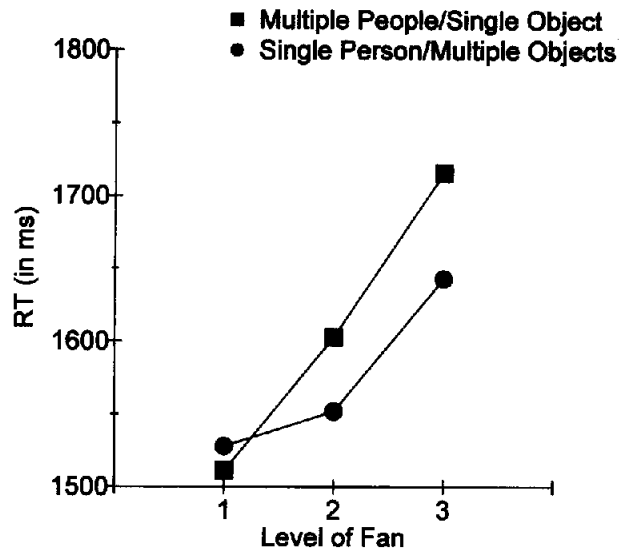

Figure 3. Studied response times (RTs) for Experiment 5.

Results and Discussion

People in Experiment 5 made 2.8% errors on the recognition test, so the error data were not considered further. The RT data are summarized in Figure 3. There was no evidence of a person-based organization. Specifically, fan effects of similar magnitude were observed for both the single person/multiple objects and multiple people/single object conditions, similar to what was observed in Experiments 2, 3, and 4.

The results of a 2 (condition) × 3 (fan) ANOVA on the studied-probe data showed that the Condition × Fan interaction was not significant ($F < 1$). Also, the main effect of condition was not significant, $F(1, 47) = 2.04$, $MSE = 45{,}499$, $p > .10$. However, there was a main effect of fan, $F(2, 94) = 9.40$, $MSE = 66{,}996$. Specifically, RTs increased with increased fan level (Fan Level 1 = 1,520 ms; 2 = 1,578 ms; 3 = 1,680 ms). This is consistent with the spatial–temporal framework hypothesis in that no integration was observed when the small objects were unlikely to be bought in the same location.

Experiment 6

Experiment 6 further assessed the possibility that the person-based organization observed in Experiment 1 was due to the size of the objects used in the study sentences rather than to how the information related to situations in the world. To test this, we presented people with study sentences about people buying large objects rather than the small ones used in Experiment 1. Participants were told that all objects were ones that could be purchased at an estate sale, because the study sentences were ones such as *The banker is buying the painting.* This allowed us to avoid using objects that all

[2] We thank Rose Zacks for suggesting Experiment 5.

belonged to well-established categories, such as furniture. Previous research has found that when people study sentences that are thematically related, fan effects can be reduced or eliminated (McCloskey & Bigler, 1980; Smith et al., 1978). The dominant explanation is that people base their decisions on a plausibility or consistency judgment rather than on a recognition decision (Anderson & Reder, 1987; Reder & Anderson, 1980; Reder & Ross, 1983; Reder & Wible, 1984). The materials used in Experiment 6 avoided this possibility because the objects did not have strong preexperimental associations but rather could be interrelated in terms of how they were involved in the described situations. Again, the *is buying* verb phrase was used to emphasize an interpretation of specific events. If the critical feature is that the objects should all be part of the same situation then, as in Experiment 1, a person-based organization should be observed. However, if the critical feature is that the objects were small, then no person-based organization should be observed.

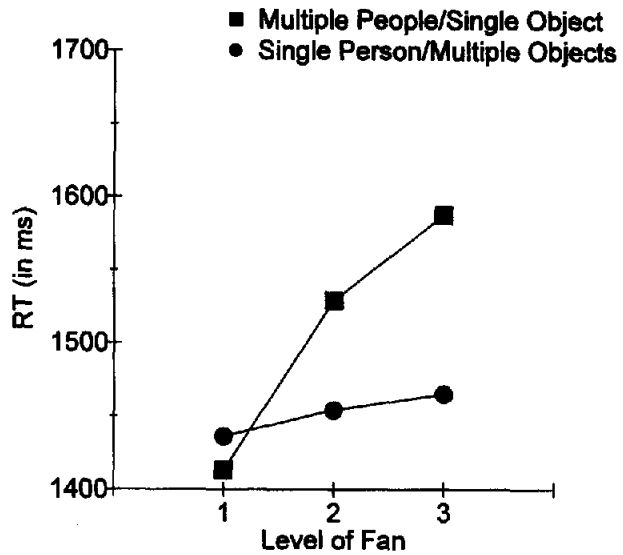

Figure 4. Studied response times (RTs) for Experiment 6.

Method

Participants. Seventy-two people were recruited from the participant pool at the University of Notre Dame and were given partial course credit. Four additional people were replaced, three for not finishing the experiment and 1 for having an error rate greater than 10%. All were native English speakers.

Materials and procedure. The materials used in Experiment 6 were generated in the same way that those in Experiments 1–5 were, with the exception that the objects were large and could plausibly be bought at an estate sale. These objects are listed in Appendix B. The *is buying* verb phrase was used, resulting in study sentences of the form *The [person] is buying the [object].* The same person concepts were used as in the previous experiments. Participants in Experiment 6 required an average of 4.7 (SD = 1.6) cycles to memorize the study sentences. The RT data were trimmed in the same fashion as in the earlier experiments. These trimmed trials composed 4.3% of the data.

Results and Discussion

People in Experiment 6 made only 3.2% errors on the recognition test, so the error data were not considered further. The RT data are summarized in Figure 4. This pattern of data is consistent with a person-based organization. The fan effect was significant for the multiple people/single object condition, but not for the single person/multiple objects condition. This is consistent with what was observed in Experiment 1. However, unlike in Experiment 1, there appears to have been a small fan effect for the single person/multiple objects condition. This may have occurred because our participants would not have been as familiar with estate sales as with buying items in a drugstore. As such, it may have been slightly more difficult for people to conceive of the described situation, so for some participants, the integration of the information would not have been as complete as was observed for Experiment 1. However, the important point is that the fan effect in the single person/multiple objects condition was substantially less than that of the multiple people/single object condition, suggesting that a nontrivial amount of integration was occurring.

The RT data were submitted to a 2 (condition) × 3 (fan) ANOVA. The results of this analysis showed a significant Condition × Fan interaction, $F(2, 142) = 3.79$, MSE = 51,886. Simple effects tests showed that fan effect was significant for the multiple people/single object condition, $F(2, 142) = 8.67$, MSE = 65,451, but not for the single person/multiple objects condition ($F < 1$). These data are consistent with the spatial–temporal framework hypothesis in that integration was observed when the objects were large but were still likely to have been bought as part of the same situation.

In addition to the interaction, there was a significant main effect of condition, $F(1, 71) = 7.26$, MSE = 50,709, with responses being faster for the single person/multiple objects condition (1,452 ms) than for the multiple people/single object condition (1,510 ms). There was also a significant main effect of fan, $F(2, 142) = 7.89$, MSE = 49,058. RT increased with increased fan level (Fan Level 1 = 1,425 ms; 2 = 1,492 ms; 3 = 1,527 ms).

General Discussion

Six experiments investigated whether situation-model organizations are observed for information that involves abstract relations, such as ownership, and if situation-model integration is mediated by whether the information is situation specific and refers to elements that could plausibly be part of a common situation. Previous researchers (Johnson-Laird, 1983; Miller & Johnson-Laird, 1976; Snare, 1972) have analyzed the concept of ownership, concluding that ownership involves the right to control an owned object or to transfer that control. Our interpretation of this analysis is that mental representations can be organized around a person because it is he or she who controls the right to use

owned objects. Facts about a single person owning several objects can be interpreted as describing a single state of affairs. In contrast, facts about a single object being owned by several people cannot be interpreted as describing a single situation. It is unlikely that more than one person will own (and control) a single object at one time. Instead, each description is likely to be interpreted as referring to a separate situation.

How information is interpreted can also guide whether it is integrated into a situation model. The first four experiments tested four accounts of when such an organization could be observed. According to a spatial–temporal framework hypothesis, situation-model integration is observed when a set of facts clearly refers to specific events and it is easy to see how several items might be interacted with together. According to a verb-dependent hypothesis, integration is observed when the verb phrase in the study sentences refers to specific events (as with the verb phrase *is buying*), but not when the verb phrase is situationally ambiguous (as with the verb phrase *owns*). The nature of the objects is less relevant. According to an interactability hypothesis, the nature of the verb phrase is less relevant. What is important for integration is that the objects all be ones that can be interacted with together (such as objects that can be bought in a drugstore). Integration is less likely when objects typically are not interacted with together (e.g., *house* and *car*). According to a semantics-of-ownership hypothesis, what is important is that the information simply contains an ownership relation. According to this view, what is important is that ownership conveys information about who has the right to control the owned objects. This leads to the integration of the information around an owner.

The organization of information should be evident in the pattern of retrieval times, with nonintegrated facts being retrieved more slowly because of interference (a fan effect), whereas integrated facts would be retrieved more quickly and would show little to no interference. The nature of the verb phrases (i.e., *is buying* or *owns*) and the objects in the study sentences (i.e., drugstore items or unrelated objects) were manipulated in the first four experiments. The results support the spatial–temporal framework hypothesis. Person-based organizations were observed in Experiment 1 when the verb phrase was *is buying* and the objects were all ones that could be bought in a drugstore. This pattern of data is consistent with a type of organization observed in many other studies (Radvansky, 1992; Radvansky et al., 1993, 1996, 1997; Radvansky & Zacks, 1991).

Experiments 5 and 6 tested an alternative account based on object size and relatedness, holding constant the *is buying* verb phrase in the study sentences. In Experiment 5, the objects were small but were purchased in different locations. The results of this study showed no consistent person-based organization. Therefore, integration is less likely to occur when a common spatial–temporal framework cannot be established. In contrast, in Experiment 6, the objects were larger, but could all be purchased at the same location and at the same time, that is, at an estate sale. The results of this study showed a person-based organization. As such, integration can occur when a common spatial–temporal framework can be established.

The results of these experiments imply that situation models can be organized around non-spatial–temporal properties, such as ownership, but that some spatial–temporal framework is needed. Reference to this framework can be either implicit, as in the current experiments, or explicit, as in similar studies that have used spatial materials (e.g., Radvansky & Zacks, 1991). Although situation-model integration was observed in the current experiments where the spatial–temporal framework needed to be inferred, it should be pointed out that it was much more difficult to observe this integration here than in cases in which spatial (e.g., Radvansky & Zacks, 1991) or temporal information (Radvansky et al., 1997) was explicitly provided in the study sentences themselves. Specifically, three times as many participants were used in the current experiments (i.e., 72) as in the experiments that explicitly provided spatial and temporal information (i.e., 24). We feel that this provides further support for the idea that the establishment of a spatial–temporal framework is needed for the creation of a situation model.

This idea that it is more difficult for people to conceive of a situation that is not grounded in some way in a particular place and time is consistent with Zwaan's (Zwaan, Langston, & Graesser, 1995; Zwaan, Magliano, & Graesser, 1995) event-indexing model of discourse comprehension. This model claims that when people are reading a narrative with the goal of understanding the text, they create situation models of the events described by the narrative. These situation models contain five indices: (a) spatial, (b) temporal, (c) character, (d) causality, and (e) intention. As long as values along these dimensions are unchanged, the reader interprets new information as being consistent with the same situation. However, when a value along one of these dimensions changes (e.g., there is a shift in time or location, or a new character enters), then there is a slowdown in cognitive processing as either the current situation model is updated or transformed, or a new situation model is constructed. The current research is consistent with this perspective in the sense that the event-indexing model states that space and time are central components of a situation model that must be actively monitored. The current experiments further show that the presence of a clear spatial–temporal framework can play an important role in the integration of information into a common situation model.

In summary, the concept of ownership is not sufficient to serve as a basis for organizing a set of facts in long-term memory, nor is it sufficient for the facts to clearly refer to situations. However, ownership can be used along with other factors to guide memory organization. Two important factors identified in the present studies are (a) that facts denote specific situations and (b) that facts be situationally coreferential; that is, several facts must refer to the same situation before they can be integrated in memory.

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(Appendixes follow)

Appendix A

Examples of Sentences From Each Experiment

Single person/multiple objects	Multiple people/single object
Experiment 1	
The teacher is buying the toothpaste.	The lawyer is buying the shampoo.
The teacher is buying the hair brush.	The writer is buying the shampoo.
The teacher is buying the candy.	The grocer is buying the shampoo.
Experiment 2	
The teacher is buying the house.	The lawyer is buying the oven.
The teacher is buying the television.	The writer is buying the oven.
The teacher is buying the stereo.	The grocer is buying the oven.
Experiment 3	
The teacher owns the toothpaste.	The lawyer owns the shampoo.
The teacher owns the hair brush.	The writer owns the shampoo.
The teacher owns the candy.	The grocer owns the shampoo.
Experiment 4	
The teacher owns the house.	The lawyer owns the oven.
The teacher owns the television.	The writer owns the oven.
The teacher owns the stereo.	The grocer owns the oven.

Appendix B

Person and Object Concepts Used in the Experiments (Exps.)

	Objects			
People	Exps. 1 and 3	Exps. 2 and 4	Exp. 5	Exp. 6
banker	toothpaste	car	toothpaste	television
farmer	hair brush	shirt	diamond ring	chair
doctor	candy	house	compact disc	trunk
teacher	shampoo	television	novel	painting
salesman	aspirin	stereo	apple	curtains
carpenter	deodorant	chair	calculator	bicycles
janitor	razor	novel	dog's leash	clock
plumber	batteries	bicycle	sneakers	lamp
engineer	greeting cards	camera	stamps	automobile
lawyer	tissues	watch	plane ticket	shovel
writer	film	oven	eyeglasses	statue
grocer	magazines	computer	flowers	bookcase

Appendix C

Nonstudied Data and Analyses

Effect	*df*	*F*	*MSE*	RT mean (in ms)
Experiment 1				
Condition	1, 71	22.40*	75,073	
MP/SO				1,769
SP/MO				1,644
Fan	2, 142	26.40*	89,465	
Level 1				1,567
Level 2				1,736
Level 3				1,818
Interaction	2, 142	5.56*	86,947	
MP/SO				
Level 1				1,567
Level 2				1,807
Level 3				1,933
SP/MO				
Level 1				1,566
Level 2				1,665
Level 3				1,702
MP/SO	2, 142	26.82*	92,800	
SP/MO	2, 142	4.27*	83,612	
Experiment 2				
Condition	1, 71	5.74*	64,043	
MP/SO				1,541
SP/MO				1,483
Fan	2, 142	12.22*	65,432	
Level 1				1,429
Level 2				1,535
Level 3				1,572
Interaction	2, 142	1.83	56,192	
MP/SO				
Level 1				1,427
Level 2				1,579
Level 3				1,618
SP/MO				
Level 1				1,430
Level 2				1,492
Level 3				1,526
Experiment 3				
Condition	1, 71	8.41*	103,774	
MP/SO				1,624
SP/MO				1,534
Fan	2, 142	23.61*	74,978	
Level 1				1,456
Level 2				1,612
Level 3				1,671
Interaction	2, 142	2.10	93,248	
MP/SO				
Level 1				1,475
Level 2				1,699
Level 3				1,698
SP/MO				
Level 1				1,436
Level 2				1,524
Level 3				1,643
Experiment 4				
Condition	1, 71	3.12**	85,529	
MP/SO				1,578
SP/MO				1,529
Fan	2, 142	24.42*	71,458	
Level 1				1,436
Level 2				1,571
Level 3				1,654
Interaction	2, 142	6.61*	72,577	
MP/SO				
Level 1				1,419
Level 2				1,572
Level 3				1,744
SP/MO				
Level 1				1,453
Level 2				1,570
Level 3				1,563
MP/SO	2, 142	23.31*	82,008	
SP/MO	2, 142	5.06*	62,027	
Experiment 5				
Condition	1, 47	13.36*	102,165	
MP/SO				1,805
SP/MO				1,667
Fan	2, 94	16.15*	79,105	
Level 1				1,606
Level 2				1,775
Level 3				1,827
Interaction	2, 94	8.23*	57,769	
MP/SO				
Level 1				1,604
Level 2				1,846
Level 3				1,965
SP/MO				
Level 1				1,609
Level 2				1,705
Level 3				1,688
MP/SO	2, 94	16.69*	97,384	
SP/MO	2, 94	3.23*	39,489	
Experiment 6				
Condition	1, 71	5.74*	117,481	
MP/SO				1,692
SP/MO				1,613
Fan	2, 142	32.63*	80,591	
Level 1				1,500
Level 2				1,698
Level 3				1,759
Interaction	2, 142	4.46*	89,719	
MP/SO				
Level 1				1,480
Level 2				1,756
Level 3				1,839
SP/MO				
Level 1				1,520
Level 2				1,640
Level 3				1,678
MP/SO	2, 142	22.40*	113,411	
SP/MO	2, 142	8.60*	56,898	

Note. RT = response time; MP/SO = multiple people/single object; SP/MO = single person/multiple objects.
*$p < .05$. **$p = .08$.

(*Appendixes continue*)

Appendix D

Filler Sentence Response Time Data (in Milliseconds) for All Six Experiments

	Studied probe			Nonstudied probe		
Experiment	2–3	3–2	3–3	2–3	3–2	3–3
1	1,828	1,897	1,902	1,940	2,014	2,234
2	1,542	1,548	1,602	1,675	1,711	1,803
3	1,674	1,692	1,691	1,835	1,912	1,940
4	1,606	1,701	1,700	1,740	1,959	1,996
5	1,848	1,836	1,952	1,970	2,126	2,148
6	1,670	1,714	1,832	1,890	1,924	1,959

Note. For fan levels 2–3, 3–2, and 3–3, the first number refers to the number of associations with the person concept, and the second refers to the number of associations with the object concept.

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Sternberg Appointed Editor of *Contemporary Psychology (APA Review of Books)*, 1999–2004

The Publications and Communications Board of the American Psychological Association announces the appointment of Robert J. Sternberg, Yale University, as editor of *Contemporary Psychology (APA Review of Books)* for a 6-year term beginning in 1999.

Sternberg, at the request of the Publications and Communications Board, as well as many readers, will be embarking on a program to make the journal more timely, more interesting, and more relevant to psychologists during his editor-elect year in 1998. Some of the changes envisioned include fewer but longer and more thoughtful reviews of books, reviews only of "new" books (with a few noteworthy exceptions), comparative textbook reviews at strategic times of the year, and changes in publication frequency and pricing. Sternberg welcomes suggestions for improving the journal and serving reader needs.

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Publishers should note that books should not be sent to Sternberg. *Publishers should continue to send two copies of books to be considered for review plus any notices of publication to*

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