Retrieving Text Inferences: Controlled and Automatic Influences

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Running head: Automatic or controlled inferences

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Abstract

Bridging inferences contribute to text coherence by identifying the connections among ideas, whereas elaborative inferences simply specify sensible extrapolations from text. Prior studies have shown that bridging inferences are indistinguishable from explicit text ideas on numerous measures, suggesting similar long-term memory (LTM) representations for the two; whereas elaborative inferences are inferior. We evaluated the LTM representations of explicit and implicit text ideas using the extended process dissociation procedure (Buchner, Erdfelder, & Vaterrodt-Plunnecke, 1995). Three experiments used the three phases of the process dissociation experimental paradigm (Jacoby, 1991) to partition the controlled, recollective contributions to text retrieval from the automatic, familiarity-based contributions.

The experiments showed that (a) explicit text ideas are more strongly supported by both controlled and automatic influences than are inferences, (b) support for the recognition of inferences is predominantly controlled, and (c) there may be a modest automatic contributions to the retrieval of bridging inferences but not elaborative inferences. These results diagnose informative differences between the LTM representation of explicit text ideas and text inferences.

Retrieving Text Inferences: Controlled and Automatic Influences

In the study of the inferences that contribute to text comprehension, the distinction between bridging and elaborative inferences has been an important one. <u>Bridging inferences</u> identify unstated text connections, and so preserve message coherence. For example, a full understanding of sequence (1) depends on the bridging inference that the events of the second sentence were motivated by the ideas of the first sentence.

(1) Valerie left early for the birthday party. She spent an hour shopping at the mall.

In detecting this relation, the understander accesses pertinent world knowledge, such as the concept PRESENT, and integrates it with the text representation (Singer & Halldorson, 1996, Singer, Halldorson, Lear, & Andrusiak, 1992). Considerable evidence has established that bridging inferences are indistinguishable or hardly distinguishable from explicit text ideas on behavioral measures including inference answer time and the time to name, recognize, and make lexical decisions about implied text concepts (Black & Bern, 1981; Bloom, Fletcher, van den Broek, Reitz, & Shapiro, 1990; Keenan, Baillet, & Brown, 1984; Myers, Shinjo, & Duffy, 1987; Potts, Keenan, & Golding, 1988; Singer, 1980; Singer & Ferreira, 1983).

In contrast, <u>elaborative inferences</u> extrapolate from text in sensible ways, but do not play a special role in coherence. In this regard, suppose one reads only the sentence, <u>Valerie left early for the birthday party</u>. The inference that Valerie was bringing a present to the party would be sound, but it would not link the sentence to a specific text antecedent. Congruent with this analysis, elaborative inferences are inferior to explicit text ideas on a variety of behavioral measures (Corbett & Dosher, 1978; McKoon & Ratcliff, 1986; Potts et al., 1988; Singer, 1980; Singer & Ferreira, 1983). However, elaborative inferences may be at least transiently activated during comprehension (Keefe & McDaniel, 1993). Furthermore, elaborative inferences may be robustly encoded when they are highly constrained. For example, <u>bird for Thanksgiving</u> constrains the category instantiation <u>turkey</u>, (O'Brien, Shank, Myers, & Rayner, 1988; see also Lucas, Tanenhaus, & Carlson, 1990; McKoon & Ratcliff, 1988).

A central concern in this realm has been the long-term memory (LTM) status of the inferences that result from comprehension (e.g., Cook, Limber, & O'Brien, 2001; Klin, Guzman, & Levine, 1999; Singer, 1994). Behavioral equivalence of explicit and implicit text ideas has frequently been interpreted to signify the equivalence of their LTM representations. However, there are several reasons to be cautious about this assumption. For example, behavioral equivalence might reflect the aforementioned transient activation of an implied concept during comprehension, rather than its encoding in LTM (Corbett & Dosher, 1978; Keefe & McDaniel, 1993; Kintsch, 1988). Alternatively, special test strategies may influence the respondent to access only a subset among the surface, propositional, and situational levels of representation that result from text comprehension (Schmalhofer & Glavanov, 1986; van Dijk & Kintsch, 1983). For example, judging the plausibility of the test probe (Reder, 1987) emphasizes the situation model. With this response strategy, encoding differences between explicit and implicit text ideas at other levels could be masked.

These considerations raise the question of the form that representational differences between explicit and implicit text ideas might take, and the origins of such differences. Contemporary theories and evidence offer at least three suggestions about these issues. First, Schmalhofer and McDaniel (2002) posited that because explicit ideas and not implicit ideas find direct expression in the text, only the former are encoded in the surface representation. The situation model, in contrast, serves to integrate text information and general knowledge, so implicit as well as explicit ideas appear in the situation model. However, it is likely that bridging inferences are more highly interconnected with other situational ideas than are elaborative inferences (Schmalhofer & McDaniel, 2002). That is, with PRESENT situationally computed upon the reading of Valerie left early for the birthday party, it is eligible to become interconnected with the ideas underlying the subsequent sentence, She spent an hour shopping at the mall.

Second, a concomitant difference between explicit and implicit representations is that the latter may not be lexically specified at any level. In this regard, the fate of the actress who has fallen from the fourteenth story might be encoded as DEAD, DEPARTED, DECEASED, or even the indeterminate SOMETHING BAD HAPPENED (McKoon & Ratcliff, 1986). Third, representational differences may also stem from the processes by which the reader derives the representations. That is, ideas, such text inferences, that people generate from an original stimulus often have enhanced memorial status, as does the original stimulus itself (Anderson & Bower, 1972; Duffy, Shinjo, & Myers, 1990; Slamecka & Graf, 1978).

To summarize, many measures may not determine whether the LTM representations of explicit and implied text ideas are equivalent (Johnson, Bransford, & Solomon, 1973). A potentially informative approach to this problem is the process dissociation procedure (Jacoby, 1991), an incisive technique for evaluating the memorial quality of an experience. Process dissociation rests on the dual-process assumption that memory retrieval is supported by a controlled contribution, called recollection; and an automatic contribution, called familiarity. Contemporary theoretical analyses have been largely silent concerning the relative contributions of recollection and familiarity to text retrieval. This study was therefore designed to examine the process dissociation profiles of explicit text ideas and text inferences, in order to compare the quality of their LTM representations. The next section describes process dissociation and its application to these issues.

Process Dissociation

Paradigm and assumptions. In a classic example of process dissociation, Jacoby's (1991, Experiment 3) participants encountered anagrams to solve and words to read in phase 1 of the experiment. In phase 2, they recited a distinct set of words that they heard. Phase 3 comprised a recognition test that presented phase 1 and 2 words, and new words. Some participants received an inclusion instruction to label as "old" all words previously encountered in phases 1 or 2. Others received an exclusion instruction: They were directed to say "old" only to those words encountered in phase 2. Jacoby proposed that, in inclusion, a phase 1 word could be labelled "old" as a result of the independent impact of two processes: Controlled recollection of the word originating in phase 1 (occurring with probability $\underline{c}$) and automatic familiarity of the word exceeding a threshold for responding "old" (occurring with probability $\underline{a}$;). Consequently, the probability of labelling a phase 1 word "old" in inclusion, O_i, is given by formula 1. On the other hand, in exclusion, a phase 1 word could be labelled "old" only if it was not recollected as originating in phase 1 (by the exclusion instruction, recollection would result in a "new" response) but its familiarity exceeded the response threshold (formula 2).

@ $$O_i = \underline{c} + \underline{a} - \underline{ca} = \underline{c} + (1-\underline{c})\underline{a} \qquad (1)$$

$$O_e = (1-\underline{c})\underline{a} \qquad (2)$$

Subtraction of (2) from (1) reveals that:

$$\underline{c} = O_i - O_e \qquad (3)$$

Finally, substitution of this value for $\underline{c}$ in (2) yields:

$$\underline{a} = O_e / (1 - (O_i - O_e)) \qquad (4)$$

Jacoby (1991, Experiment 3) reported that $\underline{c}$ was considerably greater for anagrams than read words, but the difference between the $\underline{a}$ values for the two was moderate.

Controversies and limitations of process dissociation. Two debates concerning process dissociation are of particular relevance here. First, a one-process theory of recognition competes with the central dual-process assumption of process dissociation. Consistent with the dual-process position, many experimental manipulations selectively influence either recollection or familiarity in the manner predicted by process dissociation (e.g., Jacoby, 1991; Jacoby, Toth, & Yonelinas, 1993; Toth, 1996). These findings have influenced investigators to incorporate the dual-process principle in their theories (Hintzman & Curran, 1994) and to devise other paradigms to distinguish the recollection and familiarity. In the latter regard, participants' judgements that they either remember or just "know" that a retrieval probe occurred earlier are proposed to respectively reflect recollection and familiarity (Tulving, 1985; Gardiner & Java, 1991). Some dual-influence analyses of retrieval emphasize the contribution of distinct representations rather than distinct processes (Brainerd, Reyna, & Mojardin, 1999; Clark & Gronlund, 1996).

One-process theory, in contrast, is exemplified by the SAM model of Gillund and Shiffrin (1984), according to which recognition probes are "globally" compared with the full contents of memory. Recognition decisions are based on the single process of an activation or familiarity computation about the probe, in conjunction with a recognition criterion. Gillund and Shiffrin showed that this analysis could accommodate a wide variety of memory phenomena. They presented new evidence that retrieval was not affected by whether or not it was speeded. This was proposed to contradict a dual-process hypothesis to the effect that recollection, the putatively slower process, ought to benefit from a longer retrieval period. Ratcliff, van Zandt, and McKoon (1995) used SAM model to simulate memory, by its single process, effects such as list length and study time. Ratcliff et al. showed that when process-dissociation estimates of recollection and familiarity were derived from the simulated data, the estimates failed to discern that those data were generated by a single process.

Nonetheless, the dual-process assumption is sufficiently influential that the role of recollection has by now been scrutinized in theoretical frameworks more usually associated with the single process of familiarity. Global match theorists have addressed how a controlled process of recall complements the contribution of familiarity to the retrieval process (Gillund & Shiffrin, 1984 ;Hintzman & Curran, 1994; Ratcliff et al., 1995). Within a signal-detection framework, Yonelinas (1994) showed that receiver operating curves (ROCs) are influenced by the interaction between the familiarity-based signal detection process and recollection. At the least, the dual-process assumption in general and process dissociation in particular represent a major working hypothesis in the study of memory processes.

The second controversy is that Jacoby's (1991) analysis has the limitations of (a) resting on the assumption that controlled and automatic processes operate independently and (b) not taking guessing processes into account (Graf & Komatsu, 1994; Joordens & Merikle, 1993). For these reasons, we addressed the present issues using the extended process dissociation analysis (Buchner, Erdfelder, and Vaterrodt-Plunnecke, 1995). Buchner et al. redefined the automatic parameter a as the conditional probability that the familiarity of a phase 1 word exceeds the response threshold given that the word is not recollected as originating in phase 1. Determining the value of this conditional probability does not require the assumption of the independence of the controlled and automatic processes.[1] In addition, Buchner et al. introduced the guessing parameters gi and ge for inclusion and exclusion, respectively.

@ Buchner et al. (1995) presented their analysis in the form of a multinomial processing tree model, identifying all of the processing routes that can result in "old" and "new" responses in any given experimental condition. For example, Buchner et al. assumed that, in inclusion, a phase 1 word would be labelled "old" if it was recollected as originating in phase 1 (c); it was not recollected but its familiarity exceeded the response threshold ((1-c)a); or, failing that, it was guessed to be an old word ((1-c)(1-a)gi). Consequently, the probability of labelling a phase 1 word "old" in inclusion is given by formula (5). A comparable formula (6) is derived for O_e.

$$O_i = c + (1-c)a + (1-c)(1-a)gi \tag{5}$$

$$O_e = (1-c)a + (1-c)(1-a)ge \tag{6}$$

Finally, Buchner et al. (1995) assumed that new words are never recollected as originating in phase 1 and their familiarity never exceeds the response threshold. Consequently, the guessing parameters gi and ge are simply equal to the probabilities of responding "old" to new words in inclusion and exclusion, respectively. As a result, equations (5) and (6) can be solved for the parameters c and a.

Process dissociation and text retrieval. We propose that process dissociation is as relevant to text retrieval as to the retrieval of other material. To assume otherwise would entail creating task-specific retrieval theories devoid of psychological generality (Singer & Kintsch, 2001). Furthermore, there is considerable evidence that text retrieval is supported by both recollection and familiarity. In question answering and text recognition at short testing delays, readers can confidently identify test probes with the text; in a manner consistent with conscious recollection (Reder, 1982). In another study, Hasher and Griffin (1978) informed some participants that a text they had read a week earlier had been accompanied by the incorrect title. The participants recalled six times as many explicit text ideas in the title-incorrect than in a control title-correct condition. This striking result suggests that, unable to reconstruct text ideas on the basis of its title (e.g., Going Hunting), the title-change participants scrutinized their text representations in a manner that resulted in the recollection of some ideas from the text.

Familiarity likewise appears to contribute to text retrieval. For example, reading time is lower for a story that repeats, in new words, the theme of a prior text; than for unrelated stories and for stories that repeat words but present a novel theme (Levy et al., 1995). Ordinary reading is not an explicit memory task, so the enhancement of comprehension fluency is more likely attributable to the familiarity of the text ideas than to an experience of recollection. Second, the "feeling of knowing," or familiarity, of a queried text idea affects the strategy and duration of memory search (Reder, 1987).

Consistent with these observations, Long and Prat (2002) reported that readers' knowledge affected the recollective but not the familiarity contribution to text recognition. This outcome clarified prior findings that background knowledge affects text recall but not recognition (e.g., Moravcsik & Kintsch, 1993).

Process dissociation and text inferences. Recognition and other positive evaluations about probes that represent text inferences represent a normal state of affairs rather than an anomaly. Indeed, the acceptance of related distractors (Brainerd et al., 1999) and prototypes (Clark & Gronlund, 1996) is a central phenomenon of human memory. In this regard, people make positive recognition judgments about (a) numerous classes of nonpresented associates of words encountered in lists (Underwood, 1965), (b) items that best capture the convergence among the meanings of listed words (Deese, 1959; Roediger & McDermott, 1995), and test sentences that express the interrelation among other sentences (Bransford & Franks, 1971). Both one-process and dual-process theories have already been applied to these challenging findings. Thus, it is a tenet of the one-process SAM model that distractors in recognition tasks accrue activation on the basis of their similarity to list items (Gillund & Shiffrin, 1984). In the dual-process realm, related distractors formed a central focus of the analysis of Brainerd et al., although these theorists emphasized the contributions of two representations (verbatim and gist) rather than two processes.

Text-inference recognition probes, by definition, do not appear in their antecedent texts. Therefore, the notion of a recollective contribution to inference retrieval merits scrutiny. The widely-considered construct of misrecollection is pertinent to this issue. Misrecollection may represent a source-memory error, such as identifying a process dissociation recognition probe with the incorrect study phase (Dodson & Johnson, 1996). More relevant to the present concerns is that initial study may be accompanied either by the retrieval of a cohort of items associated with a list item (Underwood, 1965) or by the representation of a prototype of a set of related list items (e.g., a sentence that integrates the meaning of several other sentences; Clark & Gronlund, 1996). Later, at retrieval, the presentation of an associate or prototype of the list items may access these representations and result in misrecollection. Even without the initial representation of the prototype, adequate similarity between the probe and multiple test items is adequate to yield misrecollection. One subtlety of this account is that a related distractor might remind the participants of its associated list item, resulting in recognition rejection rather than acceptance. However, Clark and Gronlund noted that the item(s) that generated a prototype might (a) fail to be accessed or (b) be accessed but not constitute sufficient evidence for recognition rejection.

Overview and Predictions

We applied the extended process dissociation procedure (Buchner et al., 1995) to the study of text inferences. In phase 1 of each experiment, participants read sentences or short texts, some containing explicitly stated ideas and others affording the opportunity to draw specific inferences. In phase 2, participants read words aloud. In phase 3, under inclusion or exclusion instructions, participants performed recognition judgements about phase 1 target words, phase 2 words, and new words. Recognition judgements in phase 3 permitted the estimation of the contributions of controlled and automatic processes to the recognition of words representing explicit and implicit text ideas.

Several predictions were evaluated in each of three experiments. First, process dissociation profile differences were anticipated between explicit and implicit conditions. As suggested toward the outset and in keeping with the delayed nature of phase 3 recognition, such differences would diagnose differences in the LTM representation of explicit and implicit items. Second, and more specifically, we predicted greater automatic contributions to explicit than implicit retrieval. This is because automatic influences reflect processes that operate, at least in part, on perceptual representations (Jacoby, 1991, p. 530; Toth, 1996; Yonelinas & Jacoby, 1995). However, perceptual processes (e.g., word identification; Perfetti, 1989) cannot be relevant to text inferences, the corresponding words of which are absent from the text.

We also monitored (a) the relative size of the controlled contribution to retrieval in the explicit and the implicit conditions, and (b) whether the automatic contribution to retrieval in the implicit condition exceeded zero. Existing evidence and theory did not warrant firm predictions about these comparisons. Finally, we predicted that the false alarm rate, and corresponding guessing parameter, would be greater in inclusion than exclusion. By virtue of the process dissociation instructions, there is an appreciably higher ratio of "old" to "new" responses in inclusion than exclusion. This promotes a stronger bias for guessing "old" in inclusion than exclusion (Buchner et al., 1995; Dehn & Engelkamp, 1997; Graf & Komatsu, 1994; cf. Toth, Reingold, & Jacoby, 1994). Other predictions will be discussed with reference to the specific experiments.

Experiment 1

Experiment 1 examined the process dissociation profiles of explicit text ideas and corresponding elaborative inferences. In particular, we scrutinized sentences that stated or implied a case-filling element (Fillmore, 1968). For example, the agent mailman is respectively stated and implied in The mailman delivered the letter in the rain and The letter was delivered in the rain.

These sentences were presented in phase 1 of the process dissociation procedure, and the target mailman later appeared in phase 3. The phase 3 recognition responses permitted the computation of the contributions of controlled and automatic processes to the recognition of explicit and implicit targets. These values bore on the predictions discussed earlier.

Method

Participants

The participants were 154 native-English-speaking students of introductory psychology. They took part in partial fulfillment of a course requirement.

Materials

Phase 1. The materials were four counterbalanced lists derived from 48 experimental sentences. Twenty-four sentences included a high-probability case-filling target word (e.g., mailman in 2a), and the other 24 included a low probability target word (e.g., poet in 3a).

(2) a. The mailman delivered the letter in the rain.
(3) a. The poet broke the television with the brick.

The target words played the role of agent, object, or instrument in their sentences. The high probability elements were identified as the first choice concept to fill a specified role in a fact (e.g., the agent for deliver the letter) by a mean of 88.6% of participants (Singer, 1980). The low probability elements, in contrast, were identified by Singer (1981) as possible but not highly likely case-filling elements on the basis either of Singer's (1980) norms or intuition.

Experimental sentences could appear in the explicit condition (e.g., 2a, 3a); or in the implicit condition, with the target word removed (e.g., 2b, 3b):

(2) b. The letter was delivered in the rain.
(3) b. The television was broken with the brick.

Finally, in a third condition, called "absent," a given sentence did not appear in phase 1. The target words from the absent sentences functioned as distractor words in phase 3.

The low probability condition particularly contrasted with the high probability condition in that there is no reason for poet to be part of the LTM representation of sentence (3b). Therefore, we predicted that both the controlled and automatic contributions to recognition would approximate zero in this condition.

In the first of four counterbalanced lists, high probability sentences were randomly assigned to conditions in the frequencies 6 explicit, 6 implicit, and 12 absent. Parallel assignments were made for the low probability sentences. Then, each sentence was assigned to a random position in the list, subject to the restrictions that half of the sentences in each condition appear in each half of the list, and no more than three sentences from the same condition appear consecutively. Absent sentences held "virtual" positions in the lists and explicit and implicit sentences appeared around them. List 1 thus included only 24 experimental sentences (the other 24 were absent). List 1 began with four buffer sentences and ended with two more. The buffer sentences, half explicit and half implicit in their form, were drawn at random from the same pool as the experimental sentences.

Lists 2 to 4 were constructed by cycling the sentences across conditions, following a Latin-square design. This resulted in each sentence appearing in the explicit and implicit conditions in one list each, and in the absent condition in two lists.

Phase 2. The phase 2 words were 36 nouns drawn at random from sentences from the same pool as the phase 1 experimental sentences. None of the 36 nouns appeared in phase 1 sentences. The phase 2 words were preceded by 4 buffer words.

Phase 3. The phase 3 recognition list consisted of the 24 target words of the explicit and implicit sentences of phase 1; the 36 words of phase 2; and 24 distractor words: namely, the target words from those sentences that had been assigned to the absent condition in phase 1. These 84 words were preceded by six buffer words: two from the buffer sentences of phase 1, two phase 2 buffer words, and two new words. The phase 3 words were arranged in a single random order.

Procedure

The participants were tested in groups of one to four in separate, closed rooms. Each sat at a computer station consisting of a personal computer, monitor, and keyboard. They were randomly assigned in approximately equal numbers to the eight conditions obtained by crossing list (1 to 4) and instruction (inclusion or exclusion). There were three phases of testing. Whether the participant was in the inclusion or exclusion condition pertained only to phase 3. The participant was informed at the outset that the experiment would involve several tasks.

Phase 1. Phase 1 involved the presentation of the experimental sentences. On each trial, the word READY appeared in the center of row 4 of the screen and was removed when participants pressed the space bar to begin. A fixation point was then presented for 500 ms in column 1 of row 5, followed immediately by the sentence. The participants rated the degree of activity conveyed by the sentence on a 4-point scale (1 = very passive, 4 = very active). They used the four fingers of their left hand to press the corresponding numeric keys at the top left of the keyboard. Following a response, the sentence was removed, and the next trial began 3 s later.

Phase 2. The participant pressed a key to initiate phase 2, and a fixation point then appeared for 500 ms at column 1 of row 5. Then, the phase-2 words were displayed for 2000 ms each, plus a 50-ms interword interval. The participant read each word aloud. These responses were registered by a tape recorder.

Phase 3. Phase 3 constituted a recognition task. In the inclusion condition, the participants were instructed to label a test word "old" if it had appeared either in a phase 1 sentence or in phase 2, and "new" otherwise. In exclusion, the participants were instructed to label a test word "old" only if it had appeared in phase 2. The exclusion instructions specified that if the participant remembered that a test word appeared in phase 1, it was to be labelled "new," because no word had occurred both in phases 1 and 2.

The participant pressed a key to begin phase 3. On each trial, a fixation point was presented for 500 ms, followed by the test word. The participant labelled the word either "new" or "old," using keys "x" (left index finger) and "." (right index finger), respectively. When the response was registered, the word disappeared. After a 1-s intertrial interval, the next trial began. If no response was made within 10 s, the trial terminated, and a "no" response was credited.

Results

Target Recognition Rates

The rates of responding "old" to phase 1 target words in the phase 3 recognition test appear in Table 1. Analysis of variance (ANOVA) was applied to these values, alternately treating participants (F1) and items (F2) as the random effect. In the participants-random ANOVA, relation (explicit, implicit, absent) and probability (high, low) were within-participant variables and instruction (inclusion, exclusion) was a between-participant variable. In the items-random ANOVA, relation and instruction were within-item variables and probability was a between-items variable. A significance level of $\alpha = .05$ was used unless indicated otherwise.

Insert Table 1 about here

Our main focus was the multinomial model analyses, so we present the statistics only for the significant recognition-rate ANOVA effects. Those statistics appear in Appendix A. Recognition rates were significantly higher in the explicit condition than in the implicit condition, and under inclusion than exclusion instructions. The Relation x Instruction interaction was significant, diagnosing a greater relation effect in inclusion than in exclusion. Both the Relation x Probability and Instruction x Probability interactions were also significant. These effects appear to result from the relatively high recognition rate in the implicit high-probability condition. The Relation x Instruction x Probability interaction was not significant.

A test of simple main effects revealed an effect of instruction in the absent condition, F1(1, 152) = 24.80, MSE = .04, F2(1, 46) = 51.64, MSE = 56. This indicated that the false alarm rate was higher in inclusion than exclusion.

Model Analyses

The processing tree model of Experiment 1 appears in Appendix B. Parameter estimation and hypothesis testing were performed using the general processing tree program of Hu and

Phillips (1999). The frequencies of "old" and "new" responses under each experimental condition, pooled across participants, appear in Appendix C. The model and the frequencies were entered into the program. The evaluation of a null hypothesis (e.g., $\underline{c}_{EH} = \underline{c}_{IH}$ or $\underline{c}_{IH} = 0$) was performed by subtracting the chi-square goodness-of-fit statistic, $\underline{G}^2$, for the full model in Appendix B, from $\underline{G}^2$ for the submodel constrained by the null hypothesis.[2] The difference between these values is also a $\underline{G}^2$ statistic. It has one degree of freedom because the full model and submodel differ by one free parameter. If the difference exceeds the chi-square critical value of 3.84, then the constraint imposed by the null hypothesis significantly reduces the fit of the full model and so the null hypothesis is rejected (for the details about hypothesis testing using processing tree models, see Batchelder & Riefer, 1990; Hu & Batchelder, 1994; Hu & Phillips, 1999). The $\underline{G}^2$ difference statistic is the statistic that is reported below.

The resulting parameters are shown in Table 2. We evaluated a limited number of hypotheses that compared the parameters to one another and to 0. For high probability targets, $\underline{c}$ was greater in the explicit than the implicit condition, $\underline{G}^2 = 23.64$, which in turn was greater than 0, $\underline{G}^2 = 14.69$. $\underline{A}$ was also greater in the explicit than the implicit condition, $\underline{G}^2 = 20.54$; but the latter did not differ significantly from 0, $G^2 = 0.90$. Thus the process dissociation profiles for explicit and implicit targets differed.

Insert Table 2 about here

For low probability targets, $\underline{c}$ was greater in the explicit than the implicit condition, $\underline{G}^2 = 51.75$, and the latter had the numerical value 0, $\underline{G}^2 = 0.01$. Likewise, $\underline{a}$ was greater in the explicit condition than the implicit condition, $\underline{G}^2 = 69.19$, and the latter had the numerical value 0, $\underline{G}^2 = 0.02$. As expected, the contributions of controlled and automatic processes to the recognition of targets in the low probability implicit condition were zero.

Comparisons between the high and low probability conditions revealed that $\underline{c}$ was significantly greater in the high probability than the low probability condition for implicit targets, $\underline{G}^2 = 8.67$, but not for explicit targets, $\underline{G}^2 = 0.94$. The parameter $\underline{a}$ differed significantly between the high and low probability conditions neither for explicit targets, $\underline{G}^2 = 1.87$, nor implicit targets, $\underline{G}^2 = 0.91$. Thus, the process dissociation profiles were similar for high and low probability targets that were explicit.

Discussion

In the high probability condition, the recognition of explicit targets reflected both controlled and automatic influences whereas implicit recognition reflected a smaller controlled influence and no automatic influence. These results supported our general proposal that explicit text information and elaborative inferences are represented differently in LTM. They supported the more specific prediction of a greater automatic contribution to explicit than implicit recognition. That prediction was based on the proposal that automatic processes operate on certain perceptual representations that could sensibly result from the processing of explicit text but not inferences (e.g., Jacoby, 1991).

For certain points of interest we not identify specific predictions. First, the automatic contribution to implicit recognition did not exceed zero. This outcome further substantiates the association of automatic influences with perceptual representations, which were necessarily absent for the implicit probes. Second, we detected greater controlled support of explicit than implicit recognition in the high probability condition. This could reflect that the surface features of the representation (Brainerd et al., 1999, pp. 164-165) and/or lexical components of the propositional textbase provided extra support for explicit recollection .

It is noteworthy that the significant controlled contribution to implicit recognition could result either from encoding of those inferences during the reading of the original text; or from inferentially relating the recognition probes to the antecedent text representations at retrieval time (Corbett & Dosher, 1978; McKoon & Ratcliff, 1986). Although people routinely incorrectly recognize elaborative-inference probes (Johnson et al., 1973; Singer, 1980), the evidence indicates that the corresponding inferences are not reliably encoded during reading (McKoon & Ratcliff, 1986 Potts et al., 1988; Singer & Ferreira, 1983). Experiment 1 further analyzed the retrieval processes that result in the recognition of elaborative-inference probes: The results indicated that inference recognition was exclusively supported by controlled influences. However, Experiment 1 does not particularly bear on the temporal locus of inference encoding.

Two other features of the results reconcile Experiment 1 with logical analysis and prior findings. First, both c and a were 0 in the low probability implicit condition. This is consistent with the absence of a basis for recognizing poet in the context of The television was broken with the brick. Second, as predicted, the false alarm rate, and corresponding guessing parameter, was higher in inclusion than exclusion.

Experiment 2

Having established that explicit text ideas and elaborative inferences have different LTM representations, we now focus on bridging inferences. Experiments 2 and 3 examined bridging inferences of characters' goals and motives (e.g., Dopkins, Klin, & Myers, 1993; Klin, 1995; Myers et al., 1987; Singer & Halldorson, 1996). For example, upon reading Valerie left early for the birthday party, She spent an hour shopping at the mall, people infer that the second action serves a goal of the first: namely, the purchase of a present.

Method

Participants

The participants were 136 naive individuals from the same pool that was used in Experiment 1. Sixty-eight participants were randomly assigned to each of the inclusion and exclusion conditions.

Materials

Overview. The phase 1 materials were derived from 16 two-sentence texts, each explicitly stating a highly probable target concept in the second sentence (e.g., present in text 4a below). The experimental texts could appear in one of four conditions -- explicit, motive inference, control, and absent. Text (4b), the motive inference sequence, suggested but did not explicitly state that Valerie shopped for a present. Control text (4c) was highly similar to (4b), but suggested the crucial inference less or not at all. Finally, a text could be entirely absent in phase 1.

(4) a. Valerie left early for the birthday party. She spent an hour shopping for a present at the mall. (explicit)

b. Valerie left early for the birthday party. She spent an hour shopping at the mall. (motive inference)

c. Valerie left the birthday party early. She spent an hour shopping at the mall. (control)

The large volume of text that had to appear in phase 1 prompted us to conduct this experiment in four process dissociation blocks. In phase 1 of each block, the participant evaluated the degree of activity conveyed by each of five two-sentence texts. In phase 2, 11 words were read aloud from the monitor screen. In phase 3, the participant had to recognize the phase 1 target words, phase 2 words, and distractor words. Here are the details:

<u>Phase 1</u>. The phase 1 materials were four counterbalanced lists. Each list comprised four blocks of trials. List 1 was constructed as follows: First, the 16 experimental texts were randomly assigned in equal numbers to the explicit, motive, control, and absent conditions. Second, the texts were randomly assigned to the blocks, subject to the restriction that there be one text from each condition in each block. Each text was also randomly assigned to a fixed position in its block. Texts in the absent condition simply did not appear in the phase 1 list. Third, each block began and ended with a buffer text of the same form as the experimental texts, chosen at random from a list of 28 filler passages used by Singer and Halldorson (1996, Experiment 1). Lists 2 to 4 were constructed by cycling the list 1 experimental texts across conditions, using a Latin-square procedure.

<u>Phase 2</u>. In each block, the phase 2 list consisted of nine words, preceded and followed by one buffer word. All of these words were selected at random from Singer and Halldorson's (1996, Experiment 1) filler passages. Across the four blocks, the nonbuffer words comprised 24 nouns, 6 verbs, and 6 adjectives, yielding proportions approximately equal to those of the target words of

phase 1. No phase 2 word appeared in any phase 1 text.

Phase 3. The phase 3 recognition list for each block began with the presentation of three practice words. Two of the practice words had appeared in the phase 1 buffer texts, and the other one was new. The remainder of the list consisted of the four target words (one per condition), four of the phase 2 words, and two new words. The new words were selected from Singer and Halldorson's (1996, Experiment 1) filler passages, and appeared nowhere else in the experiment. The ten nonpractice words were presented in a fixed random order.

Predictions

Like in Experiment 1, we predicted that differences between the LTM representations of explicit and implicit text ideas would be diagnosed particularly by a greater automatic contribution to recognition in the explicit than the motive (inference) condition. The function of the control condition was to highlight the relatively privileged status of bridging inferences (Singer & Halldorson, 1996). Therefore, it was predicted that the controlled parameter would be greater in the motive than the control condition. As before, without offering specific predictions, we monitored (a) the relative size of the explicit and motive controlled parameter and (b) whether the automatic contribution to inference recognition exceeded zero. Finally, we anticipated that the guessing parameter would be again be greater in inclusion than exclusion.

Procedure

In phase 1 of each of the four blocks, each trial began with the appearance of the word READY in the middle of row 4 of the screen. The participant pressed the keyboard space bar to begin the trial. A fixation point was then displayed for 500 ms at column 1, row 5 of the screen, followed by the first sentence of the text. The participant pressed the space bar again to signal comprehension of the first sentence, which resulted in the removal of that sentence. After a 50-ms interstimulus interval, the second sentence appeared. The participant then rated the activity conveyed by the text, in the same manner as in Experiment 1. The trial chronologies in phases 2 and 3 were identical to those of Experiment 1.

Results

Target Recognition Rates

The rates of responding "old" to phase 1 target words in the phase 3 recognition test appear in Table 3. In a participants-random ANOVA, relation (explicit, motive, control, absent) was a within-participants variable and instruction (inclusion, exclusion) was a between-participants variable. In an items-random ANOVA, both relation and instruction were within-items variables. There were significant main effects of instruction, F1(1, 134) = 69.72, MSE = .11, F2(1, 15) = 53.6, MSE = 259.1; and relation, F1(3, 402) = 42.07, MSE = .03, F2(3, 45) = 23.6, MSE = 5100.3. The Instruction x Relation interaction was also significant, F1(3, 402) = 23.45, MSE = .03, F2(3, 45) = 16.7, MSE = 1793.9. The interaction diagnosed that the relation effect was greater in the inclusion condition than the exclusion condition. The inclusion condition bore some resemblance to prior inspections bridging-inference recognition. Therefore, contrasts were performed for the levels of the relation variable in that condition. The inclusion recognition rate was higher in the explicit than the motive condition, F1(1, 63) = 31.56, MSE = 1.00; F2(1, 15) = 18.09, MSE = 253.43; which was higher than the control condition, F1(1, 63) = 6.58, MSE = .65, F2(1, 15) = 12.47, MSE = 47.73; which in turn was higher than absent, F1(1, 63) = 7.81, MSE = 0.50**,** F2(1, 15) = 6.47, MSE = 105.83**.**

Insert Table 3 about here

In the absent condition, mean acceptance rates of .16 and .05 were measured in the inclusion and exclusion conditions, respectively; values which differed significantly, F1(1, 134) = 12.38, MSE = .03, F2(1, 15) = 20.05, MSE = 39.79.

Model Analyses

The processing tree model is presented in Appendix D; and the frequencies of old and new responses, pooled across participants and the four process dissociation blocks, are shown in Appendix C. The modeling analyses were performed as in Experiment 1. The resulting parameter estimates are displayed in Table 4. Parameter c of the explicit condition exceeded that of the motive condition, $\underline{G}^2 = 12.50$, which in turn exceeded that of the control condition, $\underline{G}^2 = 8.97$, which did not significantly exceed 0, $\underline{G}^2 = 1.19$. Parameter $\underline{a}$ of the explicit condition exceeded those of both the motive condition, $\underline{G}^2 = 16.62$, and the control condition, $\underline{G}^2 = 9.60$. The latter two $\underline{a}$ values did not differ significantly, $\underline{G}^2 = 1.63$. However, $\underline{a}$ was significantly greater than 0 in the control condition, $\underline{G}^2 = 6.04$, but not in the motive condition, $\underline{G}^2 = 1.08$.

Insert Table 4 about here

Discussion

The results supported the main predictions. Differences in the LTM representation of explicit and implicit text ideas were again reflected by a greater automatic contribution the recognition of the explicit than implicit probes. The larger motive than control controlled parameter was consistent with our basic contention that motive inferences have a special status in text representation (McDaniel, Schmalhofer, & Keefe, 2001; Potts et al., 1988; Singer & Halldorson, 1996; Singer et al., 1992). The result patterns received further validation from the familiar outcome that the guessing parameter was larger in inclusion than exclusion.

Like in Experiment 1, explicit recognition was more strongly supported by controlled influences than was implicit recognition. As suggested earlier, this indicates that the surface or lexical representations of directly stated text ideas contribute to the experience of recollection in addition to supporting automatic processes.

The automatic influence did not differ between the motive and control conditions; but $\underline{a}$ was significantly greater than 0 in the control condition, whereas it was not in the motive condition. We judged this result to be equivocal and delay its examination until Experiment 3.

Experiment 3

We considered Experiment 2 to merit replication. Experiment 3 served that purpose, but it also implemented a priming procedure. In particular, in the phase 3 recognition lists, the target words were immediately preceded by words that had appeared explicitly in their respective texts. The prime is considered to augment the tendency for the target word to cue the relevant text representation (McKoon & Ratcliff, 1988; Singer & Halldorson, 1996). Failure to access that representation could distort the process dissociation patterns under inspection. Using the unprimed procedure of Experiment 2, our measurements might represent the averaging of trials on which the targets accessed their texts and other trials on which they did not. For example, the incorrect interpretation of an ambiguous probe such as present might impede the retrieval of the antecedent text. This, in turn, could result in misleading estimates of recollection and familiarity in our experimental conditions.

Method

The participants were 127 individuals from the same pool that was sampled for the previous experiments. Sixty-three and 64 participants were randomly assigned to the inclusion and exclusion conditions, respectively. Like in Experiment 2, the materials were arranged in four blocks. In each phase of each block, the materials were identical to those of Experiment 2 with the following exception: In phase 3, each target word was preceded by a priming word. The priming words were nouns that stemmed from the first sentence of their texts. For example, for the motive inference text, Sharon was eager to get the sports car. She went straight to the bank (target -- loan), the priming word was car.

The inclusion of the primes increased the number of words in the phase 3 lists of each block to 14; preceded by three practice words. Prime words from the texts in the absent condition were included in phase 3. Finally, the procedure was identical to that of Experiment 2.

Results

Target Recognition Rates

The mean recognition rates are shown in Table 3. ANOVA, using the same design as in Experiment 2, revealed main effects of instruction, F1(1, 125) = 101.80, MSE = 0.11, F2(1, 15) = 59.4, MSE = 11.7, and of relation, F1(3, 375) = 59.14, MSE = 0.03, F2(3, 45) = 41.6, MSE = 3.8. The Instruction x Relation interaction was significant, F1(3, 375) = 38.75, MSE = .03, F2(3, 45) = 23.4, MSE = 3.8. Contrasts ordered the inclusion acceptance rates higher in the explicit condition than the motive condition, F1(1, 59) = 68.88, MSE = .77, F2(1, 15) = 32.03, MSE = 831.18; which exceeded the control condition, F1(1, 59) = 7.45, MSE = .64, F2(1, 15) = 7.67, MSE = 191.73; which exceeded the absent condition, F1(1, 59) = 10.64, MSE = .64, F2(1, 15) = 6.88, MSE = 428.01. Finally, there was a significant effect of instruction in the absent condition, F1(1, 125) = 11.13, MSE = 0.04, F2(1, 15) = 12.6, MSE = 2.4. The latter outcome again confirmed higher false alarm rates in inclusion than exclusion.

Model Analyses

The processing tree model appears in Appendix D and the pooled frequencies of old and new responses are shown in Appendix C. Table 4 displays the resulting parameters. Parameter c in the explicit condition exceeded that of the motive condition, $G^2 = 33.42$, which exceeded that of the control condition, $G^2 = 5.16$, which was marginally greater than 0, $G^2 = 3.38$, $p = .08$. Explicit parameter a exceeded both that of the motive condition, $G^2 = 15.28$, and the control condition, $G^2 = 17.20$; and the latter two did not differ, $G^2 = .01$. However, a differed significantly from 0 both in the motive and control conditions (motive: $G^2 = 5.15$; control: $G^2 = 5.02$).

To assess the impact of the prime on the parameters, the processing tree models of Experiments 2 and 3 were combined and the corresponding parameter values compared. Parameter c in the explicit condition was greater in Experiment 3 than in Experiment 2, $G^2 = 7.36$. There were no other significant differences.

Discussion

The results resembled those of Experiment 2 both in their support of our predictions and their corroboration of validating points such as the larger guessing parameter in inclusion than exclusion. However, the difference between the explicit and motive c values appeared appreciably larger than in Experiment 2. A joint analysis of Experiments 2 and 3 confirmed that the explicit c parameter was greater in Experiment 3. This is a further indication, consistent with the results of Experiments 1 and 2, that verbatim elements of the representation contribute to the experience of recollection. The priming procedure did not benefit the motive condition relative to the control condition. This tends to deny that the unprimed procedure of Experiment 2 conferred a relative disadvantage upon the motive condition.

It is noteworthy that there were modest but significant automatic influences in both the motive and control condition. We propose that these effects, as well as the automatic contribution in the control condition of Experiment 2, reflect the impact of low-level word associations in comprehension. There is evidence that both the intended and unintended associated meanings of the words of a discourse are transiently activated during comprehension (Keefe & McDaniel, 1993; Swinney, 1979; Till, Mross, & Kintsch, 1988). Activated concepts have at least a brief opportunity to influence the construction of one or more levels of text representation (Kintsch, 1988); and, as a result, may become a weak part of that representation (McKoon & Ratcliff, 1986). To the extent that activation converged on the target word during the reading of the two-sentence text in phase 1, an automatic influence might result. We consider this hypothesis to be worthy of future scrutiny.

General Discussion

To evaluate the profile of controlled and automatic processes that support the retrieval of text inferences, we applied Buchner et al.'s (1995) extension of the process dissociation procedure to the study of elaborative and bridging inferences. The experiments provided consistent support for several predictions: (a) Different profiles were detected for explicit text ideas and text inferences; and one locus of these differences was a greater automatic contribution to the recognition of explicit ideas than inferences. The latter outcome is congruent with the operation of automatic processes on perceptual representations, such as those resulting from the recognition of the explicit words of a text (Jacoby, 1991; Yonelinas & Jacoby, 1995). (b) Text-inference recognition was consistently supported by controlled influences, a result which meshes with frequent reports of readers' recognition of the implications of text (Johnson et al., 1973). (c) The controlled contribution was greater in the motive-inference condition than the control condition of Experiments 2 and 3. This confirms that the privileged status of text-bridging inferences does not result simply from associations between words in the antecedent and outcome sentences of the bridging sequence (McKoon & Ratcliff, 1986; Potts et al., 1988; Singer & Halldorson, 1996). If it did, then those same associations would support similar retrieval profiles in the control condition (see example 4, earlier).

Bridging inferences were of special concern in this study because they have been indistinguishable from explicit text ideas according to numerous on-line and memory measures of comprehension (McDaniel et al., 2001; Potts et al., 1988; Singer & Ferreira, 1983). However, bridging inferences differ conceptually from explicit text ideas in terms of (a) the absence, in the text, of their corresponding word sequences and (b) their computational demands. These observations gave rise to the predictions of process-dissociation profile differences between explicit and implicit text ideas.

We interpret the results to indicate that explicit ideas and bridging inferences are encoded asymmetrically in the surface, textbase, and situation representations of text. In particular, only explicit ideas ought to be robustly encoded in the surface representation (Schmalhofer & McDaniel, 2002). As discussed throughout, this proposal is consistent with the outcome that only explicit target recognition was supported substantially by automatic influences. This multilevel analysis is consistent with other proposals concerning bridging inference processing. Fincher-Kiefer (1995), for example, reported that recognition time was longer for bridging inference words that also appeared explicitly elsewhere in a message than for other explicit words that did not capture a bridging inference. She interpreted this outcome as an interference effect, attributed to the posited presence of the bridging inference concept in (a) the surface representation, which would promote a "yes" response in recognition; and (b) the sort of gist representation that results from inference computation, which would promote a "no" response.

For two reasons, we do not propose that the differences that we detected between explicit ideas and bridging inferences challenges the relatively privileged status of bridging inferences in the representation of text. First, the superiority of explicit ideas to bridging inference concepts in certain recognition tasks (e.g., Fincher-Kiefer, 1995; Singer, 1980) has been treated as a dissociation from answer time and inference naming time measures rather than as evidence for the noncomputation of the bridging inferences. Such dissociations have the capacity to clarify the contributing information processes. Second, direct comparisons between elaborative and bridging inferences indicate that bridging inferences are more robustly encoded in the message representation (Potts et al., 1988; Singer, 1980; Singer & Ferreira, 1983).

There is extensive evidence that the superficial processing of a stimulus, by manipulations such as divided attention (Jacoby, Lindsay, & Toth, 1992; Jacoby et al., 1993) and shallow semantic processing (Dehn & Engelkamp, 1997; Komatsu, Graf, & Uttl, 1995; Toth, 1996), yields process dissociation profiles of a greatly diminished controlled contribution plus a relatively intact automatic contribution. This might raise the question of why, in contrast, the retrieval of bridging inferences in Experiments 2 and 3 was predominantly controlled. However, bridging inferences are not aptly characterized in terms of a reduction of semantic processing. First, text-bridging concepts are not physically present during encoding whereas superficially processed stimuli are. The physical appearance of the superficially analyzed stimulus affords the application of perceptual processes, which contribute substantially to the automatic support of retrieval (Jacoby, 1991; Mandler, 1980). Second and conversely, the only basis for the judgment that a bridging concept appeared in a text is the semantic derivation of the concept from the explicit text ideas. This derivation likely represents the reader's active involvement in the generation of the inference (Anderson & Bower, 1972; Duffy et al., 1990). Superficially processed stimuli, in contrast, are characterized by a curtailment of semantic processing. As such there is little similarity between the encoding of bridging inferences and the superficial processing of a stimulus. These proposed differences are emphatically supported by existing data. To cite two extreme examples, retrieval of the present bridging inferences was based on an automatic contribution of 0 whereas the retrieval of stimuli processed under divided attention (Jacoby et al., 1993, Table 2) was based on a controlled contribution of 0.

Toward the outset, it was indicated that the present study was not designed to discriminate between competing dual-process and single-process analyses of retrieval. However, the present evidence is rationally coherent (Brainerd et al., 1999) and avoids anomalies sometimes evident in process dissociation data. On the first point, both the controlled and automatic parameters in the absent condition of Experiment 1 equaled zero. This is consistent with the complete lack of a basis of recognizing those distractors. Likewise, greater guessing parameters in the inclusion than exclusion conditions are consistent with the higher proportion of official "yes" responses in inclusion (Buchner et al., 1995; Dehn & Engelkamp, 1997; Graf & Komatsu, 1994). With regard to process dissociation anomalies, Jacoby (1998) set out to demonstrate the impact of deviations from process dissociation assumptions on the resulting data. He instructed one participant group to use a generate-recognize strategy, contrary to typical warnings to avoid that approach. The generate-recognize results bore an anomalous reduction of familiarity under full attention as compared with divided attention. Anomalies of this sort were completely absent from Experiments 1 to 3.

In conclusion, the results revealed a clear representational difference between explicit text ideas, on the one hand, and elaborative inferences and even bridging inferences, on the other. As predicted, there was a greater automatic contribution to explicit than implicit recognition; with the latter influence being very modest. The results also revealed greater controlled support of explicit than implicit recognition. These stable findings suggest that process dissociation analysis and its variants will further clarify complex issues of text processing and representation.

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Appendix A

Significant Effects in Experiment 1 Analysis of Variance

Effect	Statistics
Instruction	F1(1, 152) = 118.30, MSE = .10
	F2(1, 46) = 300.49, MSE = 120
Relation	F1(2, 304) = 183.79, MSE = .02
	F2(2, 92) = 109.01, MSE = 117
I x R	F1(2, 304) = 70.55, MSE = .02
	F2(2, 92) = 53.46, MSE = 91
I x Probability	F1(1, 152) = 18.81, MSE = .01
	F2(1, 46) = 6.84, MSE = 120
R x P	F1(2, 304) = 10.73, MSE = .02
	F2(2, 92) = 5.35, MSE = 116

Note. Statistics are reported only for those effects significant both in the participants-random and items-random ANOVAs.

Appendix B

Processing Tree Model for Old/New Judgements in Experiment 1

Processing Path	Response	Processing Path	Response
Inclusion		Exclusion	
Explicit High		Explicit High	
(c_{EH})	old	(c_{EH})	new
($1-c_{EH}$)(a_{EH})	old	($1-c_{EH}$)(a_{EH})	old
($1-c_{EH}$)($1-a_{EH}$)(gi_H)	old	($1-c_{EH}$)($1-a_{EH}$)(ge_H)	old
($1-c_{EH}$)($1-a_{EH}$)($1-gi_H$)	new	($1-c_{EH}$)($1-a_{EH}$)($1-ge_H$)	new
Implicit High		Implicit High	
(c_{IH})	old	(c_{IH})	new
($1-c_{IH}$)(a_{IH})	old	($1-c_{IH}$)(a_{IH})	old
($1-c_{IH}$)($1-a_{IH}$)(gi_H)	old	($1-c_{IH}$)($1-a_{IH}$)(ge_H)	old
($1-c_{IH}$)($1-a_{IH}$)($1-gi_H$)	new	($1-c_{IH}$)($1-a_{IH}$)($1-ge_H$)	new
Absent (high)		Absent (high)	
(gi_H)	old	(ge_H)	old
($1-gi_H$)	new	($1-ge_H$)	new
Explicit Low		Explicit Low	
(c_{EL})	old	(c_{EL})	new
($1-c_{EL}$)(a_{EL})	old	($1-c_{EL}$)(a_{EL})	old
($1-c_{EL}$)($1-a_{EL}$)(gi_L)	old	($1-c_{EL}$)($1-a_{EL}$)(ge_L)	old
($1-c_{EL}$)($1-a_{EL}$)($1-gi_L$)	new	($1-c_{EL}$)($1-a_{EL}$)($1-ge_L$)	new
Implicit Low		Implicit Low	
(c_{IL})	old	(c_{IL})	new
($1-c_{IL}$)(a_{IL})	old	($1-c_{IL}$)(a_{IL})	old
($1-c_{IL}$)($1-a_{IL}$)(gi_L)	old	($1-c_{IL}$)($1-a_{IL}$)(ge_L)	old
($1-c_{IL}$)($1-a_{IL}$)($1-gi_L$)	new	($1-c_{IL}$)($1-a_{IL}$)($1-ge_L$)	new
Absent (low)		Absent (low)	
(gi_L)	old	(ge_L)	old
($1-gi_L$)	new	($1-ge_L$)	new

Note. c = the probability that a target word (from the subscripted condition) will be recollected as being from phase 1; a = the probability that the familiarity of a target word (from the subscripted condition) will exceed the threshold for responding "old" given that it is not recollected as being from phase 1; gi and ge = the probabilities of guessing "old" in the inclusion and exclusion conditions, respectively, given that a target word is not recollected as being from phase 1 and its familiarity does not exceed the response threshold.

Appendix C

Pooled Frequencies of Recognition Responses in Experiments 1 to 3

		Inclusion		Exclusion	
Experiment	Condition	Old	New	Old	New
1	Explicit High	262	200	70	392
	Implicit High	157	305	46	416
	Absent High	209	715	91	833
	Explicit Low	250	212	85	377
	Implicit Low	86	376	30	432
	Absent Low	175	749	86	838
2	Explicit	154	118	34	238
	Motive	92	180	16	256
	Control	66	206	27	245
	Absent	43	229	14	258
3	Explicit	180	72	33	223
	Motive	99	153	24	232
	Control	74	178	27	229
	Absent	45	207	16	240

Appendix D

Processing Tree Model for Old/New Judgements in Experiments 2 and 3

Processing Path	Response	Processing Path	Response
Inclusion		Exclusion	
Explicit		Explicit	
(c_E)	old	(c_E)	new
$(1-c_E)(a_E)$	old	$(1-c_E)(a_E)$	old
$(1-c_E)(1-a_E)(gi)$	old	$(1-c_E)(1-a_E)(ge)$	old
$(1-c_E)(1-a_E)(1-gi)$	new	$(1-c_E)(1-a_E)(1-ge)$	new
Motive		Motive	
(c_M)	old	(c_M)	new
$(1-c_M)(a_M)$	old	$(1-c_M)(a_M)$	old
$(1-c_M)(1-a_M)(gi)$	old	$(1-c_M)(1-a_M)(ge)$	old
$(1-c_M)(1-a_M)(1-gi)$	new	$(1-c_M)(1-a_M)(1-ge)$	new
Control		Control	
(c_C)	old	(c_C)	new
$(1-c_C)(a_C)$	old	$(1-c_C)(a_C)$	old
$(1-c_C)(1-a_C)(gi)$	old	$(1-c_C)(1-a_C)(ge)$	old
$(1-c_C)(1-a_C)(1-gi)$	new	$(1-c_C)(1-a_C)(1-ge)$	new
Absent		Absent	
(gi)	old	(ge)	old
$(1-gi)$	new	$(1-ge)$	new

Note. c = the probability that a target word (from the subscripted condition) will be recollected as being from phase 1; a = the probability that the familiarity of a target word (from the subscripted condition) will exceed the threshold for responding "old" given that it is not recollected as being from phase 1; gi and ge = the probabilities of guessing "old" in the inclusion and exclusion conditions, respectively, given that a target word is not recollected as being from phase 1 and its familiarity does not exceed the response threshold.

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Footnotes

1. If controlled and automatic processes are assumed to be independent, then the conditional probability can be interpreted as an unconditional probability (for details, see Buchner et al., 1995).

2. The higher the value of G^2, the worse the fit of the model to the data. G^2 for a submodel constrained by a null hypothesis will always be greater than or equal to G^2 for the full model because the former has fewer free parameters. The question is whether G^2 for the submodel is significantly greater than that for the full model (i.e., does the constraint imposed by the null hypothesis significantly reduce the fit of the full model). If so, the null hypothesis is rejected.

G^2 for the full model in Experiment 1 (Appendix B) was 3.32. The G^2 values for the full models in Experiments 2 and 3 (Appendix D) were both 0.

Table 1

Mean Recognition Rates of Phase 1 Target Words in Phase 3 of Experiment 1

	High Probability			Low Probability		
Instruction	Expl	Impl	Abs	Expl	Impl	Abs
Inclusion	.57	.34	.23	.54	.19	.19
Exclusion	.15	.10	.10	.18	.06	.09

Note. The relations were explicit (Expl.), implicit (Impl.), and absent (Abs.).

Table 2

Parameter Estimates in Experiment 1

	High Probability		Low Probability	
Parameter	Explicit	Implicit	Explicit	Implicit
c	.34[a]	.13[b]	.30[a]	.00
a	.15[a]	.02	.19[a]	.00

Note. The superscripts denote statistical comparisons among levels of the relation variable (explicit, implicit, absent) only. All alpha levels for those comparisons were .05. The guessing parameters gi and ge were, respectively, .23 and .10 in the high probability condition, and .19 and .08 in the low probability condition.

[a] Explicit statistically higher than implicit. [b] Implicit statistically higher than 0.

Table 3

Mean Recognition Rates of Phase 1 Target Words in Phase 3 in Experiments 2 and 3

		Relation			
			Motive		
Experiment	Instruction	Explicit	Inference	Control	Absent
2	Inclusion	.57	.34	.24	.16
	Exclusion	.13	.06	.10	.05
3	Inclusion	.71	.39	.29	.18
	Exclusion	.13	.09	.11	.06

Table 4

Parameter Estimates in Experiments 2 and 3

		Relation		
Experiment	Parameter	Explicit	Motive Inference	Control
2	*c*	.39[a]	.20[b]	.05
	a	.16[a]	.02	.06[c]
3	*c*	.55[a]	.21[b]	.09[d]
	a	.24[a]	.06[c]	.06[c]

Note. The alpha level for the statistical comparisons in this table was .05 unless otherwise indicated. The guessing parameters *gi* and *ge* were, respectively,

.16 and .05 in Experiment 2, and .18 and .06 in Experiment 3.

[a] Explicit statistically higher than motive. [b] Motive statistically higher than control. [c] Value statistically higher than 0. [d] Value marginally higher than 0, $.05 < p < .10$.