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Retrieval of Explicit and Implicit Text Ideas: Processing Profiles

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Two central goals of the information processing approach to discourse comprehension have been (a) the identification of the mental processes of deriving meaning from verbal messages and (b) the characterization of the resulting representations. In this chapter we describe research designed to evaluate the quality of the processes of retrieving previously encountered text ideas and to thereby assess representations from which the retrieved ideas were derived. More specifically, we set out to measure the relative contributions of recollection and familiarity to text retrieval, as diagnosed by the process dissociation procedure (Jacoby, 1991; see also Mandler, 1980). The intention was to compare the retrieval profiles for explicit text ideas, bridging inferences, and elaborative inferences. These comparisons were considered to bear on the representation of those idea classes.

The remainder of this *introduction* comprises three parts. First, we identify a discrepancy between the theoretical analyses of explicit versus implicit text ideas on the one hand and certain behavioral evidence on the other. Second, we briefly review contemporary treatments of the automaticity of text-inference processing. Then we outline how the process dissociation method may shed light on both of these issues.

Subsequent sections of the chapter then describe our previous research and a new experiment that apply process dissociation to the retrieval of (a) elaborative inferences and (b) bridging inferences. Then (c) we consider some of the theoretical issues pertinent to the pursuit of the present approach.

REPRESENTATION OF EXPLICIT AND IMPLICIT TEXT IDEAS

Relatively early in the modern investigation of language comprehension, inference was interpreted to lie at the center of human communication (Schank, 1976). In subsequent inference processing research, the distinction between bridging and elaborative inferences emerged as an important one. Bridging inferences enhance coherence by connecting discourse ideas with reference to unstated concepts or relations (Haviland & Clark, 1974). Elaborative inferences, in contrast, represent plausible extrapolations from discourse but do not particularly contribute to message coherence. Consider example (1) (Singer, 1980):

(1) a. The dentist pulled the tooth painlessly. The patient liked the new method. (explicit)
b. The tooth was pulled painlessly. The dentist used a new method. (bridging inference)
c. The tooth was pulled painlessly. The patient liked the new method. (elaborative inference)

Sequence (1a) explicitly states that a dentist pulled the tooth. Sequence (1b) would be incoherent if the understander did not infer that it was the dentist who pulled the tooth. For sequence (1c), it is a sensible but not coherence-preserving elaboration that the tooth was pulled by a dentist. Both bridging and elaborative inferences are generally viewed as deriving from the understander's world knowledge rather than from computations in a formal domain such as logic (cf. Lea, O'Brien, Fisch, Noveck, & Braine, 1990).

A variety of methods have indicated that bridging inferences are robustly encoded by the understander, whereas elaborative inferences are either not routinely encoded or are more weakly encoded (Keenan, Baillet, & Brown, 1984; McKoon & Ratcliff, 1986; Myers, Shinjo, & Duffy, 1987; Potts, Keenan, & Golding, 1988; Singer & Ferreira, 1983). These findings are consistent with the dependence of text coherence upon bridging inferences.

Many theorists (e.g., Graesser, Singer, & Trabasso, 1994; Kintsch, 1988; Raney, 2003; Schmalhofer & Glavanov, 1986) have addressed inference processing in terms of the multilevel analysis of discourse representation (van Dijk & Kintsch, 1983). According to the multilevel view, text representations comprise the surface features of the text (specific wording, grammatical constructions), a *textbase* network consisting mainly of the propositions explicitly conveyed by the text, and a multidimensional model of the situation to which the text refers. The situation model constitutes an integration of discourse ideas and world knowledge. The understander's inferences are frequently characterized as residing in the situation model (Kintsch, 1992), although the textbase is sometimes proposed to capture certain inferences (Singer, 1994; Singer & Kintsch, 2001).

Recently, Schmalhofer, McDaniel, and Keefe (2002) incisively distinguished among different categories of text-related ideas, using the multilevel analysis. Singer and Leon (this volume) described that treatment as follows:

> (Schmalhofer et al.) proposed that whereas explicit text ideas are encoded at surface, propositional, and situational levels of representation, inferences are

> initially constructed primarily or exclusively in the situation model. According to the construction-integration model (Kintsch, 1988), encoded elements at any representational level will endure only if they receive relatively high degrees of activation, which in turn depends on their degree of interconnection with other elements. Bridging inferences generally exceed elaborative inferences in their connections to other text ideas and pertinent knowledge. However, high constraint . . . can augment the interconnections of elaborative inferences. In this circumstance, elaborative inferences may become an enduring part of the text representation. (pp.10–11)

This analysis identifies a research problem: In particular, there are fundamental differences between the explicit ideas and the bridging inferences of text (e.g., only the explicit ideas are subject to perceptual encoding), but several behavioral measures tend to equate the two (Keefe & McDaniel, 1993; Potts et al., 1988; Singer, 1980). A central goal of the present research was to refine the behavioral distinction between the explicit ideas and inferences encoded from text.

AUTOMATICITY OF TEXT INFERENCE PROCESSES

An important text comprehension controversy has been whether text inference processes are controlled or automatic. The reliable encoding of bridging inferences in particular has promoted the tendency to view them as automatic. However, the equivocal status of the automaticity of text inference processes was considered by Singer, Graesser, and Trabasso (1994). They noted that bridging inferences are supported by *fast* resonance processes of which the reader is *unaware* (e.g., Albrecht & Myers, 1995; O'Brien & Albrecht, 1991; O'Brien, Albrecht, Hakala, & Rizzella, 1995), indices of automatic processes (Logan, 1988; Posner & Snyder, 1975; Schneider & Shiffrin, 1977). On the other hand, bridging computations are taxing of cognitive resources (Daneman & Carpenter, 1980; Singer, Andrusiak, Reisdorf, & Halldorson, 1992). Bridging processes are also, overall, quite slow; they are more time-consuming than (a) the detection of direct connections among text ideas (Haviland & Clark, 1974), (b) reinstating antecedent ideas to working memory (Kintsch & van Dijk, 1978; Lesgold, Roth, & Curtis, 1979), and even (c) mentally reorganizing referentially incongruent sequences of sentences (Yekovich, Walker, & Blackman, 1979). A comparable analysis emerged from Singer et al.'s (1994) inspection of anaphoric resolution, a simple form of bridging.

Thus, evidence concerning the automaticity of text inference processing is equivocal. To the extent that process dissociation patterns, a central focus of this study, bear on the automaticity *of the original encoding* of a stimulus as well as its retrieval, they might have the capacity to clarify the automaticity of deriving inferences from discourse.

PROCESS DISSOCIATION AND TEXT COMPREHENSION

The Process Dissociation Analysis

According to the process dissociation analysis, the recognition of a test probe is supported by the *familiarity* of the probe and one's *recollective* experience relating the probe to the context in which it was encountered (Jacoby, 1991; Mandler, 1980). In ordinary experience, encountering a slightly known acquaintance in an unexpected setting, such as seeing the pharmacist at the movie theatre, may produce a sense of familiarity *in the absence of* recollection.

Two dissociations between familiarity and recollection (Yonelinas, 2002) are particularly relevant for the present purposes: (a) Familiarity is sensitive to both perceptual manipulations (e.g., maintenance rehearsal of words; Gardiner, Gawlick, & Richardson-Klavehn, 1994) and conceptual manipulations (e.g., deep versus shallow semantic processing; Dehn & Engelkamp, 1997; Jacoby, Lindsay, & Toth, 1992). Recollection, in contrast, reflects only conceptual factors but is more sensitive to such manipulations than is familiarity. (b) Familiarity bears the signature of an automatic process, whereas recollection is controlled (Yonelinas, 2002).

Process dissociation blends the latter theoretical analysis with both empirical and computational procedures. The empirical method sets recollection and familiarity in opposition to one another. In a word recognition experiment, for example (Jacoby, 1991, Experiment 3), subjects encountered anagrams to solve and words to read in an initial study phase. Next, they recited a different list of words as they heard them. In a subsequent recognition test, so-called *inclusion* subjects were instructed to label a word old if it had occurred either in the initial study phase or in the heard list. *Exclusion* subjects, in contrast, answered "old" only if a word appeared in the heard list. According to the exclusion instruction, subjects ought to report recognizing an anagram/read word only if it seems *familiar*, but they are unable to *recollect* it as originating in the anagram/read list. Using R for recollection and F for familiarity, the probabilities of labelling a probe as old in inclusion (O_i) and exclusion (O_e) are expressed as follows (Jacoby, 1991):

$$O_i \nabla R \lessgtr F - RF \nabla R \lessgtr (1 \quad R)F \qquad (8.1)$$

$$O_e \nabla \qquad (1 \quad R)F \qquad (8.2)$$

Subtraction of Eq. (8.2) from Eq. (8.1) reveals that recollection can be estimated as $R \nabla O_i \quad O_e$. Substituting that expression in Eq. (8.2) then reveals that $F \nabla O_e/(1 \quad (O_i \quad O_e))$. Using this analysis, Jacoby (1991) showed that anagram words considerably exceeded phase-1 read words in degree of recollection, but not in familiarity.

It is noteworthy that it is controversial whether memory retrieval is supported by two processes or by a single, activation-based familiarity process (Gillund & Shiffrin, 1984; Hintzman, 1988; Ratcliff, van Zandt, & McKoon, 1995). However, the contribution of a second process, such as the influence in recognition of a controlled recall process, is often at least tacitly acknowledged by one-process theorists (Gillund & Shiffrin, 1984; Hintzman & Curran, 1994; see also Clark & Gronlund, 1996; Yonelinas, 2002).

Two Influences in Text Retrieval

We assumed that dual-process principles apply to text retrieval as well as other memory phenomena. To assume otherwise would require a memory theory unique to discourse, certainly an unparsimonious approach (Singer & Kintsch, 2001). Equally importantly, there is empirical evidence that both familiarity and recollection contribute to text retrieval. First, *the influence of familiarity* is reflected by the fact that reading time is faster for a story that repeats, in new words, the theme of a prior text than it is for unrelated stories and for stories that repeat words but present a novel theme (Levy, Campsall, & Browne, 1995; Masson, 1993). Because ordinary reading is not an explicit memory task, the enhancement of comprehension fluency is more likely to be due to the familiarity of the text ideas than to an experience of recollection (see also Reder, 1987). Second, *the contribution of recollection* to text memory tends to be supported by people's ability to confidently associate retrieved ideas with antecedent texts (Hasher & Griffin, 1978; Reder, 1982).

Indeed, a small number of studies have already used variants of process dissociation to distinguish the contributions of familiarity and recollection in text retrieval and related domains. In the retrieval of *Star Trek* stories, for example, Long and Prat (2002) examined the impact of readers' knowledge on the quality of text memory. Readers high or low in *Star Trek* knowledge read either a pair of *Star Trek* stories or a pair of psychology chapters. In inclusion, the subjects were instructed to label a test sentence old if they remembered that it originated in the first text or if it seemed familiar but they could not remember from which text it came. The exclusion subjects, in contrast, used the old label only for sentences that derived from the second text. The results dissociated familiarity and recollection in the domain of the readers' expertise. Specifically, readers' knowledge affected recollection and not familiarity in the recognition of *Star Trek* test sentences, but affected neither recollection nor familiarity in memory for psychology material, of which the *Star Trek* experts had no distinctive knowledge.

Likewise, Caldwell and Masson (2001) presented evidence that, in memory for the location of objects, familiarity is the same for old and young adults, but recollection is greater for young adults. Caldwell and Masson's stimuli were memorized spatial arrangements rather than texts. However, their study of spatial situations converges closely with language-based studies of spatial situation models (e.g., Morrow, Greenspan, & Bower, 1987).

Potential of Process Dissociation in This Realm

It is likely that the process dissociation analysis has the capacity to clarify central problems of text and discourse processing. One example is that memory theorists have proposed that people's experience of remembering distractor stimuli that are *related* to previously studied stimuli is supported by a process of misrecollection that is distinct from ordinary recollection (Brainerd, Wright, Reyna, & Mojardin, 2001). Because text inferences fit the definition of related distractor, this proposal carries useful implications about memory for such inferences. Second, process dissociation may be able to distinguish between multiprocess (e.g., recollection, familiarity) and multirepresentation analyses of text retrieval (Mandler, 1980). Third, process dissociation explicitly addresses the automaticity of retrieval processes, but it may likewise pertain to the automaticity of encoding (Jacoby, 1991). Clarifying the automaticity of discourse encoding would offer an important advance to the field. These ramifications of the process dissociation framework are considered in more detail in the General Discussion.

Conclusion

The scientific evaluation of whether certain inferences accompany text comprehension is frequently achieved through the use of various behavioral measures to compare those inferences with (a) control statements, (b) statements representing other inference categories, and, perhaps most stringently, (c) explicit text statements. Such investigations have sometimes revealed the indistinguishability of inferences and explicit text ideas (e.g., Potts et al., 1988). On the other hand, the physical absence of the inference from the message, coupled with the multilevel analysis of text representation (Schmalhofer et al., 2002; van Dijk & Kintsch, 1983), tends to deny that inferences and explicit ideas will be encoded in an identical manner.

Process dissociation offers the opportunity to clarify these issues, in the form of an integrated theoretical, empirical, and computational framework for the analysis of memory phenomena. The present research applied process dissociation to the encoding differences between explicit and implicit text ideas and, more speculatively, to the automaticity of text inferences processes. The next section documents our empirical investigations of these issues. First, it considers Singer and Remillard's (2004) contrast of explicit text ideas versus elaborative inferences, along with evidence stemming from a new experiment. Then it presents a comparable experiment about bridging inferences.

FAMILIARITY AND RECOLLECTION IN THE RETRIEVAL OF TEXT IDEAS

Elaborative Inferences: Deep Versus Shallow Processing

Experiment 1 of Singer and Remillard (2004; henceforth SR) focused on elaborative inferences about high-probability case-filling elements. For example, *The letter was delivered in the rain* implies the involvement of the agent, mailman (Singer, 1980). Several hypotheses were of concern. First, the physical appearance in text of the words corresponding to explicit ideas but not inferences suggests that there will be fundamental differences in their encoding (e.g., Schmalhofer et al., 2002). Therefore, we predicted that the process dissociation patterns of explicit text statements and elaborative inferences would differ. Second and furthermore, the absence of the opportunity to perceptually process the words corresponding to an elaborative inference tends to suggest a lower familiarity component for inferences than explicit ideas, because familiarity in part reflects perceptual processing. However, because familiarity is also sensitive to conceptual processing, the distinct qualities of the conceptual processing of elaborative inferences (e.g., they are generated by the reader) might complicate the interpretation of the familiarity component. Third, because recollection reflects only conceptual processes, we predicted a stronger recollective contribution to explicit ideas than to elaborative inferences.

The subjects of SR's Experiment 1 rated the activity conveyed by each stimulus sentence. In a new experiment, we replaced that semantic orienting task with a shallow task. Consistent with prior findings in the process dissociation literature, we predicted that *both* recollection and familiarity would be weaker in shallow than in deep processing (e.g., Dehn & Engelkamp, 1997; Komatsu, Graf, & Uttl, 1995; Toth, 1996), because weaker conceptual representations are derived from shallow processing, and both recollection and familiarity are supported by conceptual representations. We also advanced the stronger hypothesis that shallow processing would reduce recollection more than familiarity (e.g., Yonelinas, 2002, Figure 2).

More generally, these experiments served to validate the application of process dissociation to language processes. Violations of the assumptions of process dissociation result in anomalous result patterns, such as a particular manipulation yielding a decrease in recollection but an increase in familiarity (Jacoby, 1998). We scrutinized the results for anomalies of this sort. We also monitored the data for familiar patterns, such as the aforementioned detrimental impact of shallow processing on both recollection and familiarity.

Method. In Experiment 1 of SR, the critical materials were 24 sentences that included an explicit high-probability case-filling element (e.g., *mailman* in 2a) and an implicit counterpart (e.g., 2b):

(2) a. The mailman delivered the letter in the rain.
b. The letter was delivered in the rain.

The experiment used the three phases of Jacoby's (1991) classic procedure. During phase 1, the subjects used four keyboard keys to rate, on a four-point scale, the activity level conveyed by the explicit and implicit sentences. The sentences were viewed on computer monitors. In phase 2, the subjects read unrelated words aloud from the screen. In phase 3, they recognized test words stemming from explicit and implicit sentences of phase 1 and phase 2 words, plus distractor words.

Inclusion subjects were instructed to label a phase 3 test word as old if it had appeared among either the phase 1 or phase 2 stimuli. Exclusion subjects, in contrast, were instructed to restrict the reply *old* to those words that had appeared in phase 2. The exclusion instructions specified that if the subject remembered that a test word originated in a phase-1 sentence, it could be confidently labeled *no*, because no word appeared in both phases 1 and 2.

In the first of four counterbalanced phase-1 lists, sentence frames like set (2) were randomly assigned to the explicit and implicit conditions plus an absent condition in the respective proportions of .25 (namely, six frames), .25, and .50. Absent passages simply did not appear in phase 1. However, their critical words (e.g., *mailman*) were still presented in the phase-3 recognition test. Accordingly, the target words functioned as their own controls across the three conditions. In the remaining three lists, the sentences sets were cycled across condition following a Latin-square scheme, resulting in their assignment once each to the explicit and implicit conditions and twice to the absent condition.

The procedure of the new, shallow-processing experiment was identical, except that, during phase 1, the subjects used four keys to indicate how many words in the stimulus sentence began with a vowel (0 to 3). The deep and shallow processing experiments had 154 and 64 subjects, respectively, all of whom were students of introductory psychology.

Data Analyses. The descriptive data were the proportions of acceptance (i.e., old responses) across conditions. Recollection and familiarity were derived from the acceptance rates with the use of the *extended* process dissociation computations of Buchner, Erdfelder, and Vaterrodt-Plunnecke (1995; see also Jacoby, 1998). The distinct features of Buchner et al.'s approach are that it (a) avoids the sometimes problematic assumption that recollection and familiarity are independent processes (Jacoby, 1991; Joordens & Merikle, 1993), (b) includes distinct guessing parameters for inclusion and exclusion, and (c) uses multinomial tree processing computations to estimate recollection and familiarity. Within this framework, hypotheses are tested with the use of the chi-square goodness-of-fit statistic, G^2. This is accomplished by subtraction of the G^2 value for the full extended process dissociation model from that for the submodel constrained by a particular null hypothesis. Consider, for example,

TABLE 8–1.
Elaborative Inferences: Acceptance Rate as a Function of Relation, Instruction, and Task Relation

Task	*Instruction*	*Explicit*	*Implicit*	*Absent*
Deep	Inclusion	.57	.34	.23
	Exclusion	.15	.10	.10
Shallow	Inclusion	.32	.30	.19
	Exclusion	.08	.06	.07

Source: Deep Task data adapted from Singer and Remillard (2004, Table 1), *Memory & Cognition*. Copyright 2004, Psychonomic Society. Adapted by permission.

the hypothesis that familiarity makes no contribution to recognition in the implicit condition (i.e., familiarity ∇ 0). This hypothesis entails a model with one less free parameter than the full model (i.e., familiarity is not free to vary). The resulting difference of G^2 statistics also has the chi-square distribution.

Results. The mean acceptance rates as a function of relation (explicit, implicit, absent), instruction (inclusion, exclusion), and task are shown in Table 8–1. Analyses of variance (ANOVA) applied separately to the deep (activity) and shallow (vowel-counting) data revealed main effects of both relation and instruction. In addition, the Relation χ Instruction interaction was significant for the activity task and marginally so for the counting task; in both cases, this reflected a stronger effect of relation under the inclusion than the exclusion instruction. All effects were significant according to both subjects-random and items-random ANOVAs. Finally, tests of simple main effects within the absent condition revealed significantly higher acceptance rates for inclusion than exclusion, for both the deep and shallow tasks. These were the false alarm rates.

Of greatest interest were the parameters derived from the extended process dissociation analysis, shown in Table 8–2. We tested a limited number of hypotheses to evaluate the recollection (*R*) and familiarity (*F*) parameters.[1] In the deep processing task, *R* was greater in the explicit than the implicit condition, which in turn significantly exceeded 0. *F* was likewise greater for the explicit than the implicit condition, but the latter value was approximately 0. In the *vowel counting* task, in contrast, neither *R* nor *F* differed significantly between the explicit and implicit conditions, and only the *R* values were statistically distinguishable from 0.

[1]Singer and Remillard (2004) used the symbols *c* and *u* (conscious and unconscious processing) rather than *R* and *F*, respectively, following the conventions of Buchner et al. However, consensus in the field is converging on the terms *recollection* and *familiarity*.

TABLE 8–2.
Parameter Estimates in Retrieval of Explicit Text Ideas Versus Elaborative Inferences

Task	*Parameter*	*Explicit*	*Implicit*
Deep	Recollection	.34[a]	.13[b]
	Familiarity	.15[a]	.02
Shallow	Recollection	.13	.13[b]
	Familiarity	*.03*	*.00*

[a]Explicit statistically higher than implicit.
[b]Implicit statistically higher than 0.
Alpha was set to .05 throughout.
Source: Adapted from Singer and Remillard (in press, Table 2), *Memory & Cognition*. Copyright 2004, Psychonomic Society. Adapted by permission.

Comparisons were also made between the corresponding parameters of the deep and shallow tasks. For explicit targets, both *R* and *F* were greater for deep than for shallow processing ($G^2(1)$'s ∇ 12.68, 9.86, respectively), whereas in the implicit condition there were no such differences.

Discussion. We highlight several features of the results. Consider first the *deep task*: (a) The implicit condition exhibited weaker recollection than the explicit condition, and no support of familiarity at all. This suggests that explicit and implicit text ideas are encoded differently, consistent with our prediction. (b) Near-zero familiarity in the implicit condition is generally consistent with the irrelevance of perceptual processes (e.g., word recognition) to implied text ideas. Furthermore, it tends to demonstrate conceptual representations strong enough to support recollection but not familiarity for implied text ideas, because familiarity reflects conceptual as well as perceptual processes (Yonelinas, 2002). Had the conceptual representations of the implicit ideas been stronger, familiarity as well as recollection would have significantly exceeded 0 in the implicit condition. (c) Greater recollection in the explicit than in the implicit condition signifies richer conceptual representations for the former, because recollection is supported exclusively by conceptual representations.

The main *shallow task* results were as follows: (a) Whereas both *R* and *F* were greater in the explicit than the implicit condition for the deep task, *neither* of them was in the shallow task. This shows that vowel counting, a surface orienting task, so impairs semantic processing that robust effects distinguishing explicit and implicit stimuli are abolished (see also Singer & Halldorson, 1996, Experiment 4). (b) Both *R* and *F* were significantly lower in the explicit condition of the shallow than in the deep task. This is consistent with the reduction in both parameters in a shallow processing task, as discussed earlier (Yonelinas, 2002). Lower values of *F* in shallow than in deep orienting tasks constitute one basis for associating conceptual as well as perceptual processes with that parameter (Toth, 1996). If *F* reflected only perceptual processes, then there would be no reason for that value to diminish when people perform a semantically shallow task. Finally, we were not able to evaluate our strong hypothesis that shallow processing would reduce recollection more than familiarity, because the amount of reduction of familiarity may have been limited by a floor effect ($F \nabla .03$). (c) Harder to explain is why R in the implicit condition was *not* lower in the shallow than in the deep task. This might indicate that R reflects two types of recollection—recollection of specific *target* words and recollection of gist. Gist recollection might be about equal in the explicit and implicit conditions, whereas target recollection should be greater in the explicit condition. With respect to the deep/shallow manipulation, because the sentences were short, subjects in the counting condition may have read the sentences before counting vowels, thus extracting the gist. Subsequent counting may have interfered with the ability to recollect the target but not the gist. This would explain why counting, relative to activity judgment, reduced R in the explicit but not the implicit condition. According to this account, recognition only in the explicit condition partly reflects recollection of the specific target word.

The latter proposal is speculative in nature. However, the phantom recognition analysis of Brainerd et al. (2001) addresses the gist-based recollection of related distractor items such as text inferences. The phantom recollection framework offers the conceptual and computational tools to evaluate hypotheses of this sort.

We note that SR (Experiment 1) examined an additional variable involving the inspection of sentence frames such as (3):

(3) a. The poet broke the television with the brick.
    b. The television was broken with the brick.

Mailman is a highly predictable agent for delivering a letter, whereas *poet* is a low-probability agent for (3b). Most important for the present purposes is that neither R nor F significantly differed from 0 in the low-probability implicit condition. Insofar as there is little reason to incorrectly recognize *poet* having read (3b), this outcome tended to validate the application of process dissociation to the domain of language processes.

Other features of the results likewise tend to validate process dissociation for the present purposes. First, the substance of the parametric profiles was sensible and interpretable. Second, we detected certain familiar process dissociation patterns, such as the aforementioned reduction of both recollection and familiarity in a shallow processing task. Third, completely absent were anomalous signatures that appear when crucial process dissociation assumptions are violated (Jacoby, 1998).

We assume that the higher acceptance rate in inclusion than exclusion reflects the higher ratio of officially correct old to new responses in inclusion. This results in a higher tendency to guess old in inclusion, an outcome detected by other investigators (e.g., Graf & Komatsu, 1994) but contrary to an assumption of process dissociation (Jacoby, 1991).

In conclusion, these experiments yielded different process dissociation profiles for explicit text ideas and elaborative inferences. Those idea categories have likewise been distinguished on some behavioral measures, so these findings tend to support the application of the process dissociation framework to the text processing domain. We considered process dissociation to have the potential to yield new insights concerning the representation of bridging inferences, which a number of measures tend not to distinguish from explicit ideas. We turn next to an experiment designed to address this issue.

Bridging Inferences

In this section, we review SR's (Experiment 2) examination of bridging inferences. Applying the process dissociation analysis to bridging inferences is especially useful, because, as discussed earlier, (a) bridging inferences preserve text coherence and (b) empirical evidence suggests that they frequently accompany comprehension. One might accordingly posit equivalent retrieval profiles for explicit ideas and bridging inferences. Nonetheless, like for elaborative inferences, we predicted (a) different process dissociation profiles for explicit ideas and bridging inferences and (b) anticipated lower familiarity estimates in the bridging than in the explicit condition. These predictions particularly rested on the absence from the text of the bridging-inference words (Schmalhofer et al., 2002). (c) The relatively reliable encoding of bridging inferences might suggest that the contributing processes are automatic. Insofar as familiarity is the more automatic of the retrieval influences, familiarity for bridging inferences might significantly exceed 0 (while simultaneously being lower than for explicit ideas), in contrast with our observations for elaborative inferences.

Method. The method was highly similar to that of the elaborative inference experiments, discussed earlier. The focus was on motive-inference materials, such as set (4) (Singer & Halldorson, 1996):

(4) a. The comedian delivered the punch line. The audience howled with amusement at the JOKE. (explicit)

b. The comedian delivered the punch line. The audience howled with amusement. (implicit)

c. The comedian forgot the punch line. The audience howled with amusement. (control)

Sentence (4a) explicitly refers to a critical concept, joke. The coherence of (4b) is promoted by a bridging inference about a joke. Sequence (4c) uses wording similar to that of (4b) but implies the involvement of a joke more weakly than (4b).

The sessions again comprised Jacoby's (1991) three process-dissociation phases. The phase 1 materials were derived from 16 sets like (4). In each of four counterbalanced lists, the passages were randomly assigned in equal numbers to the explicit, implicit, and control conditions, plus an absent condition.

Phase 1 also included eight buffer passages. This large volume of text prompted us to conduct the sessions in four process dissociation miniblocks. In each block, the subject rated the activity conveyed by each of one buffer, three experimental, and then another buffer passage (phase 1); read 11 words comparable to the target words from the screen (phase 2); and then made recognition judgments about phase 1 and 2 words and distractors. The subjects were 136 naive individuals from the same pool that was used for the other experiments.

Results. The mean recognition rates are shown in Table 8–3 and the process dissociation parameters appear in Table 8–4. ANOVA applied to the acceptance rates revealed significant effects of relation, instruction, and Relation χ Instruction. The interaction reflected a stronger effect of relation under the inclusion instruction than it did under exclusion. The acceptance rates in the absent condition were again higher in inclusion (.16) than exclusion (.05).

The extended process dissociation analysis revealed that *R* (recollection) for the explicit condition exceeded that of the bridging condition, which was greater than the control condition, which did not significantly exceed 0. *F* (familiarity) was greater in the explicit condition than both the bridging and control conditions. The latter conditions did not differ significantly. However, *F* in the control condition significantly exceeded 0.

Discussion. Differences were detected between the process dissociation profiles of the explicit and implicit conditions: Namely, (a) both recollection and familiarity were greater in the explicit than in the implicit condition, and (b) recollection significantly exceeded 0 in the implicit condition but familiarity did not. These results carry several implications. First, the recognition

TABLE 8–3
Bridging Inferences: Acceptance Rate as a Function of Relation and Instruction

	Relation			
Instruction	*Explicit*	*Implicit*	*Control*	*Absent*
Inclusion	.57	.34	.24	.16
Exclusion	.13	.06	.10	.05

Source: Adapted from Singer and Remillard (2004, Table 3), *Memory & Cognition*. Copyright 2004, Psychonomic Society. Adapted by permission.

TABLE 8–4
Parameter Estimates in Retrieval of Explicit Text Ideas Versus Elaborative Inferences

	Relation		
Parameter	*Explicit*	*Implicit*	*Control*
Recollection	.39[a]	.20[b]	.05
Familiarity	.16[a]	.02	.06[c]

Source: Adapted from Singer and Remillard (2004, Table 4), *Memory & Cognition*.
[a]Explicit statistically higher than implicit.
[b]Implicit statistically higher than 0.
[c]Control statistically higher than 0.

of bridging concepts after reading appears to receive no support from perceptual processes (if it did, then F would exceed 0). We also cautiously note that the negligible contribution of familiarity to the recognition of implicit probes might deny the automaticity of the encoding of bridging inferences. We pursue this issue in the General Discussion.

Second, several features of the results suggest that the conceptual representation of bridging inferences must, in some respect, be weaker than for explicit ideas: (a) Recollection was lower in the implicit than the explicit condition. (b) There was a significant recollective component in the bridging condition but familiarity was approximately zero. Because familiarity, like recollection, reflects conceptual representations, those representations must have been relatively weak to simultaneously permit R to exceed 0 and F to approximately equal 0.

Two parametric features of the *control condition* were noteworthy. First, recollection was greater in the bridging than in the control condition, confirming the more robust conceptual representation of the bridging concepts in the former condition. This feature of the results (e.g., Singer & Halldorson, 1996) is critical to discounting the possibility that the mere wording of the stimulus sentences might, by association, promote the recognition of the bridging words. Second, SR proposed that the modest familiarity component (F ∇ .06) of the control condition might reflect the convergence upon the target concept of excitation from transiently activated word meanings (Swinney, 1979; Till, Mross, & Kintsch, 1988). This result has been replicated (SR, Experiment 3) but requires more direct scrutiny.

The process dissociation profile differences between the explicit and bridging inferences resembled those detected for elaborative inferences under deep processing, as considered earlier. This might raise questions about the privileged status of bridging inferences. Instead, we interpret this similarity to constitute a dissociation from the patterns generated by timed judgments of text inferences. Like other dissociations in the evaluation of cognitive constructs (e.g., Jacoby, 1983), we propose that this one has the capacity to discriminate among subtly different theoretical analyses.

GENERAL DISCUSSION

The main focus of this research was the evaluation of the quality of the processes of text retrieval. Simultaneously, however, we validated the application of process dissociation and its variants to this domain. Validation was necessary because the process dissociation analysis entails several stringent assumptions (e.g., Buchner et al., 1995; Joordens & Merikle, 1993; Jacoby, 1991), which, if violated, result in the appearance of uninterpretable findings (Jacoby, 1998, addresses the latter issue). The orderly comparisons among experimental conditions provided convincing evidence that process dissociation has the capacity to illuminate text representation and retrieval. For example, both recollection and familiarity approximated zero for low-probability case-filling elements (e.g., *poet* with reference to *The television was broken with the brick*), just as one would expect; and both recollection and familiarity diminished in shallow processing relative to deep processing. These patterns mesh with findings from the few other studies that have used process dissociation to study language processes (Long & Prat, 2002).

Equally importantly, the experiments distinguished among the representation of different categories of text ideas, including explicit statements, elaborative and bridging inferences, and appropriate control statements. The most robust result was that both recollection and familiarity were greater in the explicit condition than they were in the implicit conditions. This outcome is consistent both with the obvious difference that explicit but not implicit ideas find direct expression in a message and with theoretical explorations of encoding differences between explicit ideas and inferences (Schmalhofer et al., 2002). However, some features of the results were surprising or challenging, such as the findings of qualitative similarity between the bridging- and elaborative-inference retrieval profiles and of the failure of familiarity to support the acceptance of implied ideas.

These findings create an agenda for further investigation. The following theoretical issues provide a framework for our ongoing research.

Inference Recollection—Or Misrecollection

Although the recognition of an implied text concept is technically an error, it is well known that experimental subjects recognize (a) several categories of associates of learned items (Underwood, 1965), (b) concepts that capture the semantic convergence among learned items (Deese, 1959; Roediger & McDermott, 1995), and (c) discourse inferences (Johnson, Bransford, & Solomon, 1973). The tendency to recognize related distractors may reflect the representation, during learning, either of a prototype of a learned item or of a cohort of its associates (Underwood, 1965; Clark & Gronlund, 1996). The tendency may also result simply from the detection, during retrieval, of an adequate degree of semantic similarity between a related distractor and previously learned items (Yonelinas, 2002).

People's propensity to recognize implied ideas raises the possibility that a misrecollective process, distinct from recollection and familiarity, contributes to memory retrieval. In this regard, Brainerd et al. (2001) presented evidence that people's recognition within the critical-lure paradigm (Roediger & McDermott, 1995) was fit better by a three-process model than a two-process model. Also consistent with Brainerd et al.'s analysis was the conclusion that phantom recollection (their third process) made stronger contributions to the recognition of related distractors than did recollection. The phantom recollection model maps well onto the retrieval of explicit and implicit text retrieval and merits future scrutiny.

Multiple Processes or Multiple Representations?

An alternative theoretical analysis emphasizes the contribution of multiple representations to the recognition of the test probe rather than that of multiple processes. According to the conjoint recognition hypothesis (Brainerd, Reyna, & Mojardin, 1999; see also Clark & Gronlund, 1996; Mandler, 1980), for example, recognition receives support both from surface (e.g., verbatim details) and gist representations of the antecedent stimuli. Brainerd et al. (1999) proposed that recognition targets constitute superior retrieval cues for surface representations, whereas distractors, whether outright foils or implied or associated concepts, tend to cue gist representations.

Multirepresentation analyses correspond convincingly with the view that discourse comprehension results in surface, textbase, and situational representations. They also generate predictions that have the capacity to clarify the fundamentals of text retrieval. For example, if the implicit test cue *dentist* specifically reminded the subject that the original passage stated *The tooth was pulled painlessly*, then that cue ought to be *rejected* rather than accepted. This outcome, labeled recognition to reject, plays an important role in the evaluation of competing theoretical analyses (Brainerd et al., 1999, 2001). It will also be important to relate surface versus gist analyses with the alternative multirepresentation view that text retrieval invokes episodic versus world knowledge representations (Reder, 1987; Singer, 1991).

Automaticity During Retrieval—Or Encoding?

The main thrust of process dissociation is to distinguish the contributions of controlled and automatic processes to *retrieval*. However, Jacoby's (1991) treatment suggests that there may be a systematic relationship between process dissociation retrieval patterns and the antecedent *encoding* processes. He proposed, for example, that superficial processing during encoding would restrict the subsequent contribution of recollection to recognition decisions (Jacoby, 1991, p. 530). Consistent with this claim, recollection is reduced or even eliminated (Jacoby, Toth, & Yonelinas, 1993) when encoding is performed (a) under divided rather than full attention (Jacoby et al., 1992, 1993), (b) in a superficial rather than semantic manner (Dehn & Engelkamp, 1997; Komatsu et al., 1995; Toth, 1996), (c) by elderly rather than young subjects (Caldwell & Masson, 2001; Jennings & Jacoby, 1993; Titov & Knight, 1997; see also Craik & Byrd, 1981), and (d) by amnesic patients rather than healthy individuals (Verfaellie & Treadwell, 1993). The former member of each of these dichotomies is associated with the reduction or exclusion of controlled *encoding*. The corresponding process dissociation patterns are ones of reduced contributions to *retrieval* of recollection. Thus, the controlled retrieval process of recollection may be diagnostic of controlled encoding.

Such an association between the processing profiles of retrieval and encoding is relevant to the controversial question of the automaticity of inference encoding. It was discussed in the introduction that although text inference processes rely at least in part on automatic resonance processes and are not open to awareness, they apparently fit the controlled-process criteria of being resource-demanding and quite slow. Characterizing the computation of text inferences as a controlled process meshes with the view that automaticity requires invariance between task and performance (Bock, 1982; Logan, 1988). For example, the appearance of a written word permits, by the application of certain perceptual processes, the reliable identification of that word. Even more complex language functions, including parsing and regularization rules (e.g., pluralization, past tense) may exemplify such invariance (Bock, 1982). Perfetti (1989) proposed that the latter processes meet some criteria of automaticity; such as speed and immunity from interference by other ongoing processes. However, according to his analysis, the output of these processes is highly specific to their input stimuli and, as such, is sparse in its inferential content. The automaticity of these processes ensures the availability of cognitive resources for other, strategic components of comprehension. Strategic processing might be needed to encode an unfamiliar word, to decipher an ambiguous syntactic construction, or to draw certain inferences.

Such an analysis accommodates certain features of our results. First, inference processes are controlled (reflected here by the negligible contribution of familiarity, an automatic process; Yonelinas, 2002) because they do not represent an invariance between task and performance. Rather, the highly productive nature of language ensures that most text inferences are novel. This novelty does not stem from the relevance of, for example, mailmen to the letter-delivery context. Rather, it results from the fact that a text that implies the role of a mailman implies numerous competing ideas (depending on contextual subtleties; Kintsch, 1988) and, conversely, that many subtly different texts imply the role of a mailman. Second, as discussed earlier, the automatic influence detected in the explicit conditions largely reflects the operation of processes such as word identification.

These proposals are speculative, and there are some caveats to consider. First, in one instance, Singer and Remillard (2004, Experiment 3) measured a small but statistically significant contribution of familiarity to the recognition of bridging concepts. Like for the control condition of our bridging-inference experiment, this may result from the passive convergence upon the target concept of activation from the words in the stimulus sentence. Second, test items comprising phrases (e.g., *howled with amusement at the joke*) rather than single words (*joke*) might more effectively reinstate the perceptual operations of encoding than single word targets, thereby permitting the appearance of familiarity support for recognition.

CONCLUSION

This research offers convincing evidence that the process dissociation framework can be fruitfully applied to problems of language processing. The experiments indicate that there are measurable differences between people's representation of explicit and implicit text ideas. They also map out a considerable agenda of future research. It will be necessary to clarify the distinction between the recollection and misrecollection of text inferences, compare the efficacy of multiprocess versus multirepresentation theories, and clarify the relation between the automaticity of retrieval as opposed to the antecedent encoding processes.

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