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Schematic knowledge changes what judgments of learning predict in a source memory task

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Source monitoring can be influenced by information that is external to the study context, such as beliefs and general knowledge (Johnson, Hashtroudi, & Lindsay, 1993). We investigated the extent to which metamnemonic judgments predict memory for items and sources when schematic information about the sources is or is not provided at encoding. Participants made judgments of learning (JOLs) to statements presented by two speakers and were informed of the occupation of each speaker either before or after the encoding session. Replicating earlier work, prior knowledge decreased participants' tendency to erroneously attribute statements to schematically consistent but episodically incorrect speakers. The origin of this effect can be understood by examining the relationship between JOLs and performance: JOLs were equally predictive of item and source memory in the absence of prior knowledge, but were exclusively predictive of source memory when participants knew of the relationship between speakers and statements during study. Background knowledge determines the information that people solicit in service of metamnemonic judgments, suggesting that these judgments reflect control processes during encoding that reduce schematic errors.

Making meaningful judgments about past events often requires memory not only for whether these events took place, but also for contextual details that accompanied the event. Having retrieved a particular piece of information, for example, we might also need to recall who first told us about it or when the event occurred. Although we know much about the factors that influence people's assessments of how well they will remember information that they studied (see Koriat, Goldsmith, & Pansky, 2000, for a review), there have been no studies to date evaluating how well people can predict *source memory* or about the ability to access contextual details about prior episodes. Because tests of item memory query different aspects of events than do tests of source memory, predictions about item and source memory performance likely rely on different cues and, therefore, may vary across encoding contexts that promote evaluation of different aspects of the stimuli or of the processing applied to the stimuli.

In this study, we evaluate the extent to which judgments of learning (JOLs) predict success in the recognition of verbal statements and of the speaker, or source, of those statements. We use an experimental context in which multiple aspects of memory performance are assessed to evaluate the larger question of how people leverage background knowledge in the service of metamemory. Specifically, we examine how JOLs in a source memory task change when people are aware of a meaningful relationship between the content of the statement and its source. The influence of knowledge on metamemory may be as important as the effects of such knowledge on memory (Alba & Hasher, 1983) and on source memory (Bayen, Nakamura, Dupuis, & Yang, 2000), because JOLs reflect the difficulty of materials and determine how time and effort are allocated in self-guided learning (Benjamin, 2008; Koriat, 1997). Metamnemonic factors thus play a major role, not only in predicting, but also in influencing performance on memory tests. The results presented here show that awareness of a relationship between items and sources changes fundamentally what participants rely on to make JOLs and, thus, influences what aspects of memory performance they predict.

Influences of Knowledge on Source Monitoring

Source monitoring in real life is not a purely episodic task (Johnson, Hashtroudi, & Lindsay, 1993). We are often presented with situations in which the relationship between a message and its source is meaningful, like finding movie reviews in the entertainment section of a newspaper. Making source judgments about such information involves a search for episodic memory traces and an evaluation of the results of this search that may involve drawing on knowledge outside of the study context. Thus, when asked to recall the context in which we learned a specific fact, expectations stemming from personal beliefs, biases, or background knowledge can influence the decision-making process by complementing the evaluation of episodic re-

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trieval. Because the activation of knowledge structures is largely automatic, whereas episodic retrieval can be faulty and effortful, background knowledge may play a particularly salient role under suboptimal retrieval conditions (e.g., Benjamin, 2001; Sherman & Bessenoff, 1999).

Demonstrations of semantic influences on memory performance are found in work on source monitoring for schematic and nonschematic information (Bayen et al., 2000; Hicks & Cockman, 2003; Mather, Johnson, & De Leonardis, 1999; Sherman & Bessenoff, 1999; Spaniol & Bayen, 2002). In these studies, participants studied statements presented by two sources, usually speakers belonging to two different groups (e.g., people with different occupations), and later were asked to attribute statements to the original sources. Some of the information presented at study by each source was consistent with the schema associated with that source, and some was schematically consistent with the other source. This information heavily influenced source attributions at test, because participants attributed more schema-consistent statements to the schema-consistent source than to the schema-inconsistent source.

These results follow from schema theories of memory accuracy (Alba & Hasher, 1983). The activation of schemata can enhance memory accuracy for schema-relevant details but can also induce participants to falsely remember plausible information that was never presented (e.g., Brewer & Treyens, 1981). In social cognition, information relevant to social categories can influence memory judgments in line with common stereotypes or expectations, resulting, for example, in biased attributions of friendly and unfriendly behaviors (Sherman & Bessenoff, 1999) or schema-consistent occupations (Payne, Jacoby, & Lambert, 2004) to individuals from different social groups or in biased attributions of fame and gender-stereotyped statements to gender-consistent sources (Banaji & Greenwald, 1995; Marsh, Cook, & Hicks, 2006). According to source-monitoring frameworks, schematic distortions of this type or, more generally, false memories resulting from knowledge-driven inferential processes are all examples of source-monitoring failures.

Inferential gap filling of this sort may result from processes operating at both encoding and retrieval. During encoding, schema-consistent and -inconsistent information may be allocated different degrees of attention: Nonschematic information must be stored explicitly with rich distinctive detail in a way that schematic information need not be (see Benjamin, 2008, for a review of strategic encoding effects). This often results in better and more vivid immediate memory for schema-inconsistent information (Lampinen, Faries, Neuschatz, & Toglia, 2000; Neuschatz, Lampinen, Preston, Hawkins, & Toglia, 2002; Pezdek, Whetstone, Reynolds, Askari, & Dougherty, 1989; Sherman, Lee, Bessenoff, & Frost, 1998; Stangor & McMillan, 1992). However, people seem to rely more heavily on schemata under conditions of greater processing difficulty, such as during speeded responding or dual tasking (e.g., Benjamin, 2001; Benjamin & Bjork, 2000; Benjamin & Craik, 2001; Sherman, Groom, Ehrenberg, & Klauer, 2003; Stangor & McMillan, 1992). The memory advantage for schema-inconsistent information also decreases over time and may eventually reverse (Neuschatz et al., 2002; Smith & Graesser, 1981; Tuckey & Brewer, 2003). Typically, the ease with which schematic intrusions occur is attributed to automatic activation of knowledge structures (Devine, 1989) and to their generative role in recall (Hunt & Einstein, 1981).

The story is similar for source-monitoring failures at retrieval. When given schematic information about sources just before retrieval, people show schematic response biases in their source attributions (Bayen et al., 2000). Because semantic information is likely consulted only after attempts at episodic retrieval, reliance on schemata can be predicted from the quality of episodic retrieval (Spaniol & Bayen, 2002). Episodic and semantic influences on source decisions may be difficult to distinguish, at least in terms of subjective confidence (Hicks & Cockman, 2003), but manipulations that allow people to encode item–source pairings more distinctively should reduce the amount of schematic bias at test. This prediction receives partial support in the literature, with most studies showing schema-driven attribution errors at test, even when schematic information was available before or during encoding (Bayen et al., 2000; Mather et al., 1999), and with only one study showing a dramatic decline in biased responding when such information was given before encoding (Hicks & Cockman, 2003). In the present study, we used a similar paradigm to assess how the availability of schematic information prior to study may offset schematic biases in source judgments. Furthermore, we evaluated the metacognitive consequences of the availability of schemata by comparing participants' predictions and their later memory for items and sources.

Metacognition and Knowledge Structures

Although one major explanation of the empirical effects of providing schematic information prior to study is metacognitive in nature, perceptions of how the availability of schemata influences metamemory remains unexplored. When schemata are not available or are difficult to discern during encoding, the relationship between items and sources is largely arbitrary, and participants must try to remember items and sources (and the relationship between them) on purely episodic grounds. However, when people are aware of schematic associations between items and sources, this information becomes a critical aspect of the encoding experience. People may engage in differential encoding of schema-consistent and -inconsistent information precisely because they are aware that semantic structures will support correct decisions about schema-consistent information, but will oppose correct decisions about schema-inconsistent information.

We asked whether subjective assessments of learning would be differentially related to item and source memory performance in different encoding contexts. If participants encode schema-consistent and -inconsistent materials differently, such a strategy should be evident in their metacognitive judgments during encoding. This hypothesis makes two claims about the relationship between predictions and later memory performance.

First, mean judgments should reflect the distinction between schema-consistent and -inconsistent items only when that information is available before encoding. Because JOLs reflect inferences about memory states rather than the strength of memory traces (Benjamin & Bjork, 1996; Benjamin, Bjork, & Schwartz, 1998; Hertzog, Dunlosky, Robinson, & Kidder, 2003; Koriat, 1997; Koriat & Ma'ayan, 2005; Schwartz, Benjamin, & Bjork, 1997), they tend to be based on multiple aspects of the encoding experience, including properties of the materials or of the study context, as well as the subjective experience of encoding. In this case, schematic information may motivate differences in metamnemonic judgments between stimuli that comport with that schema and stimuli that do not.

Second, differences in encoding contexts and metacognitive evaluations should yield distinctive patterns of correlations with memory for items and memory for sources. Judgments provided with schematic support should reflect the degree to which an item–source pairing comports with the given schema. To the degree that schematic knowledge increases attention to intrinsic associations between items and sources, it promotes performance on a test that queries memory associatively. Because tests of source memory provide the item and solicit the source, source memory performance should be well predicted by JOLs made in this context. However, because memory for items does not tap associations between items and sources, JOLs should not predict item memory. In contrast, judgments given without schematic support are primarily item based: They should reflect inherent variations in idiosyncratic item memorability, idiosyncratic changes in encoding strategies, and fluctuations of attention and effort. In the absence of clear intrinsic cues that might help people encode items and sources via the same associations that can be made in the presence of schematic information, JOLs should not preferentially predict source memory performance. On the basis of item-specific cues or idiosyncratic encoding strategies alone, JOLs should predict memory for both items and sources.

In the present experiment, participants studied statements presented by two speakers (see Bayen et al., 2000) and made predictions about future recall. Each speaker produced an equal number of doctor-like, lawyer-like, and neutral statements. Half of the job-related statements were consistent with each speaker's occupation and half were not. Participants either were given no information about the speakers' occupations until after the encoding phase (*schema-after-encoding* condition) or were told the speakers' occupations at encoding and were reminded at retrieval (*schema-before-encoding* condition). At test, half of the statements appeared unchanged and half were altered slightly. Participants were asked to decide whether each statement was produced by the doctor source, was produced by the lawyer source, or was unstudied. We expected to see less schematic bias in the schema-before-encoding condition, because a schema provided before encoding should alert participants to engage in more elaborate processing for inconsistent items, thus improving the accuracy of source attributions relative to the schema-after-encoding condition.

Of central interest is the relationship between JOLs and memory performance. In the schema-after-encoding condition, JOLs primarily should reflect participants' subjective assessments of the episodic memorability of each statement. To the extent that participants are able to assess their ability to remember unrelated information on purely episodic grounds, higher JOLs should predict better memory for *both* items and sources. In the schema-before-encoding condition, schematic information should alert participants to schematic differences in statement–speaker pairings. Because JOLs are likely to be based on a heuristic evaluation of schematic fit, they should predict accuracy for source memory, but not for item memory.

METHOD

Participants

Sixty-four undergraduates from the University of Illinois participated to fulfill a class requirement, 32 in each condition. Two participants in the schema-after-encoding condition were replaced because they gave the same JOL to over 90% of the items.

Materials

The items were 32 doctor-consistent statements, 32 lawyer-consistent statements, and 32 neutral statements, all taken from Bayen et al. (2000). They were presented by two characters, John and Bill. For half of the participants, John was identified as the doctor and Bill as the lawyer; the reverse was true for the other half. This identification took place prior to study in the schema-before-encoding condition and prior to test in the schema-after-encoding condition. Each speaker presented 48 statements: 16 consistent with and 16 inconsistent with his profession, and 16 items of equal expectancy (neutral items).

At test, participants received 96 items. Half of these items had been studied earlier and included, for each speaker, 8 items that were consistent with the speaker's profession, 8 inconsistent items, and 8 neutral items. The other 8 items of each kind were replaced by distractor items (i.e., items where the original wording was changed by substituting one or two of the key words to alter sentence meaning). There were two versions of the test materials, so each statement was presented as a test item for half of the participants and as a distractor item for the other half in each condition.

Design and Procedure

The design was a 2 (instructional condition) $\times$ 3 (item type) $\times$ 2 (original source) mixed factorial. Instructional condition was a between-participants factor. Item type and source were manipulated within participants. The order of the statements was randomized at study and at test for each participant, with the constraint that, at study, neither speaker presented more than two consecutive statements.

Participants in the schema-after-encoding condition were told that they would read statements presented by two speakers, John and Bill. At this point, participants in the schema-before-encoding condition were told that it would be helpful to know that Bill was a doctor (or a lawyer) and that John was a lawyer (or a doctor). All participants were told that they would be estimating how well they might remember each statement later. No information was provided about the nature of the test or what aspects of the stimuli might be relevant for performance on that test, as in previous studies using this methodology. During the study phase, the name of the speaker and the statement were presented together for 6 sec, at which point a 1–5 scale appeared at the bottom of the screen and participants pressed a key to record their JOL (1 = *not at all confident*, 5 = *very confident*).

The test phase began immediately afterward. Participants were told that they would receive a list of statements and would have to indicate, for each one, whether it had been spoken by John, Bill, or neither.

Table 1
Item Memory and Source Memory at Each JOL Level Across All Items in the Two Experimental Conditions

	Schema After Encoding			Schema Before Encoding		
	Item			Item		
JOL Level	HR	FAR	Source	HR	FAR	Source
1	.74	.47	.60	.77	.44	.54
2	.79	.40	.60	.76	.42	.64
3	.81	.39	.62	.81	.36	.71
4	.87	.37	.66	.82	.43	.78
5	.84	.39	.70	.83	.44	.75
M	.82	.42	.63	.80	.41	.68
d'	1.24	–	–	1.15	–	–
γ	.13*	–	.15*	.03	–	.25*

Note—For item discrimination, the hit rate (HR) is the proportion of test items recognized as old (i.e., attributed to either speaker), and the false alarm rate (FAR) is the proportion of distractor items incorrectly attributed to an old speaker. Source memory is the proportion of items correctly attributed to the original source, given that the item was recognized as old. $^*p < .05$.

Participants in the schema-after-encoding condition were told that it might be helpful to know that Bill was a doctor (or a lawyer) and that John was a lawyer (or a doctor); participants in the schema-before-encoding condition were reminded of the speakers' occupations.

RESULTS

Scoring and Analyses

We recorded participants' response times for JOL ratings and for source decisions. We removed responses that exceeded the time frame for response times allowed by the program (32 sec): Three responses were removed for the source analysis and six for the analyses with JOLs in the schema-after-encoding condition, and two responses for the analyses with JOLs in the schema-before-encoding condition. Item memory was assessed as the probability of endorsing either speaker for a previously studied item, and source memory was scored as the conditional subset of those cases in which the correct speaker was chosen. All effects are significant at the $\alpha < .05$ level, unless otherwise noted.

Effects of Schemata on Item Memory

Table 1 lists the hit rates and false alarm rates for all items together; Table 2 lists them by item type at each JOL level. Discriminability (d') scores were calculated after replacing empty cells by half the smallest possible value in each cell for hit rates and false alarm rates of 0, and 1 minus half the smallest possible value in each cell for hit rates and false alarm rates of 1 (see Wickens, 2002). Because of the large number of corrections needed following such partialling of the data, d' scores are not provided for each level.

Overall item discriminability did not differ reliably between the two instructional conditions [$t(62) = 0.77$]. Item discrimination was better for neutral items than for consistent [$t(31) = 5.23$ and 5.14] and inconsistent [$t(31) = 4.90$ and 6.05] items in the schema-after- and schema-before-encoding conditions, respectively. Discriminability for consistent and inconsistent items did not differ between conditions [$t(31) = 0.52$ and 0.70]; thus, as in prior work (Hicks & Cockman, 2003), the presence of schematic information at study did not affect item memory performance.

Effects of Schemata on Source Memory

Unlike for item memory, the pattern of source attributions was expected to vary across conditions, reflecting participants' use of schematic cues. Figure 1 shows the mean conditional probabilities of correct attributions of the three types of test items to the two speakers (i.e., the proportions of attributions to the correct speaker out of all items recognized as old). A clear pattern of schema reliance was obtained in both conditions, with more attributions of doctor-expected statements to the doctor source and lawyer-expected statements to the lawyer source. Attributions for neutral items did not differ: A 2 (instructional condition) × 2 (original source) ANOVA performed on these items alone showed no main effects and no interaction (all *F*s < 1), so further analyses are restricted to doctor- and lawyer-expected items.

A 2 (instructional condition) × 2 (item type) × 2 (original source) ANOVA showed a significant two-way inter-

Table 2
Item Memory and Source Memory at Each JOL Level for Consistent (C), Inconsistent (I), and Neutral (N) Items in the Two Experimental Conditions

	Schema After Encoding									Schema Before Encoding								
	Item Memory									Item Memory								
	C		I		N		Source Memory			C		I		N		Source Memory		
JOL	HR	FAR	HR	FAR	HR	FAR	C	I	N	HR	FAR	HR	FAR	HR	FAR	C	I	N
1	.83	.55	.71	.46	.80	.42	.76	.31	.65	.82	.58	.78	.54	.73	.35	.56	.41	.59
2	.83	.53	.74	.48	.79	.24	.80	.29	.74	.70	.32	.71	.52	.88	.32	.73	.48	.69
3	.79	.43	.84	.45	.78	.24	.87	.38	.62	.76	.54	.71	.44	.93	.30	.78	.61	.72
4	.88	.55	.79	.38	.93	.24	.87	.31	.71	.83	.40	.90	.41	.84	.36	.75	.55	.81
5	.80	.41	.81	.31	.83	.38	.93	.51	.74	.78	.44	.84	.64	.83	.32	.80	.45	.84
M	.81	.49	.81	.47	.84	.29	.84	.37	.68	.76	.43	.77	.48	.85	.32	.78	.53	.73
d'	1.01		1.09		1.71					1.00		0.91		1.65				
γ	.15		.25*		.16		.23	.04	.14	.07		.03		.16		.20*	.08	.31*

Note—For item discrimination, the hit rate (HR) is the proportion of test items recognized as old (i.e., attributed to either speaker), and the false alarm rate (FAR) is the proportion of distractor items incorrectly attributed to an old speaker. Source memory is the proportion of items correctly attributed to the original source, given that the item was recognized as old. $^*p < .05$, one-sample *t* test.

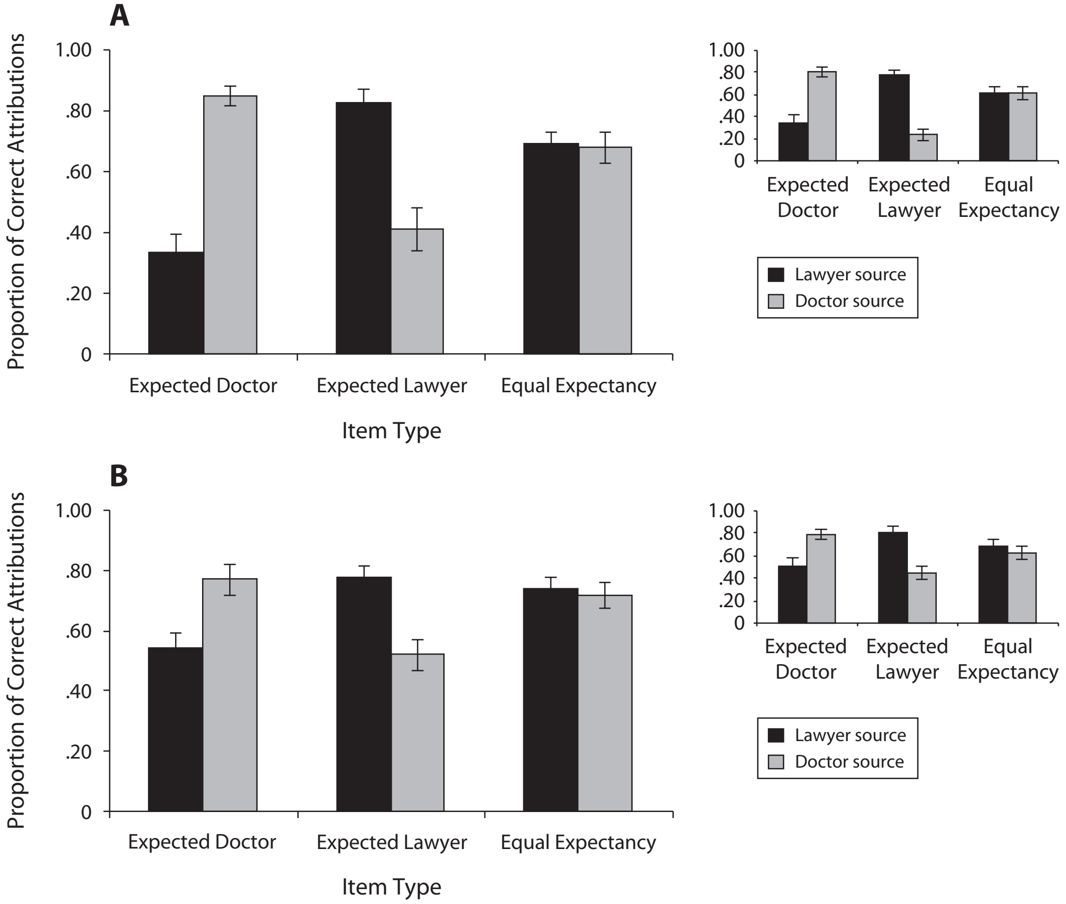

Figure 1. Proportion of responses attributed to the original speaker for the three types of items as a function of original speaker identity in (A) the schema-after-encoding condition and (B) the schema-before-encoding condition for test items (larger graph) and distractor items (smaller graph). Error bars are standard errors.

action between item type and source [$F(1,62) = 43.94$], with participants correctly attributing more statements to schema-consistent than to schema-inconsistent speakers. The three-way interaction was also reliable [$F(1,62) = 4.38$], because the schema-driven effect was greater in the schema-after- than in the schema-before-encoding condition. (All other effects were not reliable; Fs < 2.) To compare the magnitude of this effect across conditions, we calculated a single bias score for each participant, measured as the difference between the proportion of correct responses attributed to the schema-consistent versus -inconsistent speakers. Mean bias scores were higher in the schema-after-encoding condition (.47) than in the schema-before-encoding condition (.25) [$t(62) = 2.13$].[1]

Thus, the presentation of schematic information before encoding reduced schema-driven attributions at test, replicating earlier work (Hicks & Cockman, 2003). In theory, this reduction could have occurred because participants were better able to attribute consistent statements to their original (and expected) source or because they were more successful in attributing inconsistent statements to their original (and unexpected) source. Our results support the latter alternative (see also Hicks & Cockman, 2003): Participants attributed the majority of schema-consistent statements to the original speaker in both the schema-after-encoding (.84) and the schema-before-encoding (.78) conditions [$t(62) = 1.27$], but they attributed inconsistent statements to the original source more often in the schema-before-encoding condition (.53) than in the schema-after-encoding condition (.37) [$t(62) = 2.15$].

Following Hicks and Cockman (2003), we evaluated the extent to which these attributions were driven by schema-biased (or knowledge-based) guessing by comparing average levels of performance for all doctor-expected items with those for all lawyer-expected items in each condition. When participants attribute statements to the consistent source in the absence of episodic memory, this pushes the correct response rate for consistent items closer to 1 and for inconsistent items closer to 0 by equal amounts; asymptotically, this strategy leads to an average performance of .50 across consistent and inconsistent items. Average performance for both types of items was consistently higher than .50 in this study (schema after encoding, doctor-consistent items, .60; lawyer-consistent items, .61; schema before encoding, doctor-consistent items, .67; lawyer-consistent items, .64; all ts > 3), allowing us to rule out the hypothesis that performance at test was driven solely by such biases. More importantly, mean attribution scores were numerically higher in the schema-before-encoding condition, so the improvement in accuracy in this condition cannot be attributed solely to adjustments in strategic guessing as a result of the availability of schematic information. Instead, the improvement was due to better performance for inconsistent items, because the availability of background knowledge *decreased* participants' reliance on schemata, moving the means for inconsistent items away from 0 (i.e., the level of performance predicted by schema-driven guessing).

At the same time, participants in this condition did not show a strong preference for the original speaker, with average performance for inconsistent items at only .53. The difference between this result and the dramatic improvement reported by Hicks and Cockman (2003) may be due to several factors, including motivational differences, levels of processing (e.g., statements in this study were not accompanied by pictures of the speakers), or overall task difficulty (e.g., participants' level of involvedness increased substantially with the addition of a metacognitive task). More central to our main argument is the fact that manipulating the availability of schematic knowledge influenced both performance and JOL ratings, as outlined in the next section.

Effects of Schemata on JOL Ratings

Table 3 shows the distribution of responses for each JOL level and for each type of item, together with condition means. The proportion of responses given to each item type at each JOL level is comparable across all item types in the schema-after-encoding condition [$F(2,62) = 0.39$], as was expected, because participants could not engage in systematic schema-driven, associative encoding. A clear schema-dependent pattern is seen in the schema-before-encoding condition [$F(2,62) = 31.69$], where consistent items received higher JOLs than did items that were inconsistent [$t(31) = 6.02$] or neutral [$t(31) = 6.89$]. Inconsistent and neutral items did not differ [$t(31) = 0.99$]. In general, participants indicated greater confidence in their ability to retain information supported by schemata than information that was inconsistent or neutral with respect to a schema.

On what did people base such judgments? The difference in JOL ratings for consistent and inconsistent items might arise from greater difficulty in encoding schema-inconsistent information or from a deliberate strategy of assigning elevated ratings to consistent items because of strong schematic support and greater ease of processing (e.g., Begg, Duft, Lalonde, Melnick, & Sanvito, 1989). In light of the close resemblance of JOLs given to inconsistent and neutral items, people may have predicted that items with no schematic support and items for which schematic support was irrelevant would be more difficult to recall on a subsequent test. Thus, the difference in ratings for consistent and inconsistent items may reflect a deliberate evaluation of consistent information as being easier to remember. With respect to metamnemonic control, this implies that participants in the schema-before-encoding condition were willing to sacrifice encoding effort for materials for which they knew schematic context would support accurate performance. This prediction is borne out in the performance data for consistent items, because the availability of schemata produced no advantage for source attribution accuracy in that condition relative to the schema-after-encoding condition. In fact, superficial encoding of consistent information may be responsible for the small decline in performance seen with these items in this condition relative to the schema-after-encoding condition.

Importantly, this does not imply that participants processed inconsistent and neutral items in the same way. The similarity in JOL ratings given to these two types of items cannot be interpreted unambiguously as reflecting similar evaluations of encoding difficulty or comparable expenditures of effort, because participants likely engaged in different encoding operations for these items. Inconsistent and neutral items differ in content, so inconsistent items could be encoded with respect to a schema, whereas neutral items had to be encoded episodically on an item-by-item basis. In fact, the availability of schematic information at study produced different results for these items: Differences in source memory between conditions were due to improvements in accuracy for *inconsistent* items, showing that the availability of schemata was particularly beneficial for the encoding of this information over schematically neutral information.

Predicting Item and Source Attributions From JOLs at Study

Finally, we evaluated whether JOLs in the two conditions predicted memory for items and sources. For both

Table 3
Proportion of Responses Given at Each JOL Level and Overall Means (With Standard Deviations) for All Consistent (C), Inconsistent (I), and Neutral (N) Items Across Conditions

	Schema After Encoding				Schema Before Encoding			
JOL Level	Overall	C	I	N	Overall	C	I	N
1	.13	.13	.13	.12	.19	.05	.29	.25
2	.27	.29	.28	.23	.25	.14	.32	.28
3	.25	.24	.25	.26	.20	.17	.21	.24
4	.17	.17	.14	.19	.16	.27	.08	.13
5	.18	.17	.19	.18	.19	.37	.11	.10
M		2.96	2.99	3.09		3.78	2.40	2.55
SD		0.79	0.93	0.70		0.74	0.79	0.65

item and source memory, we calculated gamma correlations between response accuracy and the magnitude of the JOL rating for each item.

Table 1 lists the proportions of correct attributions to an old speaker for test items (item memory) and to the original speaker for test items recognized as being presented by an old speaker (source memory), as well as gamma correlations between judgments and performance. As was expected, JOLs in the schema-after-encoding condition predicted both item memory [$\gamma = .13$, $t(30) = 2.33$][2] and source memory [$\gamma = .15$, $t(31) = 2.30$] performance and did not differ from one another. In contrast, judgments in the schema-before-encoding condition reliably predicted only memory for source [$\gamma = .25$, $t(31) = 3.96$] but not memory for items [$\gamma = .03$, $t(31) = 0.56$].[3] Thus, drawing attention to different characteristics of the material during encoding had clear consequences for what JOLs predicted: A focus on associative relationships between items and sources on the basis of schematic information resulted in accurate predictions for source memory (in the schema-before-encoding condition), whereas a focus on item-specific characteristics predicted performance for both associative and nonassociative aspects of the material (in the schema-after-encoding condition).

Gamma correlations for consistent, inconsistent, and neutral items are shown separately in Table 2, together with proportions of correct attributions at each JOL level. Rather than showing differences in the benefit provided by schemata for items studied in each condition, these correlations show the extent to which episodic information alone influenced source attributions within each item type.[4] Computation of gammas with such low item counts makes traditional hypothesis testing questionable, but the results reveal a suggestive pattern. As was the case with the overall gamma correlations, gammas for item memory were low in the schema-before-encoding condition, but were relatively higher in the schema-after-encoding condition. More interesting, gammas for source memory were similarly high in both conditions, but the distribution of correct attributions across JOL levels suggests different degrees of success in relying on episodic and schematic information in the two conditions, as outlined below.

For consistent items, original predictions based on episodic memorability in the schema-after-encoding condition and on evaluations of schematic fit in the schema-before-encoding condition were supported by schema-consistent source information provided at test, and thus the predictiveness of these judgments was high. This was not the case with inconsistent items. In the schema-after-encoding condition, the influence of schematic information provided at test made original predictions based on episodic memorability for these items virtually nondiagnostic ($\gamma = .04$). In the schema-before-encoding condition, where participants could engage in more elaborate episodic processing to retain these unexpected pairings, source accuracy was low for items given the lowest JOLs, highest for items given intermediate JOLs, and low for items given the highest JOLs. In other words, participants who were unsure about future episodic memory for a difficult statement were, in fact, likely to make inaccurate source attributions, but participants who were sure that they would recognize a statement later were also likely to do so. Thus, high levels of confidence in encoding incongruent item–source pairings episodically did not predict attribution accuracy when strong schematic information competed with relatively weaker episodic memory traces. We interpret this result within the context of schematic and episodic influences on memory performance in the Discussion section.

DISCUSSION

Metamnemonic judgments help inform theories of memory by revealing the types of inferential processes that may underlie strategic contributions to performance. Here, we evaluated whether subjective assessments of learning can shed light on how people exploit schematic and episodic information in a source-monitoring task. We show that metamnemonic judgments reveal strategic evaluations of learning that influence the degree of schematic bias shown at test, and that schematic information can change the relationship between JOLs and later memory performance.

Schematic Information and Source Bias

When one attempts to remember an event and its contextual details, both the ability to discriminate this event from many others and the ability to identify the original source depend on accurate retrieval of episodic information. For item memory, incomplete or inaccurate episodic recall leads to failures in item recognition; for source memory, it implies that source attributions are likely to be influenced by other information. In this experiment, we replicated two critical findings concerning schematic influences on source monitoring. First, source judgments are biased by schematic knowledge. Second, awareness of a meaningful relationship between items and sources has little effect on item discriminability (Bayen et al., 2000) but reliably decreases the degree to which source attributions are biased by schematic knowledge (cf. Hicks & Cockman, 2003).

Schema-driven source memory performance has been attributed largely to schematic guessing biases operating at test following failures of episodic retrieval when schematic information is withheld until test (Bayen et al., 2000); conversely, reductions in schematic bias due to privileged encoding with schematic knowledge have been attributed to improved memory for the original item–source pairings (Hicks & Cockman, 2003). We obtained evidence for a reduction in schematic bias as a result of a selective improvement in source attributions for inconsistent information—that is, information that was most likely to benefit from the availability of schemata at study. Our results suggest a metacognitive basis for this effect, as reviewed below.

Contextual Influences on Metamnemonic Judgments

Theories of metamemory have much to say about the situational characteristics that drive judgments, but often the goals of the rememberer are not considered explicitly. Here, metamnemonic judgments solicited during encoding reveal a possible relationship between ease of learning and encoding effort that contribute to the decrease in schematic bias shown in source attributions. It is known that JOLs predict the expenditure of time and effort in self-controlled learning (Benjamin, 2008; Son & Metcalfe, 2000; Thiede & Dunlosky, 1999); consequently, JOLs that reflect the difference between items that will benefit and items that will be impaired by schematic information reveal a means by which the schematic biases can be strategically confronted and reduced by the learner.

Participants who knew of a relationship between items and sources primarily encoded the association between them and monitored its consistency as they did so, as is shown by the large difference in mean judgments provided to consistent and inconsistent items during study and by the fact that such judgments predicted memory for sources, but not for items. By attending to associations selectively, these participants were able to modulate study effort appropriately and to expend relatively greater effort on encoding more difficult (i.e., inconsistent) items. Because attempts to integrate inconsistent information into a schema generate distinctive memory traces, allocation of resources on this basis effectively reduced schematic bias. In short, possession of schematic knowledge changes the way in which encoding takes place, with obvious consequences for performance.

Participants who were not aware of the relationship between items and sources could monitor only idiosyncratic item characteristics, as revealed by the lack of a difference in mean judgments between item types and by the fact that such judgments predicted both item and source memory. Not being able to distribute encoding effort in a manner that would combat the bias introduced by schematic information at test resulted in a higher proportion of incorrect source attributions.

The results follow from theories postulating a direct relationship between the amount of effort expended during encoding and later performance. This relationship is subject to influence from factors outside the immediate encoding context: Episodic binding of sources to items is more successful in informative encoding contexts and less successful in contexts that do not support selectively elaborate encoding of difficult information. In this study, as well as within the larger body of research on schematic influences on memory and their social implications, the judicious allocation of resources to more difficult or less difficult material and the corresponding changes in memory performance depend strongly on the rememberer's preexisting knowledge.

Contextual Influences on Metamnemonic Predictions

Knowledge changed the pattern of JOLs as participants focused their attention either on the association between items and sources or on interitem variation. Dramatically, this changed what those judgments predicted on a later test of memory. In the absence of schematic knowledge, JOLs reflected learners' evaluations of the idiosyncratic memorability of each item and thus were related to the ability to remember the item itself and its source. When schematic information was available, JOLs primarily reflected the fit between the current item and the held schema and thus did not predict memory for the item. They did, however, predict memory for source, since tests of source memory tap the type of associative processes engaged during evaluation of schematic fit. In sum, as the nature of the processes operating at encoding changed with awareness of external knowledge, the predictiveness of JOLs for various measures of performance also changed: The greater amount of item-directed processing required when no schema was available made JOLs more successful predictors of item memory in the schema-after- than in the schema-before-encoding condition, whereas the greater degree of associative processing for items and sources in the schema-before-encoding condition made these judgments more successful predictors of source memory than of item memory.

Context also modulated the degree to which episodic encoding affected the diagnosticity of predictions for different types of information. Prediction accuracy for consistent items (as shown by gammas) was similar in both conditions, as was performance; instead, the different influence of schemata on performance was seen most clearly with inconsistent items—that is, items with the poorest calibration results. In the schema-after-encoding condition, original predictions were unrelated to performance, suggesting strong influences of schematic context over episodic memories for arbitrary item–source associations. Interestingly, calibration was not higher in the schema-before-encoding condition, suggesting strong influences of schematic context over episodic memories even for item–source associations that are formed when people are aware of their schematic inconsistency. In fact, schematic information provided at test influenced source attributions to a greater extent than participants predicted: Source attribution accuracy was lower for items given higher confidence ratings than for items with intermediate ratings, pointing out the weakness of even the subjectively strongest episodic memory traces relative to the influence of schemata.

The results are consistent with work comparing the influence of episodic knowledge and preexisting knowledge on memory performance: The advantage of richer encoding of unexpected information over less elaborate encoding of predictable information decreases under more difficult encoding or retrieval conditions (e.g., Sherman & Bessenoff, 1999) or over longer retention intervals (e.g., Smith & Graesser, 1981). In this experiment, encoding and evaluating learning for a large and equivalent number of consistent and inconsistent statements produced a considerable memory load; retrieval attempts at test seemed to return relatively weak episodic traces for unexpected or inconsistent information, as compared with a lifetime's worth of experience with familiar occupation schemata. The presence of this effect for items that were judged to be learned best suggests that people may be unable to anticipate, and thereby underestimate, the effect of task difficulty on later performance when assigning JOLs during study.

Analogously, Koriat, Bjork, Sheffer, and Bar (2004) showed that people are largely insensitive to the effects of another well-studied variable, retention interval, when predicting future memory performance: Learners reported similar levels of confidence in remembering information over the short term and the long term, seemingly unable to predict their own forgetting. The effect was strongest with high-confidence items. Thus, knowledge of basic memory phenomena does not appear to influence subjective evaluations of learning as people base their JOLs on information immediately available in the encoding context. In the present experiment, people failed to appreciate the influence of schemata on later memory when reporting temporarily high levels of confidence for inconsistent information, suggesting that JOLs may be unreliable predictors of source memory in situations where episodic encoding of sources is difficult. It remains an open question to what extent people can and do incorporate knowledge of schematic influences on memory in contexts allowing for less demanding encoding; more generally, this question requires integration of theories about people's current memory states and about the flexibility of people's beliefs about these memory states.

Conclusion

Collecting metamnemonic judgments in source-monitoring tasks achieves two goals: It informs research on source monitoring by comparing differences in people's encoding strategies of items and sources under different study conditions, and it informs research on metacognitive monitoring by comparing the diagnosticity of judgments based on different types of information for different tests of memory. From both perspectives, the present study highlights the importance of contextual detail for performance by demonstrating the powerful influences of schematic information on memory and on metamnemonic behavior in source monitoring. The accuracy of source attributions can be understood by examining the nature of episodic encoding, with background knowledge providing a considerable benefit in offsetting later schematic biases. In addition, JOLs, and their predictiveness for different aspects of memory performance, can be understood better by considering the motivational context of the metacognizer. Emphasis on different aspects of the information being studied fundamentally changes the nature of the reported assessments of learning, highlighting the context-sensitive nature of metamnemonic ratings.

AUTHOR NOTE

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NOTES

1. Distractor items that participants incorrectly attributed to one of the two speakers (false alarms) followed the same pattern (shown in the upper right-hand corner of the graphs in Figure 1). Although a large number of empty cells precluded further statistical comparisons of the magnitude of the schema-driven effect on these items, this effect again appeared to be larger in the schema-after- than in the schema-before-encoding condition.

2. One participant had all ties.

3. Gamma is a notoriously inefficient estimator (Benjamin & Diaz, 2008), and condition variability was consequently quite high, leading the interaction between instructional condition and gammas to be only marginally reliable [$F(1,61) = 2.54$, $p < .06$, one-tailed].

4. Schematic support is irrelevant for this comparison, because all schema-consistent items benefit from schema support and all schema-inconsistent items lack schema support.

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