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MAKING SENSE AND NONSENSE OF EXPERIENCE: ATTRIBUTIONS IN MEMORY AND JUDGMENT

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One of the authors (M.G.R.) is a guitarist of admittedly modest skill. While attempting to compose original songs he will occasionally produce a sequence of notes or chords which are played too easily or sound too coherent to be his own creation. When this "too smooth" sequence is detected, he will sometimes assume that the song is one he already learned (i.e., was a part of past experience) based on the ease with which it is played. That is, why would the song be played so smoothly on an initial attempt if it had not been learned sometime in the past? One interpretation of this experience is that it reflects the use of a fluency heuristic; that is, the ease of ongoing processing is attributed to past experience and so gives rise to a feeling of familiarity. The current chapter will attempt to evaluate the evidence that ease of processing, in any number of forms, can form the basis for the subjective experience of memory.

The idea of a fluency heuristic stems from the attributional approach to memory first formulated by Jacoby and Dallas (1981). Jacoby and Dallas drew on Kahneman and Tversky's (1973) notion of the availability heuristic, whereby people estimate the frequency of a class of events such as "the probability of being eaten by a shark" by evaluating how easy it is to remember instances of such events. In the case of memory, the argument is that people could assess the qualities of ongoing experience, such as enhanced perceptual identifiability of words, and interpret those qualities as a sign of a particular past experience. In doing so, they would have an experience of familiarity rather than of fluent processing.

Jacoby, Kelley, and Dywan (1989a) suggested that the attributional analysis could be extended to the case of generating details, such that people who interpret their easy generation of details as evidence of a memory would have one experience, but people who interpret it as the easy exercise of imagination would have quite a different experience.

The core difference between the attributional approach to remembering and the standard view of remembering as the retrieval of memory traces is the emphasis on attribution or interpretation. For example, in global memory models, the construct of familiarity is understood to be the consequence of activating multiple traces or attributes that have been stored in memory. However, according to the attributional approach to memory, there is an additional layer of complexity to memory. People do not have direct experience of activated traces. What people experience are thoughts and images, either detailed or sketchy, extended in time or mere fragments, unfolding quickly or appearing with difficulty during a retrieval attempt. To understand the subjective experience of remembering, we need to understand what sort of information people take as signs that they are remembering rather than imagining or inventing. We also need to understand the process of attribution, and in some cases, misattribution.

The attributional approach to memory is closely related to Johnson's reality monitoring and source monitoring framework. Johnson and Raye (1981) and Johnson, Hashtroudi, and Lindsay (1993) also moved their theorizing from the level of what is stored in memory (e.g., the conceptualization of representations of events "tagged" with the information that each event was experienced in a particular way, time, and place) to the level of the qualities of images and thoughts experienced during recall or recognition. Past experiences of different types such as an actually perceived event versus an imagined event lead to later differences in the qualities of the memory. For example, perceived events typically lead to memories with more perceptual detail than do imagined events, and people can use the amount of perceptual detail retrieved as a cue to whether a memory had its origin in a perceptual experience or an imagined experience (Johnson, Foley, Suengas, & Raye, 1988; Suengas & Johnson, 1988). The attributional approach has generally focused on the process by which people distinguish between events that occurred and events that did not occur, whereas the source monitoring framework has focused more on the process by which people distinguish between various sources of events that did occur. The source monitoring framework evaluates a variety of qualities in memorial experience, such as vividness of perceptual details, emotional aspects, and coherence in a sequence of remembered events (e.g., work using the Memory Characteristics Questionnaire, Johnson et al., 1988), while the attributional framework has focused more on the ease of perceiving or generating ideas as evidence that one is remembering. However, the two frameworks share an essential similarity in treating the subjective experience of memory as an attribution.

We will first review research on whether ease of perceptual processing serves as a basis for familiarity in recognition memory and on criticisms of the role of perceptual fluency in recognition. Then we assess the generality of the notion of a fluency heuristic by exploring whether there are other enhancements of processing due to repetition that are both specific and substantial enough to serve as the basis for a fluency heuristic, namely conceptual fluency and retrieval fluency. If memory is indeed an attribution regarding effects of past experience on current experience, then the relative diagnosticity of those cues as indicators of past experience is critical for memory accuracy. We will discuss the relation between the basis for memory judgments and memory monitoring. There is ambiguity in the source of variations in current processing, such that effects of past experience can be misattributed to current conditions, affecting judgments of everything from perceptual judgments of brightness and duration to judgments of the complexity of a text. Finally we will discuss the attribution and interpretation process, which is key in determining whether fluent processing will be attributed to the past, and so give rise to familiarity, or to a quality of the current stimulus.

I. Perceptual Fluency as a Basis for Familiarity

A. THEORY AND EVIDENCE

In two-factor theories of recognition (e.g., Atkinson & Juola, 1974; Jacoby, 1991; Mandler, 1980; Yonelinas, 1997), decisions can be made by using a target as a cue to access recollective details or on the basis of the general familiarity of a target. However, the nature of familiarity has been of some question. For example, one may conceive of familiarity as the consequence of simply accessing and reactivating latent memory traces (e.g., Gillund & Shiffrin, 1984; Hintzman, 1988; Kintsch, 1970). Alternatively, Jacoby and Dallas (1981) proposed that familiarity may be mediated by attributions about perceptual processing rather than by a memory trace per se. Specifically, they contended that familiarity is rooted in an unconscious attributional process, whereby ease of perceptual processing or *perceptual fluency* is attributed to past experience. A person makes this attribution unconsciously—the conscious experience of fluent processing is that something feels familiar. Thus, Jacoby and Dallas proposed that use of a fluency heuristic can give rise to the feeling of familiarity.

As support for the role of perceptual fluency in familiarity, Jacoby and Dallas (1981) had participants study a list of words followed by visual perceptual identification and recognition decisions. Relative perceptual fluency was assessed as the probability of successfully identifying words when they were presented briefly and followed by a patterned mask. Studying words on the list in the first phase increased the probability of perceptual identification in the later test phase, as revealed by the

fact that items that had been read recently were more likely to be identified at test than new words. Consistent with the use of relative fluency as a heuristic basis for recognition judgments, ease of identification was correlated with the probability that an item was called "old." Subsequent work provided evidence that ease of processing mediates recognition judgments under some conditions. Johnston and colleagues, for example (Johnston, Dark, & Jacoby, 1985; Johnston, Hawley, & Elliot, 1991) found that items that were identified most rapidly on a recognition test were also most likely to be judged "old."

More direct tests of the fluency heuristic have manipulated processing fluency at the time of test and measured whether recognition judgments varied accordingly. For example, Jacoby and Whitehouse (1989) used a masked priming paradigm in order to manipulate fluency of processing. Presentation of a target was immediately preceded by a very brief flash of either the actual target (referred to as a *match* trial) or an unrelated word (referred to as a *mismatch* trial). The logic was that even though participants were unaware of the masked prime presentation, matching trials should enhance fluency of perceptual processing of the target relative to instances where the mask was unrelated to the target (i.e., on mismatch trials). Jacoby and Whitehouse's data supported this idea. Participants were 9% more likely to falsely call a new target "old" on match trials than on mismatch trials. The effect seems to hinge on participants' attributions about the source of their own fluent processing. A second condition employed by Jacoby and Whitehouse makes this point clear. In that condition, the duration of the flashed prime was increased so as to allow participants to be explicitly aware of its presentation. When this change was instituted, participants were actually more likely to falsely call a new item old on *mismatch* trials than on *match* trials. Thus, when sources of fluency are noticed and appreciated by the rememberer, enhancements in perceptual processing may be attributed to features of the test conditions and so not give rise to a feeling of familiarity. However, when the source of the enhancement in fluency is less transparent, there is a tendency to attribute fluent processing to the study episode. Later work has replicated this general pattern of data (e.g., Bernstein & Welch, 1991; Gellatly, Banton, & Woods, 1995; Joordens & Merikle, 1992; Westernman, 2001) and the basic findings have proven to be quite robust.

Other research has shown that illusory familiarity may be induced by manipulating the perceptual clarity of a target (Goldinger, Kleider, & Shelley, 1999; Whittlesea, 1993; Whittlesea, Jacoby, & Girard, 1990). For example, Whittlesea et al. (1990) had participants study a list of seven words presented for a very brief duration (67 ms for each item) followed immediately by a target word. Participants were instructed to first identify the target item and then make a recognition decision; clarity of the target was varied by presenting it in conjunction with either a light or a heavy visual mask. Results showed that both old and new items were more likely to be called "old" when targets were perceptually clear (i.e., when masking was light). Goldinger et al. (Experiment 3b) have demonstrated a similar

illusion of familiarity using the same general procedure. Participants were briefly presented with a series of words, read by one of two different voices, followed by a recognition test for a target. In this case, auditory clarity of the target at test was manipulated by presenting it in the context of soft or loud background noise. Again, participants favored the perceptually clear presentation, being 11% more likely to call an item "old" when it was presented in soft noise than in loud noise. Interestingly, reversals of this illusion, whereby the effect of prior study on later perception is misattributed to perceptual clarity, have also been demonstrated. We will discuss such misattributions in a later section of the chapter.

Whittlesea and his colleagues have produced a number of demonstrations of illusory familiarity in support of his SCAPPE framework of memory (Whittlesea, 1997). One key aspect of Whittlesea's account of familiarity and misattributions is his emphasis on the fact that people use *relative* rather than absolute fluency; that is, it is not fluency *per se* that gives rise to the feeling of familiarity but surprisingly fluent processing arising from the discrepancy between the quality of processing and the norm one might expect for that particular item. The emphasis on relative rather than absolute fluency of processing was also noted by Jacoby and Dallas (1981). They did so to account for the fact that absolute fluency of processing is higher for high frequency words than low frequency words, but past experience actually increases the fluency of perceiving low frequency words more than high frequency words. Thus, absolute perceptual fluency would not be a good indicator of whether an item had been studied or not, as it is too dependent on preexperimental characteristics of the item.

In support of the notion that it is surprisingly fluent processing rather than absolute fluent processing that is one basis for familiarity, Whittlesea and Williams (1998) had participants study items that varied in meaning and orthographic regularity. Specifically, participants studied words (e.g., DAISY, TABLE), orthographically regular nonwords (e.g., HENSON, BARDEN), and orthographically irregular nonwords (e.g., STOWPFUS, LICTPUB). Orthographically regular nonwords were designed to be easily pronounceable and so possessed qualities consistent with words that are normally encountered, with the exception of course that they lacked any meaning. Results demonstrated that participants were most likely to falsely call such items old at test. In particular, participants were 21% more likely to falsely call orthographically regular nonwords old in comparison to regular words and 28% more likely to falsely call orthographically irregular nonwords old than orthographically irregular nonwords. If fluency *per se* were the basis for recognition judgments, the regular words, which were pronounced most quickly, would have garnered the highest probability of "old" responses. However, such fluent processing of words would be unsurprising, as participants would attribute the fluency experienced to the fact that the items were well-known words. In contrast, the orthographically regular nonwords were processed in a surprisingly fluent way given that they were not words. Whittlesea and Williams suggest that the

surprisingly fluent processing of orthographically regular nonwords was attributed (falsely) to the most likely source: the study list.

Overall, there is some support for the notion that relative ease of perceptual processing is used as a basis for memory judgments. Items that are named most rapidly are more likely to be called "old" than less fluently named items (Johnston et al., 1985, 1991), and there is also a great deal of evidence showing that relative ease of perceptual processing brought about by manipulations at test may in fact be misattributed to prior experience (e.g., Jacoby & Whitehouse, 1989; Whittlesea et al., 1990; Whittlesea & Williams, 1998). Thus, ease of processing may constitute an important factor in familiarity. The perspective has not been without its criticisms, however, to which we turn next.

B. CRITICISMS OF THE PERCEPTUAL FLUENCY APPROACH

The notion that the relative fluency with which an item is processed can be attributed to past experience and thus support recognition performance has been criticized by several researchers (e.g., Hintzman & Caulton, 1997; Poldrack & Logan, 1997; Snodgrass, Hirschman, & Fan, 1996; Wagner & Gabrieli, 1998; Wagner, Gabrieli, & Verfaellie, 1997; Watkins & Gibson, 1988). Poldrack and Logan, for example, argued that variability in fluency, as measured by response latencies to target stimuli, is not sufficient to account for the levels of discriminability seen in recognition judgments. Their argument lies primarily in a signal detection analysis (i.e., Green & Swets, 1965) of response latencies and recognition responses. Poldrack and Logan had participants study blocks of words and nonwords. At test, participants were presented with old and new words and nonwords that were first subjected to a lexical decision judgment, which served as the fluency measure, and then to a recognition decision. Conventional measures of discriminability were calculated for recognition judgments (d') along with a corresponding measure of response time discriminability, denoted dRT . The dRT measure is analogous to d' , with the exception that it is quantifying the distance between standardized distributions of reaction times for old and new items rather than standardized distributions of familiarity for old and new items. The basic logic was that if variability in response speed mediates recognition performance, then measures of dRT should approach d' and account for a significant portion of the recognition data. Contrary to this hypothesis, results yielded considerably smaller dRT measures than d' measures for recognition judgments, leading Poldrack and Logan to conclude that "... response speed can support only small portions of observed recognition performance" (p. 8). Ratios of dRT to d' were fairly small and rarely accounted for more than 20% of the variance in recognition performance.

Wagner and Gabrieli (1998) have made a different argument against perceptual fluency as a basis for recognition memory. Specifically, they point to dissociations between perceptual fluency measured via perceptual implicit memory tasks

such as perceptual identification and explicit recognition memory. If a single common process were at the heart of performance on both sorts of tests, one would expect manipulations to have parallel effects on performance. The dissociations are particularly apparent for manipulations of conceptual processing at study, as recognition memory is typically influenced to a far greater degree by conceptual processing than is perceptual priming (e.g., Jacoby & Dallas, 1981). Wagner and Gabrieli further note several other encoding tasks (e.g., picture naming versus word reading, anagram solving versus word reading) that produce dissociable effects on explicit recognition tests and implicit perceptual measures. For example, generating a word from an anagram leads to better recognition memory performance than word reading; word identification priming, however, is greater after reading (Allen & Jacoby, 1990).

In addition to such behavioral dissociations, priming of perceptual processes that often serve as an index of perceptual fluency are anatomically separate from the other processes that dominate recognition judgments in typical studies. Gabrieli, Fleischman, Keane, Reminger, and Morrell (1995) report a patient (M.S.) with a lesion to the right occipital lobe. The patient has preserved visual recognition memory but demonstrates impaired performance on implicit tasks such as word identification. They argue that enhanced perceptual processing due to prior experience may involve modality-specific sensory cortices while recognition memory is largely reliant on medial temporal and diencephalic structures.

C. A BOUNDARY CONDITION FOR THE FLUENCY HEURISTIC

Jacoby and Dallas' (1981) original formulation of the perceptual fluency heuristic presented studies of dissociations between measures of perceptual identification and recognition memory, as well as cases where variables affected the two in a similar way. They suggested that there are multiple bases for recognition judgments, including familiarity versus the retrieval of specific contextual information (cf. Mandler, 1980). The relative mix of familiarity and recollection in recognition memory would determine the relation between measures of fluency and measures of recognition, and whether variables would produce dissociations or associations between the two. They further suggested that using relative perceptual fluency as a basis for recognition would correspond to feelings of guessing or intuiting the status of an item on a recognition test, whereas retrieval of study context would be a more analytic basis for responding (Jacoby & Dallas, p. 334).

This idea is further substantiated by evidence indicating that perceptual fluency is primarily a factor in recognition judgments only when the probability of recollection is quite low or even absent. Johnston et al.'s (1991) first four experiments found no evidence for using fluency as a basis for recognition judgments. In Experiment 5, they used a mock subliminal study procedure in which participants were told that words were being presented very briefly when in reality no

words were presented. At test, participants were required to identify items as they became unmasked and then to make recognition decisions. Recognition data were subdivided into quartiles based on the mean latency of identification allowing for a comparison of the probability that quickly identified items versus more slowly identified items were called old. Results showed that items in the fastest quartile were 27% more likely to be called "old" than items in the slowest quartile. However, when study conditions were changed to produce better encoding of items, the advantage for fast items over slow items was diminished. Thus, presentation of study items in conjunction with a vowel counting task brought about only an 11% advantage for fast items over slow items. As well, simply naming words at study had the effect of eliminating the greater probability of an "old" response for fast items compared to slow items.

Verfaillie and Cernak (1999) have presented data along much the same lines showing that the probability of calling an item "old" on a recognition test did not vary across fluency quartiles when participants had a high level of memory discriminability. However, the probability of calling an item "old" did vary across fluency quartiles when participants were amnesic or when normal participants were tested at low levels of memory discriminability. In addition, several other studies that did reveal an effect of perceptual fluency by manipulating the perceptual clarity of a target to create memory illusions were done under conditions where participants had little opportunity to elaborate on items at study. For example, the Whittlesea et al. (1990) study described earlier that manipulated test item processing fluency with light versus heavy density visual masks presented study items for only 67 ms each. Thus, relative perceptual fluency appears to be used as a basis for memory in the absence of alternatives such as recollection of details.

Taken together, it would seem that perceptual fluency mediates recognition performance when more diagnostic bases for recognition such as recollection are either absent or diminished. Under more typical recognition memory conditions that permit elaborative processing at study, variables that affect perceptual fluency do not have corresponding effects on recognition judgments and conversely, conceptual manipulations which affect recognition do not affect performance on perceptual identification measures. This evidence would appear to restrict the utility of perceptual fluency as a causal factor in recognition memory to cases where people feel they are guessing or intuiting their responses, as Jacoby and Dallas (1981) initially suggested.

However, perceptual fluency represents only one form of processing fluency and only one possible piece of evidence that one is remembering. Transfer effects from one experience to the repetition of that experience can occur for a wide range of different tasks and judgments, or for different components of processing. We will address the issue of whether variations in the ease of more conceptually based processing can also be a source of familiarity.

II. Beyond Perceptual Fluency: Bases for the Experience of Remembering

A. LEVELS OF TRANSFER

According to an attributional approach, any cue in current experience that is diagnostic of a past experience has the potential to serve as the basis for the experience of remembering. This is essentially a Brunswikian approach (1956) to memory judgments, where the problem for the rememberer is to identify cues in ongoing experience that signal that one has experienced the same task and stimulus before. Jacoby et al. (1989a) took such an approach to the subjective experience of memory and speculated that any transfer effect from one experience to the other could be a cue that one had experienced such an event in the past. However, to be diagnostic, the transfer would have to be quite specific. In this section we will discuss a range of cues in current experience that could contribute to the subjective experience of remembering.

The set of potential cues that one is remembering is undoubtedly much broader than perceptual fluency as assessed by naming latency or lexical decision. For example, ease of cognitive operations such as deriving the meaning of events, ranging from computing the meaning of individual words to constructing a situation model of a text, could serve as a basis for judging words or texts as familiar. In addition, when the memory task is cued recall or free recall, an additional component of experience comes into play, as the rememberer can now experience the ease of generating any thoughts about a prior event. The mere fact of "retrieval," or generating candidate responses to a memory cue, and the ease of retrieving such candidate responses, which we will call *retrieval fluency*, could also serve as a cue that one is remembering rather than imagining. When thoughts are generated, the vividness of perceptual qualities in the image or the amount of detail generated should be good indicators that one is remembering.

An important precondition for whether other forms of fluent processing can serve as a cue to remembering is whether the transfer effects from past experience to later experience are both specific and salient. Recent research on transfer from a past experience to a new experience (that is, the priming effect on old compared to new items) has demonstrated effects that are highly specific to the particular task. Franks, Bilibrey, Lien, and McNamara (2000) had participants perform one task on a set of words in an acquisition phase, followed by a test phase where they performed either the same task or a different task, for old versus new words. The tasks included judgments of animacy, bigness, likeability, hardness, vowel count, lexical decision, and whether a word had a letter "e" in it. In 13 experiments, they found that same-task priming was substantially greater than cross-task priming. In many comparisons, *no* cross-task priming occurred, including between judgments of animacy and lexical decision and between judgments of animacy and bigness.

The specific priming effects found by Franks et al. (2000) were substantial, both in terms of the absolute size of the repetition priming effect in milliseconds and in terms of the effect size, particularly for tasks that went beyond perceptual processing. The effect sizes for repetition priming in liking, hardness, bigness, and animacy decisions ranged from .99 to 2.45. Their results also showed that lexical decision reaction times can miss important increases in processing fluency, particularly when complex processes performed at study are repeated at test. For example, the size of repetition priming for animacy judgments ranged from 69 to 129 msec across experiments, with effect sizes ranging from .99 to 2.04. In contrast, in two experiments where animacy decisions were followed by lexical decision, the repetition priming effect averaged just 10 msec in one experiment and 37 msec in a second experiment, with effect sizes of .34 and .69, respectively. Thus, lexical decision as an overall measure of memory-based processing fluency was insensitive to large variations in the fluency of other processes. The question for our purposes is whether the specific transfer of processing effects could trigger feelings of familiarity.

The relative ease of processing in any sort of task is a function of the joint constraints created by the cue and the task, in conjunction with people's skill on the task in general and specific past history with the cue-task combination. This creates a methodological problem when attempting to evaluate whether people use information about variations in their processing as an indication that they had engaged in that particular task with that particular cue before. When a person's goal is to remember, he or she will represent the task in a different way and often attempt to recreate the context of the prior episode or attempt to recreate the specific activity initially performed. So, for example, when we have the feeling that we have already seen the movie we are watching, we may try out various contexts ("Did I watch this in a theater? Was it something I rented?") which in turn may lead to a more specific level of transfer and a stronger feeling of familiarity (Kelley & Jacoby, 1998). Because of the specificity of transfer, it would be ideal to measure fluency in the context of a recall or recognition task, rather than in a separate task such as perceptual identification or lexical decision. However, the spontaneous feeling of familiarity that arises without intentions to remember (e.g., "I think I've seen this movie before") could stem from a feeling that successive aspects of an event are too easy to predict.

Franks et al. (2000) did find some level of cross-task priming, although the effect sizes were much smaller than for repetition priming. They speculated that when cross-task priming did occur, it was because the initial task automatically elicited a certain judgment or process, such as automatically imagining a reference object in order to make bigness judgments, that was then intentionally required by the transfer task. Vriezen, Moscovitch, and Bellos (1995) also found great specificity of priming with very low levels of cross-task priming. They suggested that priming between tasks depends upon the overlap in component processes, such that priming

occurs across classification tasks that refer to the same semantic domain but not across domains. For example, judgments of overall size and judgments of relative dimensions ("Is it taller than it is wide?") both tap structural information, and substantial cross-task priming occurs. In contrast, judgments of whether items are man-made tap functional information and no cross-task priming occurs between a judgment of man-made and a judgment of size. An interesting question from an attribution perspective is whether people can engage in recognition activities that give them access to specific fluency due to prior processing, and whether that fluency can then serve as the basis for familiarity.

B. ATTRIBUTIONS OF CONCEPTUAL FLUENCY

These examples of very specific and substantial transfer effects on tasks that require more than perceptual processing suggest the plausibility of relative fluency of various forms of processing as a basis for memory judgments. The data so far indicate that people do seem to attribute ease of conceptual processing, what can be termed *conceptual fluency*, to prior experience. Whittlesea and colleagues have demonstrated how fluency produced by a manipulation of conceptual rather than perceptual processing of a target may produce familiarity. For example, Whittlesea (1993, Experiment 5) presented participants with target words for a recognition test at the end of sentences that were either predictive (e.g., "The stormy seas tossed the... BOAT") or neutral (e.g., "The evening gown was missing a... BEAD"). When sentences were predictive of the target, participants were more likely to call a target item "old." This pattern was true even for new targets, as false alarms were 18% more likely in predictive contexts than in neutral contexts. Moreover, target latencies were considerably faster for predictive contexts, indicating that these items were processed with greater fluency than items in neutral contexts.

In follow-up work, Whittlesea and Williams (2001b) found that a short pause between presentation of the sentence stem and presentation of the recognition test item was critical for the creation of false alarms via predictive contexts. When the pause was eliminated, the level of false alarms for targets following a predictive sentence stem were no higher than for targets following a merely consistent stem. Whittlesea and Williams suggest that the pause allows participants to experience uncertainty about what comes next, even for the predictive contexts. For example, the stem "The stormy seas tossed the..." could be completed with a variety of words, such as BOAT, SHIP, YACHT, or even LOG. When the target item is presented, participants may feel that it completes the stem surprisingly well. Rather than attributing the goodness of fit to the predictability of the stem, they attribute it to the item having been studied previously, and so judge it old. In contrast, if the stem perfectly predicts the target (e.g., "Row, row, row your... BOAT"), the goodness of fit of the target is entirely attributed to the predictability of the stem and so does not increase the likelihood of false alarms.

More evidence for conceptual fluency has been put forth by Rajaram and Geraci (2000). They used a masked prime procedure in which recognition targets (e.g., BOOK) were preceded either by a semantically related prime (e.g., AUTHOR) or by an unrelated prime (e.g., DELAY). If conceptual fluency is used as a basis for memory, one would expect that presentation of a related prime would increase the chance that targets would be called "old." Overall, results showed that both old and new targets were more likely to be judged old when they were semantically related to the preceding prime.

C. RETRIEVAL FLUENCY

In addition to the relative fluency of perceptual or conceptual processing, another cue that may be the basis for memory judgments is *retrieval fluency*, or the ease with which an item, idea, or even contextual details come to mind during recall. Lindsay and Kelley (1996) examined retrieval fluency using a cued-recall paradigm. Participants studied a list of words and were then given word fragments as recall cues at test. Retrieval fluency was subtly manipulated by varying the ease with which fragment cues would lead people to generate the word by omitting one versus two letters from each word to create fragments. If ease of generation is attributed to memory for prior study, it was expected that more easily completed fragments would have the greater chance of being called old. Results were largely supportive of this prediction. Participants were more likely to recall words when cued with fragments missing only one letter compared to two letters, even when fragments could be completed only with new words. As well, the effect of ease of generation persisted even when participants were warned about the nature of the cues (Experiment 3). Thus, the ease with which a word could be generated had a significant effect on whether participants claimed that an item was studied.

Retrieval fluency may also play a role in the false recalls that occur in a paradigm developed by Kato (1985). Participants studied a list of word pairs, some of which were related (e.g., MORNING EVENING) and some of which were unrelated (NURSE DOLLAR). A portion of the unrelated word pairs were constructed such that when the first word and several letters of the second word were presented as cues for recall, a semantically related but incorrect response was highly accessible. So, for example, for the deceptive study item NURSE DOLLAR, the test cue would be NURSE DO...R, and the incorrect response "doctor" would be strongly cued. False recall of the competitive alternative was very high for deceptive items: in fact, it was as high as veridical recall. Kato accounted for this effect by noting that the nature of the cue for deceptive items affords such potent retrieval of the semantically related competitor that other target items are blocked from retrieval. Alternatively, "retrieval" could be so fluent that the competitor is accepted as studied without further search. In our work with such materials, people often

report that they must be remembering the item, because "why else would it come to mind?"

Retrieval fluency was also implicated in Jacoby and Hollingshead's (1990) work on a new generate-recognize model of cued recall. Their major change to earlier generate-recognize models (e.g., Anderson & Bower, 1972; Bahrick, 1970; Kintsch, 1970) was in their conceptualization of the generation process. Instead of the preexisting relations between cue and target being the major determinant of the generation process, they incorporated the idea that the probability of a target coming to mind in response to a cue also reflects specific recent experiences. More importantly for the current discussion, they assumed that when the generation of items is particularly fluent, those items are not subjected to a recognition check but are simply accepted as having been studied. In line with such a use of retrieval fluency, Jacoby and Hollingshead found that the level of intrusion errors was higher in a cued recall condition than in a generate/recognize condition where participants were forced to do a recognition check on each generated item.

Graesser, Woll, Kowalski, and Smith (1980) have demonstrated that false recall of text for scripted activities is strongly correlated with the probability that a given activity is produced during free generation. They also found support for the idea that retrieval after a longer retention interval is increasingly reconstructive rather than reproductive (Bartlett, 1932; Kintsch, 1977). At a short (30 min) delay, there was no relation between a measure of recall that corrected for guessing and the likelihood that a particular item could be produced during free generation. But after a week's delay, recall was strongly correlated with the probability of free generation ($r = .45$). If people assume that easily generated ideas come to mind because they were part of the to-be-recalled event (i.e., if they use a retrieval fluency heuristic for recall), then as memory for the event becomes less of a determinant of what comes to mind at recall, free generation drives remembering.

Along similar lines, Smith, Ward, Tindell, Sifonis, and Wilkenfeld (2000) have also demonstrated a role of retrieval fluency in recall. Participants studied categorized lists which were missing several exemplars. At test, participants would often recall category exemplars which had not been presented. What is particularly interesting is that output dominance, the probability that an item is listed as an instance of a category (i.e., Barsalou, 1985), was strongly predictive of how often nonpresented category members were falsely recalled. In their third experiment, Smith et al. systematically controlled output dominance by withholding low, medium, and high output dominance items for separate sets of items. For example, a high output dominance item withheld from the category BIRDS would be ROBIN. The medium output dominance item SWORD might be withheld from the category WEAPONS, and the low output dominance item RUG might be withheld from the category FURNITURE. Results showed that the higher the output dominance of a category memory, the more likely it was to be recalled, both falsely and correctly. As Smith et al. state in summarizing their overall findings

... results suggest that those items that come to mind most readily also play a major role in accurate recall, and they are often misinterpreted as exemplars that were actually presented (p. 394).

Retrieval fluency may also play a role in the false memories generated by the Deese-Roediger-McDermott paradigm (Deese, 1959; Roediger & McDermott, 1995). In that paradigm, participants are shown lists of items (e.g., *bed, rest, awake, dream, pillow*) each of which is semantically related to an unrepresented theme word referred to as the critical lure (e.g., *sleep*). The typical finding is that participants are highly likely to either recall or recognize the critical lure, oftentimes at levels equivalent to list items (Roediger & McDermott, 1995). Given that critical lures are strong backward associates of items presented at study, it is plausible that ease of the critical lure coming to mind at test might be attributed to study.

Overall, there is evidence that measures intended to tap perceptual fluency and its contribution to the subjective experience of familiarity underestimate the extent to which remembering relies on an attribution. As noted, substantial transfer effects occur when complex judgments such as animacy or liking are reinstated at test (Franks et al., 2000), effects that would likely be missed by traditional measures of perceptual fluency such as lexical decision. Measures of fluency must capture these more complex processes to fully assess the extent to which processing fluency gives rise to familiarity. However, from an attributional perspective, while the specificity of transfer effects from past experience is important for determining whether those transfer effects can be cues to remembering, rememberers must also appreciate the diagnosticity of the cues that are encountered. The next section will take up these memory monitoring issues.

III. Memory Cues and Diagnosticity

Much research in memory treats the process of recollection as distinct from the process or processes that give rise to familiarity (Gardiner, 1988; Jacoby, 1991). From the perspective of an attributional approach to the subjective experience of remembering, the distinction between familiarity and recollection is less important. On the attributional level, both the feeling of familiarity and the experience of recollecting details are due to interpreting cues in current experience as evidence of a past experience. The distinction between familiarity and recollection that is important from an attributional perspective is the relative diagnosticity of the cues that are available and whether people appreciate the diagnosticity of the cues.

To illustrate, it is plausible that familiarity is less diagnostic of memory accuracy than is the recollection of details. There are a variety of sources which can produce familiarity besides a specific prior experience. For example, preexisting knowledge can give rise to a feeling of familiarity that can be mistakenly attributed to a specific

episode. Confabulation of a long train of vivid and detailed thoughts is much rarer, fortunately. People do seem to generally appreciate the greater diagnosticity of being able to generate vivid details rather than just feeling that something is familiar.

In line with the greater diagnosticity associated with generation of details, confidence judgments are generally higher for recognition items that people say they "remember" rather than just "know" (Yonelinas, 1997). More importantly, there is better memory monitoring resolution for "remember" judgments than for "know" judgments. Monitoring resolution is the ability to discriminate between correct and incorrect memories, and is reflected in the Kruskal-Goodman gamma correlation between ratings of confidence and the accuracy of memories (see Koriat & Goldsmith, 1996; Nelson, 1984). Gammas can take on values from -1 to $+1$, with higher positive gammas representing better monitoring resolution. One example of better monitoring resolution for "remember" judgments comes from recent work by Brigham and Meissner (in press) on the own-race bias in face identification. The own-race bias refers to better memory discriminability in face recognition for faces of one's own race compared to faces of other races. Brigham and Meissner found that the own-race bias appears to be driven by a higher probability of own-race faces being recognized and accompanied by "remember" judgments, with no difference in the probability of recognition on the basis of "knowing." Importantly for the issue of the diagnosticity of recollection versus familiarity, they also found that own-race faces supported better memory monitoring than other-race faces; that is, the gamma coefficients relating confidence and accuracy were higher for own-race faces than other-race faces. Being able to generate distinctive details at the time of test (as indicated by the "remember" judgments) led to higher confidence that participants were remembering. Thus, the confidence that one is remembering when one can generate distinctive details is usually not misplaced.

Additional evidence for the diagnosticity of generating vivid and detailed images during recall or recognition comes from work by Robinson, Johnson, and Robertson (2000). They assessed memory for a videotaped mock theft with either cued recall or recognition tests. Robinson et al. contrasted the contribution of processing fluency to confidence and accuracy compared to the contribution of ratings of the vividness and detail present in memories. They found that ratings of vividness and detail were largely responsible for variations in confidence judgments in tests of both recall and recognition, and furthermore, that vividness and detail were highly diagnostic of memory accuracy. This led to very high relations between confidence and accuracy in recall and, to a lesser extent, in recognition.

In the Robinson et al. (2000) study, measures of fluency of test items were far less related to memory confidence and memory accuracy than the ratings of vividness and detail. Fluency was measured both as ratings of the subjective effort of retrieval and as reaction time to read and generate a response to test items, including reading four test options for the recognition test, so measures

of processing fluency may have been somewhat inexact. What may be more important in regard to whether people rely on relative processing fluency during retrieval is the presence of alternatives to fluency that are more diagnostic of a memory such as amount of detail and vividness in the memory. Given that the studied event was a videotaped crime, rich in perceptual details, and that the test occurred shortly after study, people may have been able to base most of their memory responses on what turned out to be highly diagnostic cues: vividness and detail.

The diagnosticity of various bases for memory judgments echoes the pattern of results reviewed earlier examining whether perceptual fluency serves as a basis for recognition memory judgments. When memory judgments can be based only on familiarity, and recollection of details is almost entirely absent, variations in perceptual fluency seemed to be used as a basis for judgments (Johnston et al., 1991; Verfaillie & Cermak, 1999; Whittlesea et al., 1990). However, when information regarded as more diagnostic of memory accuracy is present, people shift to using the more diagnostic information.

One illustration of people's ability to shift to a more diagnostic basis for judgment is Schacter and colleagues' investigations of the distinctiveness heuristic (Israel & Schacter, 1997; Schacter, Israel, & Racine, 1999), whereby people shift to demanding detailed recollection as a basis for judging an item "old" on a recognition test. For example, Israel and Schacter demonstrated that use of a distinctiveness heuristic allowed people to avoid false alarms to critical items that are semantically related to a large set of studied items in the Deese-Roediger-McDermott paradigm. One precondition for the distinctiveness heuristic may be whether people encoded distinctive details, as in the case of studying items as pictures rather than words, so that they can switch from responding on the basis of familiarity to responding on the basis of the retrieval of distinctive details. Similarly, Jennings and Jacoby (1997) found that young adults are able to use recollection to counteract the effects of potential errors on a recognition test due to the familiarity of repeated foils, but that older adults are limited in doing so by a deficit in recollection.

A second precondition to using recollection as an alternative to familiarity may be recognizing the need for it; that is, noticing that aspects of the testing situation have made one basis for memory judgments, such as familiarity, a poor indicator of the past experience in question. For example, Bartlett, Halpern, and Dowling (1995) found that patients with Alzheimer's disease apparently based their recognition memory for tunes on familiarity, which led them to simply judge traditional melodies as having been studied, and novel melodies as new. In contrast, older adults managed to avoid such high numbers of false alarms to traditional tunes, either by using a higher criterion of familiarity or by recollection, but only for tunes that were readily nameable. When it was difficult to name a traditional tune, older adults interpreted the familiarity of that tune as due to the study episode.

IV. Effects of the Past Misattributed

Effects of specific past experiences on later processing can be correctly attributed to the past and give rise to a feeling of remembering. But depending on the situation, the source of the variations in processing may be ambiguous and can be misattributed to variations in the qualities of a stimulus. One of the most important situational determinants of the interpretation people make regarding their current processing is the goal that they hold. When people are not directed to remember, but instead asked to make other judgments about test items, they may misattribute processing fluency that arises from a past experience to aspects of the current situation. In these cases, fluency is misattributed to a particular characteristic of a stimulus (e.g., duration, noise, pleasantness) resulting in biased judgments for previously presented stimuli compared to stimuli that are new.

One example of such a misattribution is Witherspoon and Allan's (1985) experiments on visual duration judgments. They had participants study a list of words prior to making judgments of how long target items were presented on the screen. Half of the items presented for the duration judgment had been previously viewed while the other half had not. Previous study enabled people to identify target items more readily; in turn, this ease of identification was misattributed to longer presentation duration of the old items. Similarly, Whittlesea et al. (1990) found that prior study of words could also lead people to judge later visual presentation of targets as more clear.

A parallel effect of prior presentation on current perceptual processing has also been found for judgments of auditory background noise. For example, Jacoby, Allan, Collins, and Larwill (1988) had participants rate the loudness of background noise either as previously studied or as new sentences were being presented on tape. The noise accompanying old sentences was rated as less loud than the noise accompanying new sentences. This phenomenon is particularly striking given that it does not disappear even when one understands the cause of it. In this way, it is cognitively impenetrable, much like many visual illusions. The noise is experienced as being less loud because old sentences are perceived more fluently than the new sentences, a fluency that is mistakenly misattributed to a lower noise level. The noise misattribution is at least partially due to enhanced perceptual processing that is highly specific. For example, background noise is rated as softer when old words are presented in the same voice as that heard at study, but not when such words are presented in the voice of a different speaker (Goldinger et al., 1999).

The above examples illustrate misattributions of transfer effects from earlier perceptual processing to later perceptual judgments such as visual duration, background noise, and visual clarity. There is also evidence for misattributions of transfer effects from earlier conceptual processing to later conceptual judgments. One such conceptual transfer effect is the fact that reading the answers to general knowledge questions makes those answers more accessible on a later general

knowledge test (Blaxton, 1989). Kelley and Lindsay (1993) reasoned that such changes in accessibility could affect people's confidence in the answers they retrieve in response to general knowledge questions and, further, could even change what they believe to be the answer. They tested people on general knowledge questions, such as "What is the capital of Texas?" after first presenting a study list that contained correct (Austin), incorrect (Dallas), or neutral fillers for each question. Prior study of the correct answer increased the probability that people correctly answered the corresponding question and, as well, increased the speed with which the correct answer was generated. There was also a consistent negative correlation between time to produce the answer and confidence, even though prior presentation of the correct answer speeded access to that answer. This suggests that people use ease of retrieval as a basis for confidence in their answer to general knowledge questions. More interesting, perhaps, is that prior study of incorrect answers (such as Dallas) had the same effect: An increased probability that people answered the corresponding question incorrectly, an increased speed of responding with the incorrect answer, and similarly sized negative correlations between time to retrieve and confidence that the answers were correct.

The change in accessibility of possible correct and incorrect answers to general knowledge questions due to prior reading led people to accept those easily accessed answers as correct. But in another context, ease of retrieval could be interpreted as evidence that the answer had been studied before. Kelley (in preparation) used the same sort of general knowledge questions with corresponding correct and incorrect answers in a cued recall experiment. Participants studied general knowledge questions paired with either correct or incorrect answers that they thought were the responses of a previous participant. Several days later they returned for a cued recall test where they were given the general knowledge question and asked to remember the answer given by the student whose responses they had studied. True recall dropped off as the study-test delay increased but participants had a constant bias to respond with the correct answer when memory failed, even if the incorrect answer had been studied. In this case, easy retrieval of the correct answer was sometimes due to preexisting general knowledge, which was nonetheless attributed to the study presentation. The basis for easily accessing ideas is ambiguous: Easy retrieval could reflect preexisting knowledge or it could reflect a specific prior episode. The task people are attempting to accomplish, in this case answering general knowledge questions versus remembering someone else's answer, can change their interpretation of why an item comes to mind.

We noted earlier that changes in later perceptual processing is only one of many consequences of an experience. Studies of transfer effects on text processing illustrate the different levels on which such transfer can occur. Van Dijk and Kintsch's (1983) model of text comprehension distinguishes between comprehension processes at three levels of analysis: Analysis of surface structure, construction of propositions or the textbase, and construction of a situation model that represents

what the text is attempting to portray. Transfer, as assessed by reading times, has been found at multiple levels, from the level of individual words (Carr, Brown & Charalambous, 1989), to the macrostructure of the text (Levy & Burns, 1990), to the level of overlapping characters and themes (Levy, Campsall, Browne, Cooper, 1995).

Such transfer effects can be misattributed to qualities of the text itself when people use their subjective ease of comprehension as a basis for rating the reading level of various sentences. For example, Kelley (1999) had participants read and paraphrase a set of sentences. Participants returned two days later to read and rate the grade level at which the previously read and new sentences were written. Results showed that old sentences were rated as being written for a lower grade level compared to the new sentences. Although this "illusion of simplicity" could result from enhanced processing at the level of individual words, that contribution might be minimal compared to enhanced processing at the level of constructing the propositions or building a situation model of what the sentence represents. In pilot studies, there was no effect of just reading sentences in the first phase on ratings in the second phase when participants were not instructed to paraphrase. Our interpretation is that participants were doing only minimal processing and, in line with that interpretation, the old/new effect on judgments of grade level of the text emerged when participants were required to paraphrase the sentences in the first phase. Later experiments found a similar effect of prior reading on later judgments of "objective" difficulty of the text by using less difficult sentences and having participants read them in preparation for later questions.

The illusion that a text is written at a simple level can be a strikingly large effect. While preparing the materials for the experiment, I (C.M.K.) had directed my research assistant to come up with really challenging sentences from advanced texts, because I thought they would afford a greater repetition effect. One morning before she arrived at work, I checked by her desk and saw samples of the sentences, which were just the right level of difficulty, except for some at the top of the sheet that were far too simple. I left her a note telling her to drop those and pick more sentences as difficult as the ones at the bottom of the sheet. She came to my office laughing at the note: The sentences were all from similar sources, and the "easy" ones were sentences I had already read over the previous week. This illustrated a second problem with using one's own subjective experience as a basis for judgment for others, in that I was probably picking sentences that were nearly impossible for many of the student participants to understand.

Such an effect of specific past experiences on judgments may be ubiquitous and produce biases that are difficult to appreciate or escape. A similar phenomenon occurs when people are asked to rate the objective difficulty of anagrams. We found that reading words in a first phase increases the probability that people can then solve anagrams of those words in a second phase, and increases the speed with which they solve them (Kelley & Jacoby, 1996). However, people

misinterpret the increased accessibility of the solution words as being a quality of the anagrams themselves, and so rate old anagrams as objectively easier than new anagrams. People use their subjective experience of problem solving difficulty and their subjective experience of comprehension as if it were a direct reading of the objective qualities of a problem or text. That is problematic in a number of domains. For example, teachers have to estimate the difficulty of material for their students, and manual writers and drug companies have to estimate the difficulty of their instructions. In each case, using one's own subjective experience can be a biased basis for judgment for others.

Ease of processing has been implicated in a number of other types of judgments, including pleasantness (Whittlesea, 1993), liking (Mandler, Nakamura, & Van Zandt, 1987; Reber, Winkielman, & Schwarz, 1998), modality (Kelley, Jacoby, & Hollingshead, 1989), and even estimates of fame (Jacoby et al., 1989b). These misattributions are important psychological phenomena in themselves. But the presence of such *misattributions* of the effects of past experience also reinforces the idea that the subjective experience of remembering, like the subjective experience of ease of comprehension, of problem difficulty, or of certainty about general knowledge, arises from an attribution regarding qualities of cognitive and perceptual processing or the contents of ideas that come to mind. These misattributions of effects of the past also partially answer our question about whether past experiences do indeed alter later processing at a variety of levels, and whether those variations in processing are large enough to affect subjective experience and judgments based on subjective experience.

V. The Attribution Process

People's ability to attribute the fluency of their processing to the correct source, either to qualities of the situation or stimulus, or to prior experience determines whether they will be prone to illusory familiarity or other alterations in subjective experience. A prime example of that is the study by Jacoby and Whitehouse (1989) described earlier, where a matching masked prime presented before a recognition test item increased the probability that the item would be called "old," but only when participants were not aware of the presentation of the prime. Thus, the attribution process varies with how the test situation is constructed, as task variations may make irrelevant sources of fluency more or less salient.

A particularly intriguing finding regarding the attribution process comes from work in which Whittlesea and Williams (2001a) varied the orthographic similarity of targets to a preceding prime. Participants studied 60 natural words (e.g., SINGLE, GARDEN, PELICAN) prior to a memory test. At test, target naming fluency was manipulated by first presenting participants with a nonword prime that

either rhymed with the target (e.g., SINGLE-SINGLE) or did not rhyme with the target (e.g., BARDEN-PELICAN). Participants were instructed to say the prime and target aloud, make a decision as to whether the pair rhymed, and then make a recognition decision. Results indicated that the rhyming prime speeded naming of the target item relative to the nonrhyme prime condition, and that participants were 6% more likely to call new targets "old" following a rhyming prime compared to a nonrhyming prime. A second experiment used this same method with one important exception. Half of the targets were missing one letter (e.g., SINGLE and half were left intact (e.g., SINGLE). The test procedure was essentially the same across experiments, with only the additional requirement of having participants solve the target when it appeared as a fragment before naming the target. Nevertheless, a much larger illusion of familiarity arose for targets following rhyming primes when fragmentary and intact forms of the targets were mixed in the test list: Participants were 19% more likely to falsely call a rhyming item "old" than a nonrhyming item. Whittlesea and Williams interpreted these data in light of the task demands created by presenting some items as fragments. When some items were fragmented, participants may have viewed the prime primarily as a tool to aid in solving the fragment. Consequently, any effect of the prime on ease of naming the target became less salient or was "backgrounded," in the terminology of Whittlesea and Williams. The result was that fluently named rhyming items were interpreted as being surprisingly fluent and that fluency was in turn attributed to prior study.

Many of the studies which have manipulated ease of processing to test whether it is a basis for familiarity have used the experimenters' intuitions about whether a manipulation will be patently obvious to the participant, and so discounted, or whether the manipulation will be sufficiently subtle to be misinterpreted as familiarity. But there is very little known about the attribution process *per se*, other than the major role played by the goal held by participants. Some sources of illusory familiarity appear to be cognitively impenetrable (Lindsay & Kelley, 1996), while others disappear when people become aware of the extraneous source of familiarity (Jacoby & Whitehouse, 1989).

Social cognition is rich in studies of how people's judgments are biased by extraneous influences such as mood, priming, and stereotypes, and the mechanisms by which people attempt to counteract such biases (Wegenert, Petty, & Dunn, 1998). Some of the factors that moderate such biases may also be relevant to the case where processing is biased by manipulations that create illusory familiarity. For example, correcting for biases in social cognition domains seems to require more cognitive effort and consequently more motivation than does just allowing the bias to occur. Making people accountable for their judgments by making their responses identifiable rather than anonymous increases the likelihood that they will attempt to correct for a bias (Martin, Seta, & Crella, 1990). Another indication that corrections for bias require cognitive effort is that individual differences in

need for cognition, a measure of how much people enjoy actively thinking and analyzing, are associated with the likelihood of attempting to correct judgments for bias (Martin et al.).

Similarly, monitoring a situation for possible sources of illusory familiarity may require cognitive resources. The false fame studies (Jacoby et al., 1989b) found that when people studied a list of nonfamous names, such as the now famous "Sebastian Weisdorf," and later encountered those studied names in a test of whether names referred to a famous or nonfamous person, they misattributed the familiarity of the studied names to the fact that they were famous. People could work to recollect the details of prior study when all the names on the studied list were not famous and so correctly judge them "nonfamous" on the fame test, but that was an attention-demanding way to escape the false fame effect. Older adults (Dywan & Jacoby, 1990) were less able to recollect and, as a consequence, less able to escape the false fame effect.

When people understand how the structure of their current processing environment can lead to fluent processing or fluent retrieval of ideas, they should be able to improve their memory accuracy by discounting those effects (cf. Jacoby & Whithouse, 1989). In a recent study using the deceptive "nurse-dollar" materials described previously, we (Kelley & Sahakyan, submitted) found that older adults and young adults who study the word pairs under conditions of divided attention were particularly susceptible to responding in cued recall with an easily retrieved but unstudied response such as "doctor." Such responses occurred even when incentives for accuracy were in place. Our participants in those studies varied in the degree to which they were aware that the deceptive word pairs led them to make errors. Some spontaneously said "Oh, you're trying to trick me!" but others simply blithely report the unstudied item. Individual differences in such memory monitoring abilities may have important consequences for memory accuracy.

A further contributor to the attribution process are people's naive theories of what gives rise to false familiarity or easy retrieval of nonmemories. If their naive theories are correct, people might be able to compensate for the influence of erroneous sources of familiarity or retrieval fluency. But, when their naive theories are incorrect, the bias might go unchecked or even be exacerbated by a correction process in the wrong direction.

People's naive theories of retrieval fluency appear to be wrong in at least one domain, that of predicting whether they will be able to answer a just-studied item on a future test. The ease of accessing items from memory is used as a basis for a number of metamnemonic judgments (Benjamin, Bjork, & Schwartz, 1998; Kelley & Lindsay, 1993; Koriat, 1993; Koriat & Levy-Sadot, 2001). For example, Benjamin et al. (1998) had participants answer 20 general knowledge questions, recording latencies for answering each question. After answering each question, participants predicted whether they would be able to freely recall their answer (on

a blank page with no cues) after a 20-min interval. There was actually a negative relationship between predictions of recall and recall 20 min later. Participants used their initial fluency of retrieval to predict future recall and so predicted that answers retrieved most quickly were most likely to be recalled on the final test. In fact, answers initially retrieved most quickly were the least likely to be recalled, as a faster search of semantic memory created a less elaborate episodic memory for having searched for the answer.

VI. Conclusions

Attributional accounts of memory have perhaps been most beneficial in highlighting the fact that memory cannot be solely conceived of as the activation of a latent trace that is then assessed against some criterion. Rather, there is a great deal more complexity to the subjective experience of memory. This point is vividly illustrated by the findings of Whittlesea and Williams (2001a). In that work, targets preceded by rhyming primes were moderately more likely to be called "old" when all targets presented were intact. However, a fairly minor change in targets (i.e., removing one letter from half of the items) was sufficient to triple the chance that new targets were falsely endorsed as having been studied. If memory were simply a process of differentiating between various levels of activation, it would be hard to conceive of how a seemingly innocuous change in target status would produce such a large change in false memories. Thus, memory is not only the product of activation but also a process of interpreting possible cues in current processing.

The attributional perspective extends well beyond attributions specifically concerning memory. The literature on misattributions is replete with examples showing that many aspects of subjective experience are affected by variations in processing that are really due to specific past experiences. For example, prior exposure to stimuli may later lead those stimuli to seem visually clearer (Whittlesea et al., 1990), to be accompanied by lower levels of noise (e.g., Goldinger et al., 1999; Jacoby et al., 1988), or to remain longer in view (Witherspoon & Allan, 1985). Prior exposure may also make stimuli appear to be pleasant or likable (Reber et al., 1998; Whittlesea, 1993), make text seem objectively simple (Kelley, 1999) or anagrams appear objectively easy (Kelley & Jacoby, 1996). These misattributions regarding ease of current processing indicate that people are sensitive to the processing changes that may also underlie familiarity. The different subjective experiences really depend on the attribution people make. In both the line of work where fluency is manipulated to create illusory memories and where enhanced processing due to past experience is misattributed to characteristics of a stimulus, the key is that the nature of our subjective experiences varies with the interpretation we give to qualities of ongoing processing.

A classic example from Perky (1910) is another case where misattributions revealed a fundamental link between phenomena. In Perky's experiment, participants were seated in the center of a room and instructed to imagine an object (e.g., a tomato, an orange) while staring at a fixation point on a wall. They were then asked to report qualities of their imagined object. Unknown to the participants, the wall they were staring at was in fact a large window looking in on a dark room, with an opening through which Perky and his assistants covertly projected colored pictures. Participants shown these pictures while imagining often reported quite vivid, distinct images that they attributed to their own imagination (and were surprised or even indignant when they learned the true nature of the experiment). Based on these findings, Perky concluded that:

... under suitable experimental conditions, a distinctly suprathreshold visual perception may be mistaken for and incorporated into an image of imagination, with the least suspicion on the observer's part that any external stimulus is presented to the eye... It follows that the image of imagination must have much in common with the perception of everyday life (p. 450).

Along similar lines, we would suggest that the experience of remembering must have much in common with the perception of fluent processing.

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REAL-WORLD ESTIMATION: ESTIMATION MODES AND SEEDING EFFECTS

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I. Introduction

More people live in Ethiopia (64 million) than in the United Kingdom (59 million). Located at 34° north latitude, Atlanta, Georgia is just one degree north of Tijuana Mexico. At the moment, Bill Gates is worth about \$64 billion; the GDP of Tunisia (with its population of 9.7 million people) was \$63 billion in 2000. Montreal is about 2900 kilometers from Edmonton, Alberta; the distance between Edmonton and the city of Chihuahua in Mexico is about 2800 kilometers. At \$48,000 a new Honda S2000 cost more than a new BMW Z3 sports car which goes for \$45,000. etc, etc.

To many people, these facts taken separately, or in tandem, are surprising, even counterintuitive. From a cognitive perspective, this is an interesting response because it suggests that people do have intuitions about many different real-world quantities and that these intuitions can be very wrong. At the same time, exposure to numerical facts like these can be highly informative. This latter point has been made a number of times using a method called *seeding the knowledge-base* (Bostrom & Brown, 2001; Brown, 2001; Brown, Friedman, & Lee, 2001; Brown & Siegler, 1993, 1996, 2001; Friedman & Brown, 2000a,b; Friedman, Kerkman, & Brown, in press-b; LaVoie, Bourne & Healy, in press; Murray & Brown, 2001; Walbaum, 1997). In the usual seeding experiment, participants first provide numerical estimates for a set of items; they then learn the actual values of a subset