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Varieties of Recollective Experience

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Abstract

Four variants on Tulving's "Remember/Know" paradigm supported a tripartite classification of recollective experience in recognition memory into Remembering (as in conscious recollection of a past episode), Knowing (similar to retrieval from semantic memory), and Feeling (a priming-based judgment of familiarity). Recognition-by-knowing and recognition-by-feeling are differentiated by level of processing at the time of encoding (Experiments 1–3), shifts in the criterion for item recognition (Experiment 2), response latencies (Experiments 1–3), and changes in the response window (Experiment 3). False recognition is often accompanied by "feeling", but rarely by "knowing"; *d'* is higher for knowing than for feeling (Experiments 1–4). Recognition-by-knowing increases with additional study trials, while recognition-by-feeling falls to zero (Experiment 4). In these ways, recognition-by-knowing is distinguished from recognition-by-feeling in much the same way as, in the traditional Remember/Know paradigm, recognition-by-remembering can be distinguished from recognition-without-remembering. Implications are discussed for dual-process theories of memory, and the search for the neural substrates of memory retrieval.

Keywords

medial-temporal lobe memory system; amnesic syndrome; familiarity; recognition; recollection; remember/know paradigm

> Although we have learned a great deal about memory over the years, it often seems that whenever we discover yet another previously unknown fact about memory, we have succeeded in adding more to what there is to know than to what we do know (Tulving, 1995, p. 839).

One of the landmarks of the "consciousness revolution" in psychology was the emergence of research on the phenomenal experience of remembering the past. These studies began with Tulving (1985), who distinguished between two qualitatively different recollective experiences: *remembering*, or one's concrete awareness of oneself in the past ("autonoetic consciousness", p.1), and *knowing*, one's abstract knowledge of the past ("noetic

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consciousness", p.1). Since that time, what has come to be known as the *Remember/Know* (R/K) *paradigm* has become very popular in cognitive psychology (Migo, Mayes, & Montaldi, 2012; Reder et al., 2000; Yonelinas, 2002; Yonelinas, Aly, Wang, & Koen, 2010) – and more recently in the psychology of emotion (Gorlin et al., 2018).

The R/K paradigm was further developed by Gardiner (Gardiner, 1988, Exp. 1), who asked subjects to study a list of words under phonemic or semantic orienting tasks, and then to complete a yes/no recognition test. Whenever the subjects endorsed an item as old, they were asked to indicate the nature of their recollective experience. If recognition of a particular item was accompanied by conscious recollection of its occurrence on the study list, they were to rate the item as "remembered"; if not, they were to rate it as "known". About 25% of recognized targets were assigned to the Know category, meaning that they were correctly recognized in the absence of recollective experience. More to the point, the experiment yielded a dissociation between level of processing and recollective experience: Remember judgments were affected by the level of processing at the time of encoding, but Know judgments were not.

Although Gardiner's development of the R-K paradigm was inspired by Tulving's 1985 paper, his conception and Tulving's seem to be somewhat different. For Tulving, the R-K distinction maps onto his earlier distinction between episodic and semantic memory (Tulving, 1972). Remembering reflects the person's awareness that an event "is a veridical part of his own past existence" (1985, p. 3), while knowing reflects the person's "symbolic knowledge of the world" (1985, p. 3). But for Gardiner, the R-K distinction maps more closely onto Mandler's (1980) distinction between retrieval and familiarity. Recognition-by-retrieval, now commonly known as "recollection", involves remembering an event as an event, including the personal and spatiotemporal context in which the event occurred, and the role of the self as the agent or patient, stimulus or experiencer of the event (Brown & Fish, 1983; Fillmore, 1971; Kihlstrom, 1997, 2009; Kihlstrom, Beer, & Klein, 2002; Kihlstrom & Klein, 1994; Rissman & Majid, 2019). By contrast, recognition-by-familiarity involves an intuitive feeling that some event occurred in the past, in the absence of conscious recollection of that event (Kihlstrom, Shames, & Dorfman, 1996). For Gardiner and others (e.g., Wixted, 2009; Wixted & Mickes, 2010), Remember judgments reflect recognition-by-retrieval, while Know judgments reflect recognition-by-familiarity.

Similarly, Yonelinas (2002; Yonelinas et al., 2010) has mapped recollection (remembering) and knowing (interpreted as familiarity) onto Jacoby's (1991) process-dissociation framework for analyzing memory and other aspects of performance: recollection reflects controlled processing, while familiarity is a product of automatic processing. Recognition-by-recollection is conceived as an all-or-none "threshold" process: either subjects remember studying the target item or they don't. Recognition-by-familiarity is conceived as a continuous "signal-detection" process, depending on the strength of studied items.

An alternative framework is provided by Schacter's (1987) distinction between explicit and implicit memory – another landmark in the consciousness revolution (Kihlstrom, 1987, 2012). Explicit memory involves the conscious recollection of an experience from the past, as in recall or recognition, while implicit memory refers to any memory-based change in experience, thought, or action that occurs independent of, and in the classic case in the absence of, conscious recollection. Priming and saving in relearning are good examples of the latter. From this point of view, remembering reflects explicit memory, while knowing, interpreted as familiarity, reflects something closer to implicit memory. These alternative interpretations of remembering and knowing are connected, from Mandler's point of view, because both priming and recognition by familiarity are based on the activation by an event of previously stored knowledge, while recollection involves a further process of elaboration. Schacter does not endorse this activation view of implicit memory (Schacter & Badgaiyan, 2001), but that is another matter.

These divergent perspectives on remembering and knowing suggest that it may be misleading to conflate knowing with intuiting, and semantic memory with implicit memory. In fact, there may be at least three varieties of recollective experience -- or, as it were, three different memory *qualia*. *Remembering* involves the conscious recollection of some past event, as an explicit expression of episodic memory. *Knowing* refers to abstract knowledge of that event, much like an item in semantic memory. *Feeling* is the intuition that an event occurred in the past, as an implicit expression of episodic memory.

These different memory qualia are familiar to anyone who has ever taken a multiple-choice test. Sometimes, we choose a response because we *remember* the circumstances under which we learned it -- the particular lecture, or, as sometimes happens, the location on the textbook page where the information appeared (Johnson & Raye, 1981; Rothkopf, 1971). On other occasions, we choose a response because we just *know* the answer – it is part of our generalized, abstract knowledge about the world, and we do not (and need not) remember the circumstances under which we learned the answer – an experience analogous to source amnesia (Evans, 1979; Evans & Thorne, 1966; Schacter, Harbluk, & McClachlan, 1984). On still other occasions, we choose a response because we *intuit* that it is the correct one. We do not actually know the answer, and we certainly do not remember where we learned it, but we choose a response because it strikes us as familiar, and we infer from this feeling of familiarity that, of all the choices available, this is the one that is most likely to be correct (Jacoby, 1991). We are guessing, in a way that we are not guessing when we are remembering or knowing (Gardiner & Java, 1990), but it is not random guessing of the sort that signal-detection theory takes into account. Rather, our guesses are informed by the feeling of familiarity.

The interpretation of "knowing" as retrieval from semantic memory receives some support from neuropsychological research. In the case of patient K.C., for example, who became densely amnesic following a closed head injury was unable to remember even a single event from his entire life (Tulving, 1989; Tulving, Schacter, McLachlan, & Moscovitch, 1988). Nevertheless, he retained considerable "impersonal" autobiographical knowledge – for example, that he spent weekends and summers at a family cottage. Similarly, patient D.B. suffered a severe retrograde and anterograde amnesia following anoxic encephalopathy secondary to a heart attack (Klein, Loftus, & Kihlstrom, 2002; Klein, Rozendal, & Cosmides, 2002). Nevertheless, he was able to answer questions about the recent past that did not involve his own personal experiences.

A wide variety of studies support a distinction between episodic and semantic autobiographical memory -- what Klein et al. (2002, p. 357) called the "lived past" and the "known past". For example, normal aging reduces the amount of episodic detail associated with remote autobiographical memory, but has no comparable effect on semantic detail (Devitt, Addis, & Schacter, 2017; Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002). For example, aging subjects may not remember a specific incident from first grade, but still remember the name of their first-grade teacher (e.g., Piolino, Desgranges, Benali, & Eustache, 2002). Similar differences have been observed in children (Kalenzaga et al., 2015; Willoughby, Desrocher, Levine, & Rovet, 2012); patients with amnestic mild cognitive impairment (e.g., Murphy, Troyer, Levine, & Moscovitch, 2008), Korskoff syndrome (Rensen et al., 2017), and depression (Söderlund et al., 2014); probands at risk for Alzheimer's disease (Grilli, Wank, Bercel, & Ryan, 2018); and healthy individuals with severely deficient autobiographical memory (Palombo, Alain, Soderlund, Khuu, & Levine, 2015).

The apparent dissociation between the "lived past" and the "known past" seems similar to Tulving's original distinction between *remembering*, construed as retrieval from episodic memory, and *knowing*, construed as retrieval from semantic memory (see also Klein & Steindam, 2016). *Knowing* the personal past somewhat resembles source amnesia, in that people have knowledge of events occurring in their personal lives, without conscious recollection of the experience by which they acquired that knowledge. Malvina Dean, who died in 2009, was the last living survivor of the Titanic disaster, and this fact was an important part of her identity; but given that she was only two months old at the time, she had no conscious recollection of the event.

Similarly, intuitive *feelings* about the personal past resemble the *feeling of knowing* (Hart, 1965), which can occur in episodic as well as semantic memory (Schacter, 1983). The role of such intuitions in episodic memory is illustrated by a study of retrograde amnesia induced by electroconvulsive therapy (ECT; Dorfman, Kihlstrom, Cork, & Misiaszek, 1995). In this experiment, depressed patients studied a wordlist immediately prior to receiving ECT. Afterwards, they showed a dense amnesia when tested with stem-cued recall, but normal levels of stem priming. On half the items of a subsequent recognition test, the patients were instructed to adopt a strict criterion for recognition, saying "yes" only if they were "fairly sure" that they had studied the item previously; for the remaining half, they were instructed to adopt a looser criterion, responding "yes" if they only "thought" that they might have seen the word, or if it seemed familiar to them "at all". Compared to controls, the patients showed a profound recognition deficit under the strict criterion; but their performance improved significantly under the loose criterion, with no increase in false positives, resulting in a significant increase in *d'*. The patients were not merely guessing under the looser criterion, but rather were strategically using the feeling of familiarity that accompanies priming to improve their recognition performance (for similar observations in sensory signal-detection, see Tataryn & Kihlstrom, 2017).

These intuitive feelings of familiarity lie at the core of most interpretations of the R/K distinction (Migo, Mayes, & Montaldi, 2012; Williams & Lindsay, 2019). For example, Yonelinas (2001, 2002; Yonelinas et al., 2010) has marshalled considerable evidence for a dual-process signal-detection (DPSD) model of recognition memory in which recollection (an alternate label for remembering) is conceived as a "threshold" process in which subjects recall specific information about an event, and familiarity is a "signal-detection" process based only on memory strength. The model successfully accounts for findings from a variety of R/K experiments as well as experiments involving confidence ratings and Jacoby's process-dissociation procedure. Familiarity appears to enable amnesic patients to perform reasonably well on recognition tests of episodic memory (e.g., Hirst et al., 1986), suggesting that the hippocampus plays a critical role in recollection, but not in familiarity; similarly, it may be that the perirhinal cortex is critical for familiarity, but not for recollection (Bowles et al., 2007).

Still, the feeling of knowing is not the same as knowing, and both are different from remembering a past event in its full spatiotemporal and personal context. Employing a tripartite distinction among remembering, "just knowing", and familiarity similar to the one at issue in the present research, Conway and his colleagues documented an "R-to-K shift" in the acquisition of semantic knowledge concerning psychological facts (Conway, Gardiner, Perfect, Anderson, & Cohen, 1997) or the meaning of obscure words (Dewhurst, Conway, & Brandt, 2009). On an initial test, the subjects' dominant response was "remembering" the circumstances under which a fact was learned; on a later test, the dominant response shifted to "just knowing" that a statement was true.

This paper reports a series of extensions of Gardiner's (1988, Exp. 1) reference experiment, attempting to distinguish among remembering, knowing, and feeling in episodic memory. The research addressed three major questions: (1) Can the recollective experiences of knowing and feeling could be dissociated from each other, and from remembering, in that they respond differently to various experimental manipulations? (2) Do the response latencies for recognition differ among the different recollective experiences? (3) Do remembering, knowing, and feeling differ in accuracy?.

Experiment 1

The first experiment was a conceptual replication of Gardiner's (1988) Experiment 1, examining the effect of depth of processing on recollective experience, with instructions to the subjects altered to clearly distinguish between "knowing" and "feeling", as alternatives to "remembering". The results of this experiment are presented in full. The analysis of later experiments has been abbreviated in the interests of space (and readability).

Method

Subjects

A total of 26 Yale University undergraduates, all native speakers of English, volunteered to participate in an experiment on "Language and Memory", in return for cash payment for each of two sessions lasting less than one hour each. In this and all of the other experiments reported in this paper, sample size was determined by the historical conventions of experimental cognitive psychology (as described by Rouder & Haff, 2019), with an average of 33 subjects in each study, employing powerful within-subject designs. All experiments were approved by the appropriate Institutional Review Board, and all subjects gave informed consent prior to their paid participation.

Materials

All of the experiments reported in this paper employed a set of 160 nouns of medium to high frequency (20–50/million according to Kucera & Francis, 1967) developed by Rajaram (1993). Another list of 24 words, nonoverlapping with the stimulus set, was randomly drawn from a newspaper to serve as a practice trial for the recognition test.

Procedure

The same basic procedure was followed in most of the experiments reported in this paper. The subjects studied a list of 80 words under conditions of a levels of processing manipulation: for 40 items in the phonemic condition, they generated rhymes; for 40 items in the semantic condition they generated free associates. For each item on the study list, subjects were presented with a fixation point for 400 msec, followed by a prompt indicating the subject’s task (phonemic or semantic) for 1.0 sec, and finally the target word for 2.5 seconds; after a blank interval of 500 msec, the next cycle was begun. After a 24-hour retention interval, the subjects returned to the laboratory to perform a yes/no recognition test, distinguishing between 80 targets and 80 lures. Test items remained on the screen until the subject responded. Both the study and test phases of the experiment were controlled by computer software, which also recorded subjects’ response latencies during the recognition test.

For each item recognized, the subjects also reported their accompanying recollective experience in terms of remembering, knowing, or feeling, using the following instructions, adapted from Gardiner (1988) and Rajaram (1993).

> On a computer screen you will see a number of words presented one at a time. For each word, please indicate, by pressing the appropriate key, whether or not you recognize that word from the study list which was presented earlier. If you *do not* recognize the word, press “N”. If you *do* recognize the word, indicate the basis for your judgment of familiarity -- that is, whether you actually remember the word from the study list or whether there is some other basis for your recognition judgment.
>
> *Remember judgments*. If your recognition of the word is accompanied by a conscious recollection of its prior occurrence in the study list, then press the key marked “R” (for “Remember”). “Remember” means that you are consciously aware again of some aspect or aspects of what happened or what was experienced at the time the word was presented -- for example, aspects of the physical appearance of the word on the computer screen, or of something that happened in the room, such as the buzzing of a fly in the background, or of what you were thinking and doing at the time. In other words, a “remembered” word should bring back to mind a particular association, image, or something more personal from the time of study, or something about its appearance or position -- for example, what came before or after that word.

If you cannot consciously recollect anything about the actual occurrence or what happened or what was experienced at the time of its occurrence, you should not respond with an “R” (for “Remember”), but should make one of two other possible responses.

Know judgments. In this case you might simply know, for example, that the word was on the list, in the same way that you know your own name, or birthday, or that Bill Clinton is President of the United States [*Note:* These experiments were conducted in the mid-to-late 1990s]. You don’t remember anything about the experience of acquiring this knowledge, you just know that it’s true. In the same way, you might know that a word was presented for study, even though you don’t remember anything about what you experienced at the time that the word was presented. If this is the case, you should press the key marked “K” (for “Know”).

Feel judgments. Alternatively, you might have a feeling or intuition that the word was on the list without actually remembering its appearance as such. This experience is the kind of experience that occurs when you’re at a party, and you see someone across the room who strikes you as familiar. You don’t know who the person is, and you don’t actually remember ever having met him or her before, but your feeling is such that if you had to guess, you’d guess that you had met that person before, or that you’d recognize his or her name. If this is the case, you should press they key marked “F” (for “Feel”).

To give you a better idea of the three distinctions that we have mentioned, consider how you might respond on a multiple-choice test in school. Sometimes, you just *know* the answer; other times, you actually *remember* having learned the material, such as where it appears on a page in your textbook; sometimes an answer just rings a bell, so you *feel* that it must be the right choice.

Results

The main data analyses paralleled those of Tulving (1985) and Gardiner (1988), focusing on recognition hits and ignoring false alarms (Table 1). A one-way repeated-measures ANOVA showed the expected levels of processing (LoP) effect on overall recognition (combining R, K, and F reports): the subjects recognized 75% of the items from the phonemic condition, and 82% of the items from the semantic condition ($F(1, 25) = 5.54$, $MSE = 0.06$, $p = .027$, $\eta_p^2 = .18$).

Dichotomous Classification of Recollective Experience: Remembered vs. “Not-Remembered” Items

In the traditional R/K paradigm, as applied by Tulving, Gardiner, and others, “Know” is a residual (default or wastebasket) category: if a subject recognizes an item and also consciously remembers its occurrence, the item is classified as “remembered”; otherwise it is classified as “known” (for a survey of variants on the traditional R/K paradigm and their effects on performance, see Williams & Lindsay, 2019). In this usage, *recognition-by-knowing* might better be termed *recognition-without-remembering*. Because “Knowing” receives a more restrictive definition in these experiments, the Know and Feel categories were first combined to yield a residual category of "Not Remembered" (NR) items, which would have received "Know" ratings according to the criterion established by Tulving and Gardiner, in contrast with the Remember category. Following Gardiner (1988, Note 1), recollective experience was treated as an independent variable.

A 2×2 repeated-measures ANOVA with two independent variables (level of processing: phonemic or semantic; recollective experience: R or NR) duplicated the significant main effect of level of processing noted earlier; in addition, there was a significant main effect of recollective experience: fewer recognized items were associated with R than with NR reports ($F(1, 25) = 8.94$, $MSE = 0.51$, $p = .006$, $\eta_p^2 = .26$). Most important, there was an interaction between level of processing and recollective experience similar to that observed by Gardiner (1988) and many others ($F(1, 25) = 6.78$, $MSE = 0.13$, $p = .015$, $\eta_p^2 = 0.21$). Compared to phonemic processing, semantic processing increased R ratings ($t(25) = 3.84$, $p = .001$, Cohen's $d = .75$), but had no effect on NR ratings ($t(25) = 1.10$, ns.

Of course, as Rajaram (1993) has noted, this interaction is not quite legitimate: because R and NR exhaust the components of recognition, the two ratings are not stochastically independent, and any variable which affects one component must affect the other component in the opposite direction. One solution, proposed by Rajaram, is to calculate the ratio of R reports to all recognition hits. This also yielded a significant levels of processing effect ($F(1, 25) = 11.24$, $MSE = 0.12$, $p = .003$, $\eta_p^2 = .31$).

Trichotomous Classification of Recollective Experience: Distinguishing among Remembering, Knowing, and Feeling

When overall recognition was decomposed into all three experiential components, fewer than half of recognized items were rated as R, with the remaining NR items split evenly between K and F. As was the case with R reports, there were more K reports associated with semantic than with phonemic processing; but the effect reversed with F reports. A 2×3 repeated-measures ANOVA with two independent variables (level of processing, phonemic or semantic; recollective experience, R, K, or F) yielded the significant main effect of level of processing noted earlier, as well as a significant main effect of recollective experience: with the trichotomous classification, the subjects' recollective experiences favored R reports, as opposed to K and F ($F(2, 50) = 3.59$, $MSE = 0.14$, $p = .025$, $\eta_p^2 = .13$). Finally, there was a significant two-way interaction: R reports were increased by semantic processing, while F reports decreased; K reports did not differentiate between the two conditions ($F(2,50) = 7.13$, $MSE = 0.10$, $p = .002$, $\eta_p^2 = .22$).

In principle, the trichotomous classification of recollective experience is vulnerable to the same problem as the conventional dichotomous classification: R, K, and F reports are not strictly independent. But this is not really the case. Neither K nor and F are residual categories, left over after R ratings have been made. Each of the categories has substantive meaning. For example, "knowing" in these experiments is not just the absence of remembering, but rather refers to abstract knowledge of list membership. Nor is "feeling" simply what is left over after items have been classified as remembered or known; rather, it refers to an intuitive "gut feeling" that suggests that an item had been encountered earlier

(Fiacconi, Peter, Owais, & Köhler, 2016; Paller, Voss, & Westerberg, 2009; Voss, Lucas, & Paller, 2012); in the absence of such a feeling, an item should not receive an F rating.

Nevertheless, in order to take account of the problem identified by Rajaram (1993), the proportion of items receiving R, K, or F ratings was calculated with respect to all studied items, rather than to the proportion of items recognized, thus loosening the constraints on each rating to some degree. Furthermore, the overall 2×3 ANOVA was decomposed into three 2×2 ANOVAs involving the three pairwise comparisons of R, K, and F. Because only two recollective experiences were considered in each analysis, excluding the third, the two elements of each pair can be considered to be *relatively* independent of each other. As Table 1 shows, R reports increased by 37% from phonemic to semantic encoding; but K reports also increased (by 14%), while F reports decreased by 26%. In no pairwise comparison is an increase in one variable necessarily offset by a comparable decrease in the other. More to the point, K and F may show the same pattern of response to level of processing and other independent variables, compared to R -- in which case we would conclude that K and F ratings are similar after all. In these experiments, the general hypothesis being tested is that there will be significant main effects and interactions involving K and F, supporting the idea that they are, indeed, different recollective experiences.

Considering only R vs. K, the main effect of level of processing was significant: as expected, recognition was higher for items receiving semantic processing ($F(1, 25) = 22.17$, $MSE = 0.12$, $p < .001$, $\eta_p^2 = .47$). The main effect of recollective experience was also significant: more items were rated as R than K ($F(1, 25) = 4.53$, $MSE = 0.20$, $p = .043$, $\eta_p^2 = .15$). The critical two-way interaction was not statistically significant, indicating that R and K reports responded similarly to changes in level of processing ($F(1, 25) = 1.90$).

Considering only R and F, there was no overall level of processing effect: the gains made by R items under semantic processing were cancelled out by the decline of F items ($F < 1$). There was a significant effect of recollective experience, such that more items received K than F ratings ($F(1, 25) = 4.80$, $MSE = 0.23$, $p = .038$, $\eta_p^2 = .16$). The critical two-way interaction was highly significant: R was higher following semantic processing, while F was higher following phonemic processing ($F(1, 25) = 18.39$, MSE = 0.20, $p < .001$, $\eta_p^2 = .42$).

Considering only K and F, the most important comparison for our purposes, the main effect of level of processing was not significant ($F(1, 25) = 1.20$); nor was the main effect of recollective experience ($F < 1$). However, the critical two-way interaction was significant: in contrast to K, F reports were more frequent following phonemic processing ($F(1, 25) = 4.82$, MSE = 0.07, $p = .038$, $\eta_p^2 = .16$).

A follow-up *t* test, described earlier, confirmed that level of processing significantly increased R ratings ($t(25) = 3.84$, $p = .001$, Cohen’s $d = .75$). The encoding effect on K ratings was in the same direction, but not statistically significant ($t(25) = 1.09$, ns). By contrast, F ratings were significantly higher following phonemic encoding ($t(25) = 2.63$, $p = .014$, $d = .52$).

Response Latencies

Table 2 shows the response latencies associated with R, K, and F judgments, by encoding condition. A 2×3 repeated-measures ANOVA revealed a significant main effect of recollective experience ($F(2,50) = 9.01$, $MSE = 8.65$, $p < .001$, $\eta_p^2 = .27$); the main effect of level of processing was not significant ($F < 1$), nor was the two-way interaction ($F(2,50) = 2.36$, $p = .086$).

Averaging across encoding conditions, planned comparisons showed that F judgments were associated with significantly longer response latencies than either R judgments ($t(25) = 2.99$, $p = .006$) or K judgments ($t(25) = 4.07$, $p < .001$); the latencies associated with R and K judgments did not differ significantly ($t < 1$).

Comparing True and False Recognition

In order to take account of responses to lures, responses to target items were summed across the two encoding conditions to yield an overall value for correct recognition (hits) for comparison to false recognition of lures (false alarms). A 2×3 repeated-measures ANOVA, with two levels of item status (target vs. lure) and three levels of recollective experience (R, K, and F) yielded a significant main effect of item: there were more hits than false alarms ($F(1, 25) = 297.36$, $MSE = 0.84$, $p < .001$, $\eta_p^2 = .92$). There was also a significant main effect of recollective experience, with more items – hits or false alarms – receiving R or F judgments than K judgments ($F(2, 50) = 5.52$, $MSE = 0.07$, $p = .007$, $\eta_p^2 = .18$). Most important, there was a significant two-way interaction: more hits than false alarms were accompanied by R or K judgments, while F judgments were approximately evenly divided between the two categories ($F(2, 50) = 25.54$, $MSE = 0.25$, $p < .001$, $\eta_p^2 = .51$).

As in the previous analysis, the overall 2×3 ANOVA was decomposed into three 2×2 ANOVAS, one for each pairwise combination of R, K, and F.

Comparing R and K, there was a significant main effect of item: hits were greater than false alarms ($F(1, 25) = 216.67$, $MSE = 1.26$, $p < .001$, $\eta_p^2= .90$). The main effect of recollective experience was not significant ($F(1, 25) = 1.79$). However, the two-way interaction was significant: the difference between hits and false alarms was somewhat reduced for K items ($F(1, 25) = 8.52$, $MSE = 0.08$, $p = .007$, $\eta_p^2 = .25$).

Comparing R and F, the main effect of item was again significant ($F(1, 25) = 107.51$, $MSE = 0.50$, $p < .001$, $\eta_p^2 = .81$). Again, the main effect of recollective experience was not significant ($F(1, 25) = 3.24$, $MSE = 0.05$, $p = 084$, $\eta_p^2 = .12$). In this comparison, however, the critical interaction was much larger, reflecting an increase in the proportion of false alarms receiving F ratings ($F(1, 25) = 39.81$, $MSE = 0.49$, $p < .001$, $\eta_p^2 = .61$).

Comparing K and F, the main effect of item was significant, ($F(1, 25) = 36.28$, $MSE = 0.18$, $p < .001$, $\eta_p^2 = .59$). The main effect of recollective experience was also significant ($F(1, 25) = 14.18$, $MSE = 0.14$, $p = .001$, $\eta_p^2 = .36$). Again, the critical two-way interaction was significant: far fewer false alarms received K ratings, compared to F ($F(1, 25) = 23.71$, $MSE = 0.17$, $p < .001$, $\eta_p^2 = .49$).

Planned comparisons showed that correct recognition of targets was much higher than false recognition of lures for both R ($t(25) = 9.92$, $p < .001$, $d = 1.93$) and K ($t(25) = 8.15$, $p < .001$, $d = 1.60$) items. This was not the case for F items, however, which yielded equal proportions of hits and false alarms ($t(25) = 0.06$).

The average proportions of hits and false alarms displayed in Table 1 were used for a signal-detection analysis to summarize the accuracy of the subjects' recognition judgments (Macmillan & Creelman, 2005; Wickens, 2002). Combining R, K, and F items yielded $d' = 1.20$. Considering only R and K items also yielded positive values of d'; by contrast, F items yielded a d' essentially at zero, indicating a total failure to discriminate between targets and lures.

Experiment 2

Experiment 1 replicated the dissociation between level of processing and recollective experience (Remembering vs. Not-Remembering) observed by Gardiner, Rajaram, and many others. More important, the experiment found a further dissociation between level of processing and the more specific judgments of Knowing and Feeling. Deep, semantic processing increased both recognition-by-remembering and, to a lesser degree, recognition-by-knowing; but shallow, phonemic processing increased recognition-by-feeling. Recognition-by-remembering and recognition-by-knowing resulted in relatively few false positives, compared to recognition-by-feeling. Knowing and Feeling also differed in terms of response latencies. Thus, the recollective experiences of Knowing and Feeling are dissociable in much the same way that the experiences of Remembering and Not-Remembering are. The conventional definition of Not Remembered as a residual category, including anything that is not consciously recollected, appears to obscure important distinctions between other forms of recollective experience – specifically, "knowing" that an item was on a list, and intuitively "feeling" that it was there.

Such findings might suggest that Remember, Know, and Feel judgments involve different underlying processes, or are based on retrieval from different memory systems -- episodic vs. semantic memory, perhaps, as Tulving (1985) originally implied (see also Tulving, 1989, 1999, 2000); or, alternatively, declarative vs. procedural memory (Gardiner & Parkin, 1990) or explicit and implicit memory (Wang & Yonelinas, 2012). However, it could also be that the various forms of recollective experience reflect retrieval from a single memory system, and that the categories of Remember, Know, and Feel are proxies for different levels of confidence associated with the recognition judgments. Both Tulving (1985) and Gardiner (1988) rejected this interpretation, even though Tulving (1985) actually presented some evidence favoring it. Gardiner & Java (1990) and Rajaram (1993) similarly concluded that the R/K distinction is not merely a proxy for confidence. On the other hand, a number of writers have argued from signal detection theory that the R/K distinction is a matter of the placement of the decision criterion (Donaldson, 1996; Dunn, 2004; Hirshman & Master, 1997; Wixted & Mickes, 2010; Xu & Bellezza, 2001). It is not clear how different recollective experiences can help but be associated with different levels of confidence. If subjects know that something happened like they know their own names, that knowledge must be associated with high level of confidence; and if they feel that something happened, but don't actually remember it, this must be more uncertain.

Experiment 2 was intended to explore the relationship between recollective experience and recognition confidence. A preliminary study, in which subjects made confidence ratings on a 1–4 scale in addition to judgments of recollective experience, confirmed the principal findings of Experiment 1: level of processing at the time of encoding had differential effects on K and F; F was associated with more false recognitions, and longer response latencies, than K. Liberalizing the criterion for recognition increased F reports markedly, especially for items studied in the phonemic encoding condition, but had little effect on K (or R) reports; it also increased false recognition, especially F reports. And as in Experiment 1, F items were associated with longer response latencies than R or K items, which did not differ.

Experiment 2 employed an alternative approach to examining the relationship between recollective experience and confidence levels, by specifically instructing subjects to adopt a strict or liberal criterion for recognition, following a procedure employed by Dorfman, Kihlstrom, Cork, & Misiaszek (1995; for a similar manipulation in sensory psychophysics, see Tataryn & Kihlstrom, 2017).

Method

Experiment 2 followed same general procedure as Experiment 1: 32 Yale undergraduates, paid for their time, studied a list of 80 words, 40 in the rhyme condition and 40 in the associate condition; 24 hours later they completed the Yes/No recognition test and RKF ratings. For half the test items, the subjects were instructed to adopt a strict criterion for recognition -- not to endorse an item unless they were relatively sure:

> Say "Yes" only if you are relatively certain that the word appeared on the presentation list. If you're fairly sure you say the word, then you should say "yes". If you're not so sure or don't think you say the word, you should say "no".

For the remainder, they were instructed to adopt a liberal criterion -- to endorse items that seemed familiar in any way, even if they did not actually remember them:

> You can say "Yes" even if you're not sure that you saw the word. If you think you might have seen the word, or if it seems familiar to you at all, then you should say "yes". If it doesn't seem familiar to you, you should say "no".

Results

Table 3 shows the proportion of items recognized in each condition of the experiment. Again in the interests of space, the analyses omit the traditional, dichotomous, Remember-Not Remember (R/N) distinction, and focus on the trichotomous classification, dividing "Not Remembered" (N) items into subcategories of Know (K) and Feel (F) as opposed to Remember (R).

Trichotomous Distinctions Among Remembering, Knowing, and Feeling

Analysis began with an overall 2×2×3 ANOVA with two levels of encoding (phonemic or semantic), two levels of response criterion (strict or liberal), and three levels of recollective experience (R, K, or F). This revealed a significant main effect of encoding, with higher levels of recognition for items studied in the semantic condition ($F(1, 31) = 7.67$, $MSE = 0.04$, $p = .009$, $\eta_p^2 = .20$). The main effect of response criterion was significant, with higher recognition levels under the liberal standard ($F(1, 31) = 24.07$, $MSE = 0.18$, $p < .001$, $\eta_p^2 = .44$). The main effect of recollective experience was also significant: compared to R items, there were far fewer K and F items ($F(1, 62) = 8.33$, $MSE = 0.96$, $p = .001$, $\eta_p^2 = .21$). The encoding-by-criterion interaction was not significant ($F(1, 31) = 1.11$), but the remaining two-way interactions were. The interaction of criterion with recollective experience was significant, as the proportion of F responses increased under the liberal criterion ($F(2, 62) = 4.36$, $MSE = 0.10$, $p = .017$, $\eta_p^2 = .12$). Most important was the significant interaction between encoding condition and recollective experience, such that F reports were more frequent for items studied in the phonemic encoding condition ($F(2, 62) = 12.49$, $MSE = 0.38$, $p < .001$, $\eta_p^2 = .29$). The three-way interaction was not significant ($F < 1$).

Following the model of previous analyses, the overall three-way ANOVA was decomposed into three 2×2×2 repeated-measures ANOVAs, one for each pairwise combination of R, K, and F within each criterion.

Considering only R and K, recognition was higher following semantic encoding ($F(1, 31) = 20.10$, $MSE = 0.38$, $p < .001$, $\eta_p^2 = .39$), and more items were rated R than K ($F(1, 31) = 15.49$, $MSE = 1.81$, $p <$.,001, $\eta_p^2 = .33$), but in this case there was no main effect of the criterion for recognition ($F < 1$). Of the two-way interactions, only the interaction of encoding and recollective experience was significant: K judgments were more frequent following semantic encoding ($F(1, 31) = 4.59$, $MSE = 0.14$, $p = .040$, $\eta_p^2 = .13$). For the interactions of criterion x encoding and criterion vs. recollective experience (both Fs < 1). The three-way interaction was not significant ($F < 1$). All in all, R and K judgments behaved quite similarly in all conditions of the experiment.

Considering the interaction between R and F, the main effect of encoding was not significant ($F = 1.30$). As expected, there was a main effect of recognition criterion, with more items recognized under the more liberal standard ($F(1, 31) = 13.27$, $MSE = 0.18$, $p = .001$, $\eta_p^2 = .30$). There was also a main effect of recollective experience, with more recognized items receiving R than F judgments ($F(1, 31) = 6.89$, $MSE = 0.93$, $p = .013$, $\eta_p^2 = .18$). The main effect of encoding condition was not significant ($F = 1.30$), nor was the interaction of recognition criterion with encoding condition ($F = 1.92$, $p = .175$). However, the interaction of recognition criterion was significant: loosening the criterion for recognition increased F but not R judgments ($F(1, 31) = 6.56$, $MSE = 0.19$, $p = .016$, $\eta_p^2 = .18$). There was an even stronger interaction between encoding condition and recollective experience: semantic encoding increased R judgments, while phonemic encoding increased F judgments ($F(1, 31) = 17.65$, $MSE = 0.76$, $p < .001$, $\eta_p^2 = .36$). The three-way interaction was not significant ($F < 1$).

A similar pattern of results was obtained with the most critical interaction, involving K and F judgments. Again, there was a main effect of recognition criterion, with more items recognized under the more liberal standard ($F(1, 31) = 22.06$, $MSE = 0.28$, $p < .001$, $\eta_p^2 = .42$). The main effect of encoding was also significant ($F(1, 31) = 6.13$, $MSE = 0.07$, $p = .019$, $\eta_p^2 = .17$). There was no main effect of recollective experience: nonrecognized items were evenly split between K and F judgments ($F = 1.54$). Nor was the encoding x criterion interaction significant ($F < 1$). However, the interaction of criterion and recollective experience was significant: F judgments increased under the liberal criterion, but K judgments did not ($F(1, 31) = 5.85$, $MSE = 0.10$, $p = .022$, $\eta_p^2 = .16$). The encoding x recollective experience interaction was also significant: F judgments, but not K judgments, increased under phonemic encoding ($F(1, 31) = 13.68$, $MSE = 0.24$, $p = .001$, $\eta_p^2 = .31$). Again, the three-way interaction was not significant ($F < 1$).

Planned comparisons confirmed the differential effects of level of processing on recollective experience found in Experiment 1. Collapsing across the two recognition criteria, semantic processing produced an increase in R reports, compared to phonemic processing ($t(31) = 3.62$, $p = .001$, $d = .64$). K responses were in the same direction, but the difference was not significant ($t(31) = 1.53$, ns). However, there were significantly more F responses following phonemic processing responses respectively ($t(31) = 4.14$, $p < .001$, $d = .73$).

Another set of planned comparisons, combining the phonemic and semantic encoding conditions, showed that loosening the criterion for recognition increased F responses ($t(31) = 4.46$, $p < .001$, $d = .79$). However, shifting the criterion had little effect on K responses ($t(31) = 1.37$, ns), and no effect at all on R responses ($t < 1$.).

Response Latencies

Table 4 shows the response latencies associated with R, K, and F judgments under the various conditions. A 2×2×3 repeated-measures ANOVA yielded a significant main effect of recollective experience ($F(2, 62) = 17.21$, $MSE = 90.35$, $p < .001$, $\eta_p^2 = .36$). There was also a significant two-way interaction of criterion with recollective experience ($F(2, 62) = 3.58$, $MSE = 5.57$, $p = .034$, $\eta_p^2 = .10$). No other main effects or interactions were significant: criterion, $F < 1$; encoding, $F < 1$; criterion × encoding, $F(1, 31) = 3.10$, ns; encoding × recollective experience, $F < 1$; criterion × encoding x recollective experience, $F(2, 62) = 1.46$.

Planned comparisons showed, again, that the response latencies of R and K judgments did not differ significantly, regardless of the recognition criterion (Strict: $t(31) = 0.60$; Liberal: $t(31) = 1.11$). By contrast, F judgments were associated with significantly longer response latencies than either R or K judgments. This was true under the liberal criterion (F vs. R: $t(31) = 3.21$, $p = .003$; F vs K: $t(31) = 2.92$, $p = .006$), but especially under the strict criterion (F vs. R: $t(31) = 5.10$, $p < .001$; F vs. K: $t(31) = 4.34$, $p < .001$).

Comparing Targets and Lures

As in the previous experiments, responses to target items were summed across the two encoding conditions for comparison to lures (Table 3). An overall 2×2×3 repeated-measures ANOVA showed that all three main effects were significant: hits exceeded false alarms (F(1,

31) = 308.76, MSE = 1.83, p < .001, η_p^2 = .91); positive responses increased under the liberal criterion (F(1, 31) = 48.19, MSE = 0.36, p < .001, η_p^2 = .61); and there were relatively few K responses, compared to R or F (F(2, 62) = 8.63, MSE = 0.42, p < .001, η_p^2 = .22). All three two-way interactions were also significant: false alarms more than doubled under the liberal criterion (F(1, 31) = 13.39, MSE = 0.03, p = .001, η_p^2 = .30); loosening the criterion for recognition also increased the proportion of F responses (F(2, 62) = 18.62, MSE = 0.22, p < .001, η_p^2 = .38); and false alarms were usually accompanied by F reports (F(2, 62) = 34.68, MSE = 0.72, p < .001, η_p^2 = .53). The three-way interaction also reached significance: false alarms under the liberal criterion was especially likely to be accompanied by F reports (F(2, 62) = 3.73, MSE = 0.03, p = .030, η_p^2 = .11).

As before, the overall ANOVA was decomposed into three 2×2×2 ANOVAS, one for each pairwise combination of R, K, and F reports.

Comparing R and K, the main effect of criterion was not significant: loosening the criterion for recognition had little effect on overall recognition (F(1, 31) = 1.97). The main effect of item status, however, was highly significant: correct hits were much more frequent than false alarms (F(1, 31) = 217.08, MSE = 2.79, p < .001, η_p^2 = .88). And the main effect of recollective experience was also significant: whether hits or false alarms, recognition was more likely to be accompanied by R than K reports (F(1, 31) = 9.64, MSE = 0.43, p = .004, η_p^2 = .24). The two-way interaction between item status and recollective experience was significant: K reports increased somewhat for hits under the more liberal criterion (F(1, 31) = 23.59, MSE = 0.48, p < .001, η_p^2 = .43). Otherwise, however, R and K reports behaved quite similarly: the remaining two-way interactions, of criterion with item status and criterion with recollective experience, were both nonsignificant, as was the three-way interaction (all F < 1).

Comparing R and F, there were significant main effects of criterion and item status: recognition increased as the criterion shifted from strict to liberal (F(1, 31) = 37.45, MSE = 0.42, p < .001, η_p^2 = .55), and hits exceeded false alarms (F(1, 31) = 93.68, MSE = 1.36, p < .001, η_p^2 = .75). There was no significant effect of recollective experience: the high proportion of hits given R ratings was balanced by the high proportion of false alarms given F ratings (F < 1). The two-way interaction of criterion with item status was also significant: false recognition of lures increased with the loosened criterion (F(1, 31) = 13.88, MSE = 0.05, p = .001, η_p^2 = .31). Both two-way interactions involving recollective experience were significant: F reports increased substantially under the liberal criterion (F(1, 31) = 24.91, MSE = 0.36, p < .001, η_p^2 = .45); and F reports were more frequently associated with false alarms than with hits (F(1, 31) = 62.07, MSE =1.43, p < .001, η_p^2 = .67). The three-way interaction was not significant (F(1, 31) = 3.00, p = .093).

For the critical comparison of K and F, all three main effects were significant, as were all three two-way interactions and the three-way interaction. Hits exceeded false alarms (F(1, 31) = 42.35, MSE = 0.22, p < .001, η_p^2 = .58); more items were endorsed under the liberal criterion (F(1, 31) = 56.99, MSE = 0.51, p < .001, η_p^2 = .65); and more items received F than K ratings (F(1, 31) = 18.78, MSE = 0.79, p < .001, η_p^2 = .38). Employing the liberal criterion increased false alarms (F(1, 31) = 6.29, MSE = 0.04, p = .018, η_p^2 = .17); F ratings increased more than K ratings under the liberal criterion (F(1, 31) = 22.37, MSE = 0.28, p < .001, η_p^2 = .42); and F ratings increased more for false alarms than for hits (F(1, 31) = 13.35, MSE = 0.26, p = .001, η_p^2 = .30). In the significant three-way interaction, F judgments, but not K judgments, increased markedly for false alarms when the criterion for recognition was loosened (F(1, 31) = 8.78, MSE = 0.05, p = .006, η_p^2 = .22).

Planned comparisons, aggregating across the two encoding conditions, showed that under the strict criterion hits exceeded false alarms in all three categories of recollective experience: R, t(31) = 11.30, p < .001, d = 2.00; K, t(31) = 6.14, p < .001, d = 1.09; F, t(31) = 2.59, p = .015, d = 0.46. When the criterion was loosened, R judgments were essentially unchanged, with respect to both hits and false alarms (both t < 1). With respect to K responses, there was a small and nonsignificant increase in K for both hits (t(31) = 1.37) and false alarms (t(31) = 1.93). For F items, by contrast, relaxing the criterion significantly increased hits by more than 50% (t(31) = 4.46, p < .001, d = 0.79), and more than doubled false alarms (t(31) = 6.58, p < .001, d = 1.16). Under the liberal criterion, hits continued to outweigh false alarms for both R (t(31) = 8.82, p < .001, d = 1.56 and K (t(31) = 6.25, p < .001, d = 1.11) judgments. For F items, however, false alarms numerically exceeded hits, although the difference was not significant (t(31) = 1.63).

Signal-detection analysis (Table 3) showed that sensitivity remained high for R items under both recognition criteria. The sensitivity of K judgments also remained stable and moderately positive, while that of F judgments was low under the strict criterion and dropped below zero when the criterion was loosened.

Experiment 3

Experiment 2 showed that F ratings increased markedly as the criterion for recognition was loosened, but this was not the case for R or K ratings. Again, remembering and knowing were associated with relatively rapid responses, while recognition-by-feeling took significantly longer. Experiment 3 picked up on this last finding, employing a “response window” technique to control the amount of time that subjects had to make their recognition judgments.

Method

As in Experiments 1 and 2, 35 Yale undergraduates first studied a list of 80 words presented by computer under a levels-of-processing manipulation, generating rhymes for half the words and associates for the remainder. After a retention interval of 24 hours, the subjects returned to the laboratory for the recognition task. Each target or lure first appeared on the computer screen for 1.5, 3.0, 4.5, or 6.0 seconds; then, while the word remained fixed in place, the recognition query (“Remember, Know, Feel, or No?”) appeared on the screen. The subjects were given an additional 1 second to make their response: pressing N if the item was new; or, if the item was old, pressing R, K, or F according to his or her recollective experience. The subjects were instructed to make their recognition responses only within this 1-second window; responses made before or after this interval were discarded.

Results

Again in the interests of space, the analyses omit the traditional, dichotomous, Remember-Not Remember (R/N) distinction, and focus on the trichotomous classification, dividing "Not Remembered" (N) items into subcategories of Know (K) and Feel (F) as opposed to Remember (R). The subjects' average response time, across all conditions of the experiment, was 0.45 secs after the response window closed. In view of the response-window manipulation, response latencies were not analyzed further.

Trichotomous Classification of Recollective Experience

Table 5 shows the proportion of targets and lures recognized in each response window. An overall 2×4×3 repeated-measures ANOVA, with 2 levels of processing (phonemic vs. semantic), 4 response windows, and 3 categories of recollective experience, yielded the usual levels of processing effect ($F(1, 34) = 24.54$, $MSE = 0.26$, $p < .001$, $\eta_p^2 = .42$). The main effect of response window was also significant: recognition progressively improved as subjects had more time to make their decisions ($F(3, 102) = 20.63$, $MS = 0.15$, $p < .001$, $\eta_p^2 = .38$). The main effect of recollective experience was also significant, with a plurality of items given R ratings, and the remainder about evenly divided between K and F ($F(2, 68) = 26.22$, $MSE = 3.67$, $p < .001$, $\eta_p^2 = .44$). The two-way interaction between encoding and response window reached significance: the difference between the phonemic and semantic conditions increased as the response window widened ($F(3, 102) = 3.32$, $MSE = 0.02$, $p = .023$, $\eta_p^2 = .09$). More important, there was also a significant two-way interaction of encoding with recollective experience: R items dominated in the semantic encoding condition, while F items dominated in the phonemic encoding condition; K items were balanced between conditions ($F(2, 68) = 20.80$, $MSE = 1.08$, $p <.001$, $\eta_p^2 = .38$). The two-way interaction between response window and recollective experience was not significant ($F = 1.36$), but the three-way interaction did achieve significance: as the response window opened, F judgments became more frequent, especially for items in the phonemic encoding condition; R judgments also became more frequent, but especially for items in the semantic encoding condition; K judgments remained constant ($F(6, 204) = 4.31$, $MSE = 0.08$, $p < .001$, $\eta_p^2 = .11$).

These effects were further unpacked with a series of 2 (encoding) ×4 (response window) × 2 (recollective experience) repeated-measures ANOVAs, for each pairwise combination of R, K, and F, and focusing on the interactions involving recollective experience.

Comparing R and K, all the main effects were significant: encoding, $F(1, 34) = 42.24$, $MSE = 1.13$, $p < .001$, $\eta_p^2 = .55$; response window, $F(3, 102) = 5.76$, $MSE = 0.60$, $p = .001$, $\eta_p^2 = .15$; recollective experience, $F(1, 34) = 40.98$, $MSE = 6.89$, $p < .001$, $\eta_p^2 = .55$. The encoding x window interaction was also significant, $F(3, 102) = 10.62$, $MSE = 0.90$, $p < .001$, $\eta_p^2 = .24$. As the response window widened, R responses increased, but K responses did not. The more relevant interaction of encoding with recollective experience was significant: R items increased markedly with semantic encoding, but K items did not ($F(1, 34) = 14.20$, $MSE = 0.92$, $p = .001$, $\eta_p^2 = .30$). The interaction of response window with recollective experience was not significant ($F = 1.54$); nor was the three-way interaction ($F(3, 102) = 2.17$, $p = .096$).

Comparing R and F, the main effects were again all significant: encoding condition, $F(1, 34) = 14.28$, $MSE = 0.34$, $p = .001$, $\eta_p^2 = .30$; response window, $F(3, 102) = 13.19$, $MSE = 0.19$, $p < .001$, $\eta_p^2 = .28$; recollective experience, $F(1, 34) = 18.81$, $MSE = 3.60$, $p < .001$, $\eta_p^2 = .36$. The interaction between encoding condition and response window was not significant ($F = 1.53$). However, the interaction between encoding and recollective experience was: R items increased substantially in the semantic encoding condition, whereas F items actually decreased with semantic encoding ($F(1, 34) = 31.29$, $MSE = 2.08$, $p < .001$, $\eta_p^2 = .48$). The interaction between response window and recollective experience was not significant ($F < 1$). However, the three-way interaction was ($F3, 102) = 7.75$, $MSE = 2.81$, $p < .001$, $\eta_p^2 = .19$).

A series of 2×2 ANOVAs, one for each response window, confirmed that the differential effect of encoding on R and F (i.e., the encoding by recollective experience interaction) was especially large at the 6-sec window: 1.5 secs, $F(1, 34) = 9.90$, $MSE = 0.26$, $p = .003$, $\eta_p^2 = .23$; 3.0 secs, $F(1, 34) = 15.64$, $MSE = 0.59$, $p < .001$, $\eta_p^2 = .32$; 4.5 secs, $F(1, 34) = 3.09$, $MSE = 0.11$, ns; 6.0 secs, $F(1, 34) = 54.76$, $MSE = 1.61$, $p < .001$, $\eta_p^2 = .62$.

Comparing K and F, the three main effects of the 2×4×2 ANOVA were again significant: encoding, $F(1,34) = 6.24$, $MSE = 0.15$, $p = .017$, $\eta_p^2 = .16$; response window, $F(3, 102) = 6.31$, $MSE = 0.08$, $p = .001$, $\eta_p^2 = .16$; recollective experience, $F(1, 34) = 8.72$, $MSE = 0.53$, $p = .006$, $\eta_p^2 = .20$. The two-way interaction of encoding and window was not significant ($F = 1.54$), nor was the interaction of window and recollective experience ($F = 2.24$) or the three-way interaction ($F = 2.52$). However, the critical interaction of encoding condition and recollective experience was significant: F responses were greater following phonemic encoding, but K responses were not ($F(1, 34) = 9.65$, $MSE = 0.23$, $p = .004$, $\eta_p^2 = .22$).

Aggregating across the four response windows, R responses were higher following semantic processing ($t(34) = 5.52$, $p < .001$, $d = .93$), but there was no difference for K responses ($t(34) < 1$). By contrast, F responses were higher following phonemic processing ($t(34) = 4.04$, $p < .001$, $d = .68$).

Comparing True and False Recognition

As before, the phonemic and semantic encoding conditions were combined to yield overall hit rate for targets, to be compared to false alarms to lures. The overall 2×4×3 repeated-measures ANOVA, with 2 levels of item status (targets vs. lures), 4 levels of response window (1.5, 3.0, 4.5, and 6.0 secs), and 3 levels of recollective experience (R, K, and F) showed that all three main effects were significant: more targets than lures were recognized ($F(1, 34) = 346.14$, $MSE = 4.05$, $p < .001$, $\eta_p^2 = .91$); recognition (true or false) increased with expanding response window ($F(3, 102) = 29.96$, $MSE = 0.12$, $p < .001$, $\eta_p^2 = .47$); and more items (targets or lures) received R or F ratings, compared to K ($F(2, 68) = 18.30$, $MSE = 0.91$, $p < .001$, $\eta_p^2 = .35$). The item status x window interaction was not significant ($F = 1.87$). However, the two-way interaction of item status and recollective experience was significant: more targets received R ratings, compared to K and F, while more lures received F ratings, compared to R and K ($F(2, 68) = 49.53$, $MSE = 1.75$, $p < .001$, $\eta_p^2 = .59$). The response window × recollective experience interaction was also significant: both R and F responses increased with the expanding response window, while K responses held fairly steady ($F(6, 204) = 3.19$, $MSE = 0.03$, $p = .005$, $\eta_p^2 = .09$). The three-way interaction was also significant: the increase in F responses was especially prominent for lures (F(6, 204) = 2.46, MSE = 0.02, p = .026, η_p^2 = .07).

The overall analysis was decomposed into separate 2×4×2 repeated-measures ANOVAs, one for each pairwise combination of R, K, and F, and emphasizing the interactions involving recollective experience.

Comparing R and K, all three main effects were significant: more targets than lures were recognized (F(1, 34) = 292.29, MSE = 5.57, p < .001, η_p^2 = .90); recognition (true and false) increased as the response window expanded (F(3, 102) = 7.89, MSE = 0.03, p < .001, η_p^2 = .19); and more recognized items received R ratings compared to K (F(1, 34) = 24.81, MSE = 1.51, p < .001, η_p^2 = .42). The item status × window interaction did not reach significance (F(3, 102) = 2.48, p = .066), and the interaction of response window with recollective experience was clearly nonsignificant (F < 1). However, the item status × recollective experience interaction was highly significant: targets yielded far more R than K responses, but R and K were fairly evenly divided among lures (F(1, 34) = 50.56, MSE = 1.95, p < .001, η_p^2 = .60). The three-way interaction was significant: (F(3, 102) = 4.36, MSE = 0.03, p = .006, η_p^2 = .11).

Comparing R and F, the main effects of item status and response window were both significant: more targets than lures were endorsed on the recognition test (F(1, 34) = 283.05, MSE = 3.93, p < .001, η_p^2 = .89), and recognition (true or false) increased as the response window expanded (F3, 102) = 21.02, MSE = 0.13, p < .001, η_p^2 = .38). The main effect of recollective experience was not significant (F < 1), because so many falsely recognized lures received F judgments. The two-way interaction of item status with response window was also not significant (F < 1). However, the interaction of item status with recollective experience was highly significant: more targets received R ratings, while more lures received F ratings (F(1, 34) = 59.41, MSE = 3.15, p < .001, η_p^2 = .64). The interaction of response window with recollective experience was also significant: F ratings increased as the response window expanded, while R ratings held fairly steady F(3, 102) = 3.44, MSE = 0.03, p = .020, η_p^2 = .09). The three-way interaction was not significant (F = 2.33, p = .079).

Comparing K and F, all three main effects were significant: overall, more targets than lures were recognized (F(1, 34) = 13.31, MSE = 0.34, p = .001, η_p^2 = .28); more items of either type were endorsed as the window opened (F(3, 102) = 18.52, MSE = .11, p < .001, η_p^2 =.35); and more items of either type received F than K ratings (F(1, 34) = 40.08, MSE = 1.22, p < .001, η_p^2 =..54) The two-way interaction between item status and response window reached significance: F responses increased with expanding response window, but K responses did not (F 3, 102) = 3.30, MSE = 0.02, p = .023, η_p^2 = .09). The interaction of item status and recollective experience was stronger: targets received more K than F ratings, while the reverse was true for lures (F(1, 34) = 10.02, MSE = 0.14, p = .003, η_p^2 = .23). The interaction of response window with recollective experience was also significant: F ratings increased as the response window expanded, but K ratings did not (F(3, 102) = 5.88, MSE = 0.04, p = .001, η_p^2 = .15). The three-way interaction was not significant (F < 1).

Follow-up one-way ANOVAs showed that R responses to targets increased across response windows (F(3, 102) = 4.23, MSE = 0.04, p = .007, η_p^2 = .11), while R responses to lures remained constant (F < 1). By contrast, K responses to targets remained constant across response windows (F < 1), while K responses to lures increased in the 4.5-sec window (F(3, 102) = 6.81, MSE = 0.03, p < .001, η_p^2 = .17). F responses increased across response windows for both targets (F(3, 102) = 5.75, MSE = 0.06, p = .001, η_p^2 = .11), and, especially, lures (F(3, 102) = 13.22, MSE = 0.08, p < .001, η_p^2 = .28).

For the signal-detection analysis (Table 5), the phonemic and semantic items were combined for comparison to the lures. Setting aside the different recollective experiences, overall recognition performance was quite good. Performance was even better considering only R items. For K items, accuracy was somewhat lower at each response window. For F items, however, performance was quite poor even with the shortest response window and fell off rapidly as the window widened.

Experiment 4

Experiments 1–3 revealed many differences between knowing and feeling, as predicted, but also many similarities between knowing and remembering. Both were enhanced by deep processing and repeated study; both were associated with high confidence levels, high accuracy, and relatively short response latencies. These findings are irrelevant to the distinction between knowing and feeling that lies at the heart of this research, but they leave the qualitative distinction between remembering and knowing somewhat in doubt. On reflection, it would seem that recognition-by-knowing is most likely to occur under one of two circumstances: over long retention intervals, or with repetition of closely similar events. Long retention intervals might promote degradation of the spatial and temporal cues which mark the episode as a unique experience; repetition might blur them beyond recognition. Furthermore, a great deal of "semantic" knowledge is acquired through repetition, after all. Tulving (1989; Tulving et al., 1988) showed that the densely amnesic patient K.C. could acquire new knowledge about his own past, through extensive repetition of the facts, even though he could not remember any specific episodes of personal experience. Conway, Dewhurst, and others have documented an "R-to-K shift" (Conway et al., 1997) or process of "schematization" (Herbert & Burt, 2004) in the acquisition of semantic knowledge, by which learners lose track of the episodic context in which new knowledge was acquired, while retaining access to the knowledge itself.

A preliminary experiment found that R and K judgments increased, and F judgments decreased, over two study-test trials separated by 24 hours – each trial consisting of the same targets, but constructed to represent a distinctly different learning episode. Experiment 4 was intended to explore the effects of massed learning trials on recollective experience.

Method

In this experiment, 44 undergraduates at the University of California, Berkeley participated in 15 study-test trials with a 20-item list conducted over a period of 90 minutes. Items were read aloud at a rate of one every 3 seconds. After a 10-minute interval in which the subjects generated word associations and listened to the instructions for rating their recollective experience, they received their first test trial, making recognition judgments for 20 targets and 20 lures listed in random order on a single sheet of paper. Successive study-test cycles consumed about 3–1/2 minutes each. On each study trial, the targets were presented in a new random order, and on each test trial the targets and lures was presented in a new random order. The subjects were run in small groups of 4–5 individuals, and were paid for their participation.

Results

Figure 1 shows the trial-by-trial performance of the experiment. To reduce clutter along the horizontal axis, results for lures are omitted; in fact, false recognition of lures occurred rarely. As intended, the subjects learned the list fairly quickly: On Trial 1, they recognized an average of 16.27 targets ($SD = 3.11$), and made very few false alarms ($M = 1.41$, $SD = 1.30$). Early in the series of trials, the subjects showed the familiar mix of remembering, knowing, and feeling. Very quickly, however, feeling dropped out of the picture, as did false alarms, and experiences of knowing replaced experiences of remembering.

Trichotomous Classification of Recollective Experience

For simplicity in exposition and analysis, Table 6 shows the results only for Trials 1, 5, 10, and 15. A 4×3 repeated-measures ANOVA showed significant main effects of both trial and recollective experience. Recognition increased across trials ($F(3, 129) = 45.48$, $MSE = 0.10$, $p < .001$, $\eta_p^2 = .51$), and there were more of both R and K judgments, compared to F ($F(2, 86) = 226.31$, $MSE = 8.79$, $p < .001$, $\eta_p^2 = .84$). The two-way interaction of trials with recollective experience was also significant ($F(6, 258) = 64.57$, $MSE = 1.44$, $p < .001$, $\eta_p^2 = .60$).

This overall ANOVA was then decomposed into three separate 4×2 ANOVAs, one for each pairwise combination of R, K, and F.

For the critical comparison of R and K, the ANOVA yielded a significant main effect of trials ($F(3, 129) = 69.77$, $MSE = 0.35$, $p < .001$, $\eta_p^2 = .62$). The main effect of recollective experience was not significant ($F(1, 43) = 3.51$, $MSE = 0.23$, $p = .068$), owing to the almost-perfect crossover interaction ($F(3, 129) = 69.14$, $MSE = 2.54$, $p < .001$, $\eta_p^2 = .62$). Recognition was accompanied by remembering on early trials, but by knowing on later trials.

For the comparison of R and F, the ANOVA yielded significant main effects of both trial ($F(3, 129) = 51.78$, $MSE = 0.58$, $p < .001$, $\eta_p^2 = .55$) and recollective experience ($F(1, 43) = 453.79$, $p < .001$, $\eta_p^2 = .91$), as well as a significant interaction ($F(3, 129) = 8.32$, $MSE = 0.13$, $p < .001$, $\eta_p^2 = .16$). R judgments increased and then decreased, while F judgments only decreased.

A similar pattern was observed in the comparison of K and F judgments, except that K judgments increased throughout: main effect of trials, $F(3, 129) = 67.39$, $MSE = 0.72$, $p <$.

001, η_p^2 = .61; main effect of recollective experience, $F(1, 43) = 643.87$, $MSE = 11.33$, $p < .001$, η_p^2 = .94; interaction, $F(3, 129) = 113.57$, $MSE = 1.66$, $p < .001$, η_p^2 = .73.

Comparing True and False Recognition

Adding an “item” factor (hits vs. false alarms) for a 4×2×3 repeated-measures ANOVA, again considering only Trials 1, 5, 10, and 15 (Table 6), all the effects described above remained significant: trials, $F(3, 129) = 14.64$, $MSE = 0.2$, $p < .001$, η_p^2 = .25; recollective experience, $F(2, 86) = 201.23$, $MSE = 4.05$, $p < .001$, η_p^2 = .82; trials by recollective experience, $F(6, 258) = 69.57$, $MSE = 0.81$, $p < .001$, η_p^2 = .62. In addition, the new main effect of item status was significant, with hits far outweighing false alarms ($F(1, 43)$ = 15,952.45, $MSE = 24.62$, $p < .001$, η_p^2 = .99). The interaction of item with trials was also significant: hits increased over trials, while false alarms decreased ($F(3, 129) = 79.48$, $MSE = 0.10$, $p < .001$, η_p^2 = .65). So was the interaction of item status with recollective experience: R and K judgments increased across trials, while F judgments decreased ($F(2, 86) = 248.76$, $MSE = 7.14$, $p < .001$, η_p^2 = .85). And the three-way interaction was also significant ($F(6, 258) = 58.68$, $MSE = 0.66$, $p < .001$, η_p^2 = .58).

The reduced dataset also served as the basis for a series of three 4×2×2 ANOVAs involving all pairwise comparisons of R, K, and F ratings.

For the critical comparison between R and K, the ANOVA yielded significant main effects of trials ($F(3, 129) = 71.68$, $MSE = 0.19$, $p < .001$, η_p^2 = .63) and item status ($F(1, 43)$ = 10,212.12, $MSE = 33.86$, $p < .001$, η_p^2 = .99). The two-way interaction of trials with item status was also significant: hits went up over trials, while false alarms went down ($F(3, 129) = 65.18$, $MSE = 0.16$, $p < .001$, η_p^2 = .60). The main effect of recollective experience was not significant ($F(1, 43) = 2.78$, $MSE = 0.10$, $p = .103$, η_p^2 = .06), because of the significant crossover interaction with trials ($F(3, 129) = 70.99$, $MSE = 1.31$, $p < .001$, η_p^2 = .62). The interaction of item status and recollective experience reached significance: hits generally received R and K ratings, while there was little differentiation among the very few false alarms ($F(1, 43) = 4.34$, $MSE = 0.14$, $p = .043$, η_p^2 = .09). The three-way interaction was highly significant: the crossover between R and K observed with hits was not observed with false alarms ($F(3, 129) = 66.91$, $MSE = 1.23$, $p < .001$, η_p^2 = .61). K ratings not only differed from F ratings; more important, they also differed from R ratings.

Considering only K and F, the ANOVA yielded significant main effects of trials ($F(3, 129)$ = 49.11, $MSE = 0.28$, $p < .001$, η_p^2 = .53), item ($F(1, 43) = 1051.57$, $MSE = 8.89$, $p < .001$, η_p^2 = .96), and recollective experience ($F(1, 43) = 597.72$, $MSE = 5.27$, $p < .001$, η_p^2 = .93), as well as a significant trials × item interaction ($F(3, 129) = 83.60$, $MSE = 0.46$, $p < .001$, η_p^2 = .66). The interaction of trials by recollective experience was also significant: K items increased, while F items decreased somewhat from their already low initial levels ($F(3, 129)$ = 130.16, $MSE = 1.05$, $p < .001$, η_p^2 = .75). The interaction of item status with recollective experience was also significant: hits received more K ratings, while false alarms received mostly F ratings ($F(1, 43) = 652.42$, $MSE = 6.08$, $p < .001$, η_p^2 = .94). And the three-way interaction was also significant: even for false alarms, F ratings disappeared entirely after the early study-test trials ($F(3, 129) = 89.08$, $MSE = 0.64$, $p < .001$, η_p^2 = .67).

A similar pattern occurred when comparing R and F items: main effect of trials, $F(3, 129) = 61.99$, $MSE = 0.38$, $p < .001$, $\eta_p^2 = .59$; main effect of item, $F(1, 43) = 1077.79$, $MSE = 11.25$, $p < .001$, $\eta_p^2 = .96$; main effect of recollective experience, $F(1, 43) = 393.56$, $MSE = 6.78$, $p < .001$, $\eta_p^2 = .90$; trials x item interaction, $F(3, 129) = 40.76$, $MSE = 0.23$, $p < .001$, $\eta_p^2 = .49$; trials x recollective experience, $F(3, 129) = 7.61$, $MSE = 0.06$, $p < .001$, $\eta_p^2 = .15$; item by recollective experience, $F(1, 43) = 505.62$, $MSE = 8.05$, $p < .001$, $\eta_p^2 = .15$; three-way interaction, $F(3, 129) = 11.95$, $MSE = 0.10$, $p < .001$, $\eta_p^2 = .22$. Both analyses, then, confirmed the findings of the previous experiments that K ratings, like R ratings, differ from F ratings.

The signal-detection analysis yielded results similar to the prior studies. In view of the relative absence of false-positive recognition of lures, hit rates of 1.00 and false-alarm rates of 0.00 were adjusted following the prescription of Macmillan and Creelman (2005). Both R and K items were associated with higher values of *d'* than F items. For F items, *d'* was low even on Trial 1 and went to zero on Trial 15. Both R and K items showed substantial values of *d'* throughout the experiment, but while *d'* decreased for R items, it increased for K items – yet another difference between remembering and knowing.

General Discussion

The experiments on recognition memory reported here support the epistemological and phenomenological distinction between “knowing” that an event occurred and “feeling” that it happened. As alternatives to conscious recognition-by-remembering, recognition-by-knowing and recognition-by-feeling differ in a number of important respects. First, they are differentiated by the effects of level of processing at the time of encoding. Reports of “Feeing” are more likely to occur following shallow phonemic semantic processing, while reports of “Knowing” are less affected by level of processing (Experiments 1–2). Recognition-by-feeling is increased when subjects are encouraged to adopt a liberal criterion for item recognition, but recognition-by-knowing is not (Experiment 2). Recognition-by feeling is associated with longer response latencies than recognition-by-knowing (Experiments 1–2), and increases when subjects are given a long time to think about their responses (Experiment 3); this is not true of recognition-by-knowing. False recognition of lures is often accompanied by “feeling”, but rarely accompanied by “knowing”, such that signal-detection measures of recognition accuracy are higher for knowing than for feeling (Experiments 1–4). Recognition-by-knowing increases with additional study trials, eventually supplanting recognition-by-remembering, while recognition-by-feeling drops essentially to zero (Experiment 4). In these ways, recognition-by-knowing is distinguished from recognition-by-feeling in much the same way as, in the traditional R/K paradigm, recognition-by-remembering is distinguished from recognition-without-remembering.

In some respects, recognition-by-knowing resembles recognition-by-remembering. Neither is affected by loosening the criterion for recognition, and both are associated with relatively short response latencies and a low level of false alarms. Still, there are some differences. Knowing is less affected than remembering by level of processing, and by the width of the response window. Most important, as already noted, knowing increased markedly with increased study-test trials, while remembering decreased.

The foregoing experiments support a tripartite classification of recollective experience in recognition memory. Sometimes, recognition is accompanied by conscious recollection – not just of the event in question, but also its spatial, temporal, and personal context – where and when it occurred, what else was going on, and what the person was thinking and doing at the time. On other occasions, however, some or all of these elements are lacking. Tulving's (1985) R/K paradigm was intended to capture this qualitative distinction between "remembering" an event and "knowing" that it occurred – Klein et al.'s (2002) distinction between the "lived past" and the "known past", and Levine et al.'s (2004) distinction between episodic and semantic autobiographical memory. However, it appears that there is more than one alternative to remembering an event. We can have abstract knowledge that an event occurred, in the absence of conscious recollection of its environmental and personal context, much as we know where we were born without actually remembering it. Or we can have an intuitive feeling that something is familiar, the way someone's face or voice can "ring a bell" at a cocktail party, even though we cannot remember the person's name or the circumstances under which we might have previously met him or her.

Many psychological theories of memory focus on the processes underlying task performance, while alternative, neuropsychological approaches focus on underling brain modules and systems. Tulving has expressed a clear preference for the systems approach (Schacter & Tulving, 1994; Tulving, 1985, 1999), as in his hypothesis that different memory systems mediate the different forms of recollective experience (autonoetic, noetic, and anoetic) that he identified. But there is also a third, complementary approach, which also has its roots in Tulving's work (Tulving & Bower, 1974; Tulving & Watkins, 1975): an informational approach which focuses on the information accessible to subjects as they reconstruct some event from the past (Kihlstrom, 1995, 1997).

A full-fledged episodic memory may be thought of as a bundle of several different kinds of features: a representation of the event itself, presumably built by binding together links among items of conceptual knowledge already existing in semantic memory; a representation of the spatiotemporal context in which the event occurred, giving the memory a unique signature in space and time; and a representation of the person him- or herself, as the agent or patient, or stimulus or experiencer, of the event in question – including the individual's emotional and motivational state in the moment. In principle, all of this information is available at the time the event is initially encoded in memory; but for a variety of reasons, some information may be inaccessible – or, at least, unaccessed -- during later attempts at retrieval (Tulving & Pearlstone, 1966). Which elements are accessed will shape the individual's recollective experience.

Information about the personal context in which an event occurred seems necessary, if memory retrieval is to have the "autonoetic" quality described by Tulving (1985). The subject will be able to remember that "This happened to me, this is what I was doing at the time, and this is how I felt about it". On the other hand, if the information relating to personal context fails to be encoded, or is subsequently lost or obscured by repetition, the memory will include only information about the situational context in which the event occurred – a sort of "list tag" (Anderson, Bothell, Lebiere, & Matessa, 1998; Reder et al., 2000). The result will be a memory that, while formally episodic in nature, because it refers to an event which occurred at a specific time and place, will also possess the abstract, impersonal character that is characteristic of a semantic memory: "This word was on that list". If both types of links are lost, all that is left are activated representations of the event itself: the "free radicals" (Tulving, 1983, p. 114) that provide the basis for priming, the feeling of familiarity, and similar effects: "This word rings a bell, so it might have been on the list". Of course, the subject's judgment might be wrong, leading to a relatively high incidence of false alarms.

Knowing and feeling are both conscious "noetic" states, in Tulving's (1985) terms, as opposed to the "autonoetic" state of remembering (and the "anoetic" state associated with the retrieval of unconscious procedural knowledge), but they differ in some respects that may have neuropsychological implications. For example, it appears that the hippocampus, which is critical for relational processing (Eichenbaum, 2002; Moscovitch, Cabeza, Winocur, & Nadel, 2016) is also critical for remembering (recollection) but not feeling (familiarity); and the parahippocampal and perirhinal cortex surrounding the hippocampus plays a role in the feeling of familiarity but not remembering (e.g., Diana, Yonelinas, & Ranganath, 2007; Kim, 2010; Montaldi & Mayes, 2010; Norman & O'Reilly, 2003; Rugg & Vilberg, 2013; Schapiro, Turk-Browne, Botvinick, & Norman, 2017; Yonelinas et al., 2010). Similarly, the ventral region of the posterior parietal cortex appears to be associated with recollection, while the dorsal region with familiarity (Frithsen & Miller, 2014).

In a recent comprehensive survey of this literature, Bastin et al. (2019) have distinguished between two core representational systems serving episodic memory: a relational system underlying recollection, consisting of the hippocampus, mammillary bodies, and the anterior nuclei of the thalamus; and an entity system underlying familiarity, consisting of occipito-temporal cortex, occipital-parietal cortex, anterior temporal cortex, perirhinal cortex and anterolateral entorhinal cortex, parahippocampal cortex and posteromedial entorhinal cortex, each element processing a different aspect of an event. There is also a self-referential system, associated with the orbital and ventromedial prefrontal cortex. These interact with a "downstream" attribution system which collects information about fluency and detail to determine both retrieval success and the accompanying subjective experience of recollection or familiarity.

Knowing, as defined here, is similar to retrieval from semantic memory, and so may activate widely distributed portions of cerebral cortex (Kim, 2016; Yee, Chrysikou, & Thompson-Schill, 2014). Still, knowing requires access to at least some pieces of relational information (e.g., links to spatiotemporal context, represented in verbal-learning experiments by a list marker), if not others (e.g., links to the self as agent, patient, stimulus, or experiencer of the event in question), so the hippocampus may play a more prominent role in knowing than it does in feeling (or nonautobiographical aspects of semantic memory). Neuroimaging studies also suggest that the retrieval of episodic autobiographical memory (episodic AM), similar to what is meant here by "remembering", is mediated by the medial temporal cortex and prefrontal cortex, as indicated by the comparisons of recollection and familiarity described above; on the other hand, retrieval of semantic autobiographical memory (semantic AM), close to what is meant here by "knowing", is served by the ventrolateral temporal cortex and other extrahippocampal structures (Levine et al., 2004; Murphy et al., 2008; Winocur &

Moscovitch, 2011). In a study employing diffusion MRI, Hodgetts et al. (2017) expanded the episodic AM system to include the fornix and the semantic AM system to include the inferior longitudinal fasciculus. In their view, the involvement of these long-range input/output pathways underscores the importance of an extended network of cortical and subcortical structures supporting both forms of autobiographical memory.

Dual-process theories have a long and distinguished history in the psychology of memory (Anderson & Bower, 1972; Atkinson & Juola, 1974; Jacoby, 1991; Mandler, 1980; Watkins & Gardiner, 1979; Yonelinas, 2002). Although intuitively appealing and formally elegant, they may not fully capture the actual experience of remembering one's past. This experience may be one of conscious recollection, but it may also entail knowing about events of the personal past that one does not personally remember; and it may include intuitions about one's past similar to the "feeling of knowing", as well as beliefs about the past derived from other sources of information. If so, future computational models, and neuropsychological investigations, of episodic memory may need to consider the possibility that there are more than just two varieties of recollective experience.

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Highlights

- Tulving's (1985) distinction between "remembering" and "knowing" was a milestone in the study of memory and consciousness.
- Most computational and neuroscientific models of recognition construe "knowing" as a priming-based feeling of familiarity.
- A series of experiments showed that "knowing", construed as retrieval from semantic memory, could be dissociated from both conscious recollection and the feeling of familiarity.
- Recollective experiences of remembering, knowing, and feeling are explained in terms of the information about an event accessible at the time of retrieval.

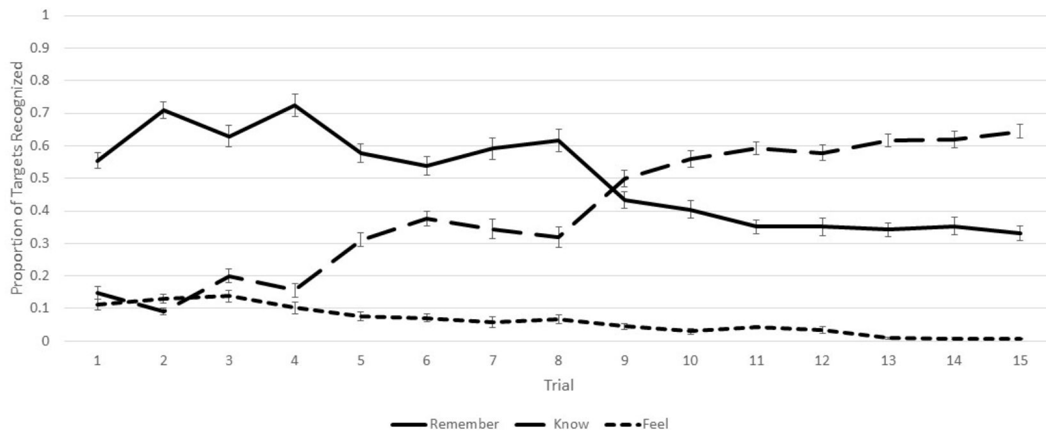

Figure 1:

Distribution of Remember, Know, and Feel ratings on each trial of Experiment 4. Error bars indicate standard errors around each mean.

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Table 1.

Experiment 1: Recognition Performance by Encoding Condition and Recollective Experience

Category	**Proportion of Items Recognized**			**d'**[a]
	Phonemic	**Semantic**	**Lure**	
All Recognized	.75 (.17)	.82 (.13)	.34 (.03)	1.20
Remember (R)	.27 (.15)	.37 (.20)	.05 (.01)	1.18
Not Remembered (NR)	.48 (.13)	.44 (.14)	.30 (.02)	0.42
Know (K)	.22 (.14)	.25 (.12)	.07 (01)	0.75
Feel (F)	.26 (.11)	.19 (.12)	.23 (.02)	0.02

Note: Standard deviations in parentheses.

[a]Comparing lures against phonemic and semantic targets combined.

Table 2.

Experiment 1: Response Latencies Associated with Recollective Experience

Recollective Experience	Encoding Condition	
	Phonemic	**Semantic**
Remember	2.29 (0.52)	2.66 (1.27)
Know	2.41 (0.92)	2.34 (0.73)
Feel	3.25 (1.39)	3.01 (1.07)

Note: Response latencies in seconds. Standard deviations in parentheses.

Table 3.

Experiment 2: Recognition Performance by Encoding Condition, Response Criterion, and Recollective Experience

Recollective Experience	Proportion of Items Recognized			d’
	Phonemic	Semantic	Lure	
Strict Criterion				
All Recognized	.69 (.21)	.77 (.18)	.26 (.16)	1.26
Remember (R)	.29 (.20)	.43 (.20)	.06 (.07)	1.21
Know (K)	.16 (.17)	.19 (.15)	.06 (.07)	0.63
Feel (F)	.23 (.14)	.14 (.09)	.14 (.10)	0.22
Liberal Criterion				
All Recognized	.84 (.18)	.88 (.13)	.50 (.23)	1.08
Remember (R)	.30 (.23)	.42 (.22)	.07 (.08)	1.11
Know (K)	.19 (.17)	.22 (.17)	.08 (08)	0.59
Feel (F)	.34 (.23)	.24 (.17)	.35 (.18)	−0.17

Note: Standard deviations in parentheses.

[a]Comparing lures against phonemic and semantic targets combined.

Table 4.

Experiment 2: Response Latencies Associated with Recollective Experience

Recollective Experience	Encoding Condition	
	Phonemic	Semantic
Strict Criterion		
Remember	2.81 (1.41)	2.96 (1.39)
Know	2.79 (1.24)	3.24 (1.92)
Feel	4.87 (3.54)	4.64 (3.31)
Liberal Criterion		
Remember	2.96 (1.42)	3.02 (1.44)
Know	3.53 (1.94)	2.91 (1.48)
Feel	4.54 (3.47)	3.85 (2.44)

Note: Response latencies in seconds. Standard deviations in parentheses

Table 5.

Experiment 3: Recognition Performance by Encoding Condition, Response Window, and Recollective Experience

Recollective Experience	Proportion of Items Recognized			d'[a]
	Phonemic	Semantic	Lure	
Window: 1.5 Seconds				
All Recognized	.60 (.23)	.62 (.18)	.22 (.14)	1.05
Remember	.27 (.19)	.37 (.22)	.05 (.07)	1.18
Know	.14 (.14)	.13 (.12)	.05 (.07)	0.52
Feel	.19 (.14)	.13 (.15)	.12 (.09)	0.18
Window: 3.0 Seconds				
All Recognized	.65 (.22)	.79 (.19)	.29 (.18)	1.14
Remember	.27 (.18)	.46 (.26)	.06 (.07)	1.22
Know	.15 (.13)	.17 (.18)	.05 (06)	0.65
Feel	.23 (.18)	.16 (.15)	.18 (.12)	0.04
Window: 4.5 Seconds				
All Recognized	.72 (.23)	.81 (.17)	.38 (.22)	1.01
Remember	.35 (.24)	.45 (.24)	.04 (.06)	1.50
Know	.13 (.14)	.14 (.16)	.11 (.14)	0.15
Feel	.23 (.14)	.22 (.14)	.23 (.12)	−0.02
Window: 6 Seconds				
All Recognized	.70 (.20)	.87 (.13)	.34 (.19)	1.22
Remember	.24 (.21)	.53 (.23)	.05 (.06)	1.34
Know	.14 (.12)	.17 (.15)	.05 (.07)	0.61
Feel	.32 (.16)	.18 (.13)	.23 (.13)	0.06

Note: Standard deviations in parentheses

[a]Comparing lures against phonemic and semantic targets combined.

Table 6.

Experiment 4: Recognition Performance by Trial and Recollective Experience

Recollective Experience	Target	Lure	*d'*[a]
Trial 1			
All Recognized	.81 (.16)	.07 (.06)	2.35
Remember	.55 (.16)	.00 (.00)	2.45
Know	.15 (.13)	.00 (.00)	1.29
Feel	.11 (.11)	.07 (.06)	0.25
Trial 5			
All Recognized	.96 (.05)	.00 (.00)	4.08
Remember	.58 (.18)	.00 (.00)	2.53
Know	.31 (.15)	.00 (.00)	1.83
Feel	.08 (.09)	.00 (.00)	0.92
Trial 10			
All Recognized	.99 (.02)	.01 (.02)	4.65
Remember	.40 (.17)	.00 (.00)	2.07
Know	.56 (.17)	.01 (.02)	2.48
Feel	.03 (.06)	.00 (.00)	0.45
Trial 15			
All Recognized	.98 (.02)	.01 (.02)	4.38
Remember	.33 (.15)	.00 (.00)	1.89
Know	.64 (.15)	.01 (.00)	2.68
Feel	.01 (.02)	.00 (.00)	0.00

Note: Standard deviations in parentheses.

[a]Comparing lures against targets.