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Recognition in Posthypnotic Amnesia, Revisited

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Abstract

Three experiments studied recognition during posthypnotic amnesia (PHA) employing confidence ratings rather than the traditional yes/no format. As the criterion for recognition was loosened, an increase in hits was accompanied by an increase in false alarms, especially to distractor items that were conceptually related to, or semantically associated with, targets. Nevertheless, hits exceeded false alarms at every level of confidence. In addition, amnesic subjects had difficulty identifying the particular list on which recognized items were presented for study or the correct order in which targets appeared on the study list. Taken together, these findings support the conclusion that successful recognition during PHA is more likely to be mediated by a priming-based feeling familiarity than conscious recollection.

Zusammenfassung:

Bei 3 Experimenten zum Studium der Wiedererkennung während posthypnotischer Amnesie (PHA) wurden Konfidenz-Ratings statt des herkömmlichen Ja-/Nein-Formats eingesetzt. Da das Kriterium für Wiedererkennung gelockert wurde, ging die Zunahme an Treffern auch mit vermehrtem falschen Alarm einher, besonders auf Distraktor-Items hin, die sich konzeptuell auf die eigentlichen Ziel-Items bezogen oder semantisch mit ihnen assoziiert waren. Dennoch überwogen die Treffer den falschen Alarm auf jedem Konfidenzlevel. Darüber hinaus hatten amnestische Versuchspersonen Schwierigkeiten, die spezielle Liste zu identifizieren, auf welcher die wiedererkannten Items zum Ansehen präsentiert wurden bzw. die korrekte Reihenfolge der Ziel-Items auf der Liste. Insgesamt stützen die Befunde die Schlussfolgerung, dass erfolgreiches Wiedererkennen während PHA wahrscheinlicher durch ein priming-basiertes Gefühl der Vertrautheit vermittelt wird statt durch bewusstes Wiedererkennen.

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Résumé:

Trois expériences ont étudié la reconnaissance au cours de l’amnésie post-hypnotique (PHA) en utilisant des évaluations de confiance plutôt que le format traditionnel oui / non. Au fur et à mesure que le critère de reconnaissance était atténué, l’augmentation des résultats s’accompagnait d’une augmentation des fausses alarmes, en particulier pour les éléments de distraction qui étaient conceptuellement liés ou associés sémantiquement à des cibles. Néanmoins, les résultats ont

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dépassé les fausses alarmes à tous les niveaux de confiance. De plus, les sujets amnésiques avaient des difficultés à identifier la liste particulière sur laquelle les éléments reconnus étaient présentés pour étude ou le bon ordre dans lequel les cibles apparaissaient sur la liste d'étude. Pris ensemble, ces résultats confortent la conclusion qu'une une reconnaissance réussie pendant la PHA est plus susceptible d'être médié par un sentiment de familiarité de basée sur l'amorçage que par un souvenir conscient.

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President-elect of the European Society of Hypnosis

Resumen:

Se estudió el reconocimiento durante amnesia poshipnótica (APH) mediante tres experimentos utilizando clasificaciones de confianza en vez del formato tradicional de sí o no. Conforme los criterios de reconocimiento se flexibilizaron, el incremento en el número de respuestas se acompañó de un incremento en falsas alarmas, especialmente hacia reactivos distractores que estaban conceptual o semánticamente relacionados con los objetivos. Sin embargo, las respuestas excedieron las falsas alarmas en cada uno de los niveles de confianza. Adicionalmente, los sujetos amnésicos tuvieron dificultad para identificar la lista particular en la que presentaba los reactivos reconocidos para su estudio o el orden correcto en el que los objetivos aparecían en la lista de estudio. Estos resultados sustentan la conclusión de que el reconocimiento exitoso durante la APH es más probable que sea mediado por sensaciones de familiaridad basadas en imprimación que en una recolección consciente.

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Keywords

hypnosis; posthypnotic amnesia; recognition; familiarity; Remember/Know paradigm

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Posthypnotic amnesia (PHA) is a disruption in memory for the events of hypnosis, induced and cancelled by suggestion, and observed primarily in highly hypnotizable subjects. The temporary, reversible nature of PHA marks it as a failure of memory retrieval, as opposed to one of encoding or consolidation, or a loss from storage. Thus, PHA is a problem of the accessibility, not availability, of memory (Tulving & Pearlstone, 1966). In an effort to understand the cognitive mechanisms underlying this retrieval failure, research has examined a number of different aspects of the retrieval process (Kihlstrom, 2020a). For example, PHA appears to entail a disorganization of at least some aspects of the retrieval process (Kihlstrom & Evans, 1979; Kihlstrom & Wilson, 1984, 1988; Spanos et al., 1988; Wilson & Kihlstrom, 1986). In addition, PHA appears to spare priming and other aspects of implicit memory, indicating that it affects conscious recollection but not unconscious influences of memory (Barnier et al., 2001; David et al., 2000; Kihlstrom, 1980).

PHA is most commonly assessed with tests of free recall—as in the request, on Item #12 of the Stanford Hypnotic Susceptibility Scale, Form C, to "please tell me everything that happened since you began looking at the target." It is well known from studies of normal memory that other forms of testing, such as cued recall and recognition, are more likely to gain access to available memories than free recall (Malmberg, 2008). Various explanations have been offered for this difference. Traditional two-stage theories of memory retrieval assume that successful recall begins with the generation of candidate items in response to the experimenter's query, followed by a recognition process that discriminates between those items which were actually studied and those which were not (e.g., Anderson & Bower, 1972; Watkins & Gardiner, 1979). Recognition testing obviates the generation process, because the experimenter provides candidate items to the subject. According to an alternative level-of-processing theory, successful retrieval depends on the overlap between cues presented at the time of retrieval and features processed at the time of encoding (Craik & Lockhart, 1972; Lockhart et al., 1976). Recognition testing provides more cues than recall, increasing the likelihood of overlap. Similarly, Tulving's theory of "episodic ecphory" holds that recall and recognition differ only quantitatively, in terms of the informational value of the retrieval cues presented to the subject (Tulving, 1974, 1976; Tulving & Thomson, 1973; Tulving & Watkins, 1973). Recognition tests, which present "copy cues" of the prior experience to the subject, contain more information than free- or cued-recall tests and thus are more likely to gain access to information available in memory.

Whatever the theory, research is unanimous that PHA is densest when assessed with free recall as opposed to cued recall or recognition tests (Allen et al., 1995, 1996; Barber & Calverley, 1966; Kihlstrom & Shor, 1978; Radtke et al., 1987; St. Jean & Coe, 1981; Williamsen et al., 1965). Recognition testing does not abolish PHA entirely, however. Some highly hypnotizable subjects remain amnesic even after viewing a videotape of themselves responding to hypnotic suggestions—perhaps the most informative retrieval cues possible (McConkey & Sheehan, 1981; McConkey et al., 1980). Interestingly, subjects who have been instructed to simulate hypnosis perform *worse* on recognition tests than real hypnotic subjects do—even scoring below chance levels (Barber & Calverley, 1966; Spanos et al., 1990; Williamsen et al., 1965). The demand characteristics (Orne, 1962) of the hypnotic situation are clear: subjects are not supposed to remember what they did during hypnosis, and it should not matter how their memory is tested—whether by free recall, cued recall, or recognition. That recognition is superior to recall during PHA reassures us that real hypnotic subjects are doing something other than responding to the demand characteristics of the experimental situation.

Of course, successful recognition can be accomplished in several different ways. It is now understood that recognition by both amnesic and nonamnesic subjects can be supported by either conscious recollection of the study episode or a priming-based feeling of familiarity (Mandler, 1980; Yonelinas, 2002; Yonelinas et al., 2010). Along similar lines, Tulving (1985) distinguished between two forms of recognition memory: recognition-by-remembering entails retrieval of an episodic memory as part of one's personal past (what Tulving called "autonoetic consciousness"). This personal connection is absent in recognition-by-knowing, in which the subject knows about a past event without actually remembering it—as in the famous patient studied by Claparède, 1911/1951; see also Kihlstrom, 1995, 1997), who retained knowledge acquired though recent experience without remembering the experience itself. Although Tulving initially likened "knowing" to semantic memory, it has become popular to interpret "knowing" in terms of a priming-based feeling of familiarity (e.g., Gardiner, 1988; for a review, see Kihlstrom, 2020b).

Neuropsychological studies of memory suggest that familiarity plays a substantial role in whatever success amnesic patients have on recognition tests (Kihlstrom, 2020b), and this may be the case for PHA as well. In an attempt to distinguish between recollection and familiarity as mediators of recognition, the studies described here substituted a continuous measure of confidence for the traditional, dichotomous, "Yes/No" ratings. Studies of normal subjects indicate that highly confident recognition judgments would be more likely to reflect recollection, and less-confident judgments would be more likely to reflect familiarity (e.g., Kihlstrom, 2020b). Adopting a liberal criterion for recognition, therefore, encourages a reliance on familiarity, and improves amnesic subjects' performance on recognition tests.

Experiment 1: Recognition Confidence

Experiment 1 was intended as a conceptual replication of previous experiments on recognition memory in PHA, substituting a continuous scale of confidence ratings for the dichotomous Yes/No judgments employed heretofore.

Method

While many previous studies of recognition during PHA have employed the items of the standardized hypnotizability scales as targets, the studies reported here employed a more traditional verbal-learning paradigm, testing memory for a list of words memorized during hypnosis.

Subjects.—The primary subjects for this experiment were 16 college undergraduates who scored in the high range (8–12) on the Harvard Group Scale of Hypnotic Susceptibility, Form A (HGSHS:A; Shor & Orne, 1962) and the very high range (11–12) on the Stanford Hypnotic Susceptibility Scale, Form C (SHSS:C; Weitzenhoffer & Hilgard, 1962). All subjects passed the suggestion for PHA on both scales, considering both initial amnesia and reversibility (Kihlstrom & Register, 1984). For the HGSHS:A session, subjects received credit toward the research participation requirement of their introductory psychology course; they received token monetary payments for the second screening with SHSS:C and for the experimental session proper. This experiment, and the others reported in this paper, was approved by the appropriate local Institutional Review Board.

Materials.—Four-word lists were constructed from the Battig and Montague (1969) normative study of category instances, following the procedure described by Kihlstrom (1980, Experiment 2). Two of the lists consisted of 16 items, each drawn from the same four natural categories (First Name of a Woman or Girl, Part of the Human Body, Four-Footed Animal, and Unit of Time), with four items per category; the other two lists consisted of 16 items drawn from four other categories (First Name of a Man or Boy, Country, Article of Clothing, and Color), again with four items per category. The two sets of categories were closely matched in terms of the average number of instances generated by subjects in 30 seconds; within the two lists of the same categories, and across the lists of different categories, the items were closely matched in terms of actual and rated frequency of generation. One of these lists was arbitrarily designated the "critical targets," and was presented to the subjects during the learning phase of the experiment; the remaining lists served as controls: the list containing the same categories as the critical targets was designated the "critical lures"; the other two lists were designated "neutral targets" and "neutral lures," respectively. Assignment of lists to the critical category was counterbalanced across subjects.

Procedure.—The procedure generally followed that employed by Kihlstrom (1980). The subjects in the hypnosis group received the hypnotic induction procedure of SHSS:C and gave a depth report using a 1-to-10 scale (O'Connell, 1964). Following administration of the "Hands Moving Together" suggestion from HGSHS:A, the subjects were asked to memorize the list of critical targets. The words were presented orally by the experimenter at the rate of one item every 3 seconds, followed by oral free recall. Study-test cycles continued until the subjects reached a criterion of two successive perfect repetitions. The subjects were then administered an adaptation of the amnesia suggestion from SHSS:C:

When you awaken… you probably will have the impression that you have slept because you will have difficulty in remembering the things you did while you were hypnotized. In particular, you will not be able to remember that you learned any words while you were hypnotized

Following arrangement of the reversibility cue, the subjects were aroused from hypnosis.

At this point, the subjects completed a series of memory tests in the following order:

Initial Free Recall.: The subjects were asked if they remembered learning any words while they were hypnotized—and, if so, what the words were.

Category Recognition.: The subjects were informed that the list they studied consisted of instances of various categories. They were presented with a typed list of the four critical and four neutral categories, arranged in random order, and asked if they recognized any of them. The subjects made their ratings on a four-point scale of confidence, where 1 = *certain that the category was not on the list*; 2 = *think that the category was not on the list, but not certain*; 3 = *think that the category was on the list, but not certain*; 4 = *certain that the category was on the li*st. In order to facilitate comparison with the subsequent studies reported here, this 1-to-4 scale was converted to a 0-to-3 scale during statistical analysis.

Cued Recall.: The subjects were asked if any of the category labels reminded them of words on the study list—and, if so, to report any such items.

Item Recognition.: The subjects were presented with a printed list of all 64 words, arranged in a random order, and asked to indicate whether any of them were on the study list, employing a four-point confidence-rating scale similar to the one described above: 1 = *certain that the word is new*; 2 = *think that the word is new, but not certain*; 3 = *think that the word is old, but not certain*; 4 = *certain that the word is old*. These judgments were also converted to a 0-to-3 scale.

Final Free Recall.: The experimenter administered the prearranged reversibility cue and a final oral recall test. The subjects were then debriefed and dismissed. The experimental session lasted 60 to 75 minutes.

A second group of 16 subjects completed the learning and testing procedures in the normal waking state, without any prior induction of hypnosis or suggestions for amnesia. Not a control group in the technical sense, these subjects were simply intended to provide a baseline of performance by subjects who had unimpaired memory.

Results

The subjects in both groups learned the list quickly, averaging about five trials to reach criterion. Table 1 shows the proportion of critical targets and lures remembered on the free- and cued-recall tests of memory, and the confidence ratings made on the recognition tests.

Free-Recall Testing of Initial Amnesia and Reversibility.—On the *Initial Free Recall* test of PHA, the hypnosis subjects displayed a dense amnesia, recalling only 3% of the targets on average, while the control subjects, naturally, recalled every item on the list. On the *Final Free Recall* test, after administration of the reversibility cue, the hypnotic subjects had virtually complete recall of the target items. This much was to be expected. The more important results pertain to the hypnotic subjects' performance on the cued recall and recognition tests during amnesia.

On the test of *Category Recognition*, the confidence ratings of the control subjects, also shown in Table 1, clearly distinguished between critical and neutral categories. By contrast, the hypnotic subjects had more difficulty distinguishing between those categories that were represented on their study list and those that were not. A 2 × 2 mixed-design analysis of variance (ANOVA) with one within-subject variable (category, critical or neutral) and one between-groups variable (condition, hypnotic or control) showed that the main effect of category was significant: overall critical categories received higher confidence ratings than neutral ones, $F(1, 30) = 192.40$, $MSE = 43.89$, $p < .001$, $\eta_p^2 = .87$. The main effect of condition was not significant: the two categories yielded approximately the same average confidence level in the two conditions ($F < 1$). Most important, the two-way interaction was significant, $F(1, 30) = 104.18$, $MSE = 23.77$, $p < .001$, $\eta_p^2 = .78$. The control subjects clearly distinguished between critical and neutral categories, while for the hypnotic subjects the difference between them barely reached conventional standards for statistical significance, $t(15) = 2.15$, $p < .05$, *Cohen's* d $= .53$. The confidence ratings for the critical targets were significantly lower for the hypnotic than for the control subjects, $t(30) = 9.49$, $p < .001$, $d = 3.39$, while the difference was reversed for the neutral targets, $t(30) = 6.90$, $p < .001$, $d = 2.45$.

As expected, performance for the hypnotic subjects improved on the *Cued Recall* test (Table 1) over that observed on the Initial Free Recall Test, $t(15) = 6.46$, $p < .001$, $d = 1.62$.

Recognition Confidence Ratings.—On the *Item Recognition* test, the confidence ratings of the control subjects perfectly distinguished between critical and neutral categories —and, within the critical categories, between targets and lures (Table 1). The amnesic

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subjects, by contrast, had much more difficulty doing so. In view of the lack of variance in the control group, further analysis proceeded with only the hypnotic group. A 2 × 2 repeated-measures ANOVA of the recognition confidence ratings made by the hypnotic group yielded significant main effects of category and item, and a significant category × item interaction: the hypnotic subjects were to distinguish between items from the critical and neutral categories, $F(1, 15) = 346.51$, $MSE = 14.96$, $p < .001$, $\eta_p^2 = .96$, and between target and lure, $F(1, 15) = 47.31$, $MSE = 1.54$, $p <$ 001, $\eta_p^2 = .76$; but, most important, they were able to distinguish between critical targets and the other items, $F(1, 15) = 88.26$, $MSE = 2.13$, $p < .001$, $\eta_p^2 = .86$. These differences in confidence ratings, while indicating that subjects with PHA retain a significant ability to distinguish between studied and nonstudied items, pale before the perfect performance of the nonamnesic control subjects.

Recognition Criteria.—The confidence ratings yielded three criteria for the item recognition test (Banks, 1970): a “strict” criterion, counting only those items that received a confidence rating of 4; a “moderate” criterion, adding those items that received confidence ratings of 3; and a “liberal” criterion, including even those items that received confidence ratings of 2 (indicating that the subjects were not sure that the item was *not* on the study list).

Because of the uniformly high confidence ratings of the control subjects, their recognition performance was perfect under the strict criterion and could not change as the criterion was loosened. Therefore, analysis proceeded with only the hypnotic subjects, as shown in Table 2. A 2 × 2 × 3 within-subject ANOVA with two levels of category (critical vs. neutral), two levels of item (target vs. lure), and three levels of criterion (strict, moderate, and liberal) revealed, as expected, a significant main effect of criterion: recognition increased as the criterion was loosened, $F(2, 30) = 450.51$, $MSE = 4.04$, $p < .001$, $\eta_p^2 = .97$. There were also main effects of category, with higher recognition of items from critical as opposed to neutral categories, $F(1, 15) = 394.27$, $MSE = 5.17$, $p < .001$, $\eta_p^2 = .96$, and of list, with targets recognized at a higher rate than lures, $F(1, 15) = 32.12$, $MSE = .574$, $p < .01$, $\eta_p^2 = .68$. The two-way interaction between these two factors was also significant: overall, targets from the critical list were recognized at a higher rate than either lures from that list, or targets and lures from the neutral list, $F(1, 15) = 38.69$, $MSE = .65$, $p < .001$, $\eta_p^2 = .72$.

The interactions involving the criterion factor were naturally of greatest interest. The distinction between critical and neutral categories was clearest at the strict confidence level and blurred somewhat as the criterion was loosened, $F(2, 30) = 40.79$, $MSE = .41$, $p < .001$, $\eta_p^2 = .73$. Neither the two-way interaction between criterion (strict, moderate, or liberal) and item [target or lure; $F(2, 30) = 2.30$, p > .1], nor the three-way interaction among criterion, category (critical or neutral), and item, $F(2, 30) = 2.08$, $p > .10$, met conventional standards for statistical significance.

Planned comparisons confirmed that the hypnotic group correctly recognized a lower proportion of critical targets recognized under each criterion: strict, $t(30) = 36.41$, $p < .001$, $d = 12.91$; moderate, $t(30) = 12.21$, $p < .001$, $d = 4.24$; liberal, $t(30) = 6.12$, $p < .001$, $p <$ 2.26. Similarly, the hypnotic subjects falsely recognized a greater proportion of critical lures:

strict, $t(30) = 14.38$, $p < .001$, $d = 4.60$; moderate, $t(30) = 34.51$, $p < .001$, 7.27; liberal, $t(30) = 15.44$, $p < .001$, $d = 8.77$.

For a signal-detection analysis, correct recognitions of critical targets were counted as hits, and incorrect recognition of critical lures were counted as false alarms (Macmillan & Creelman, 2005; Wickens, 2002). Under the strict criterion, the value of *d'* was 0.51. That is low compared to the value of 7.43 for the control group, but still indicates that the amnesic subjects discriminated between targets and lures at above chance levels. Loosening the criterion for recognition increased the value of *d'*, an outcome also obtained in other cases of memory or sensory impairment (Dorfman et al., 1995; Tataryn & Kihlstrom, 2017). Under the moderate criterion, *d'* rose to 0.81; *d'* fell somewhat, to 0.72 under the liberal criterion, reflecting the substantial increase in false alarms, but nevertheless overall accuracy of the recognition judgments.

Experiment 2: List Differentiation

Experiment 1 confirmed that during PHA subjects are able to recognize items that they cannot recall—especially if the criterion for recognition is loosened somewhat. At the same time, compared to nonamnesic controls, the amnesic subjects were less confident both in their recognition of studied items and categories and in their rejection of nonstudied lures. When these confidence ratings were translated into actual recognition judgments, the amnesic subjects were also less accurate. Even under the most liberal criterion, correct recognition of targets fell short of perfect and was accompanied by a substantial increase in false alarms.

Experiment 2 asked subjects to memorize *two* lists, not just one. In part, this was to make the recognition test more difficult for the controls; but, for the most part, the experiment was intended to determine whether, and to what extent, amnesic subjects could go beyond mere familiarity to retrieve contextual information about the items they recognized. To this end, the experiment employed a list-discrimination procedure originally introduced in the study of retroactive and proactive interference (e.g., Winograd, 1968). In the verbal-learning tradition, list membership serves as a proxy for the episodic context in which a discrete event (such as studying a word) occurred (Anderson & Bower, 1973; Underwood, 1969); remembering the list on which an item appeared is an aspect of source monitoring (Johnson & Raye, 1981; Lindsay, 2008). Performance on list-differentiation is relatively poor when recognition is based on familiarity rather than recollection and reflects controlled rather than automatic processing (e.g., Jacoby et al., 2013; Quamme et al., 2002; Reder et al., 2000; Yonelinas & Jacoby, 1996). Amnesic patients (e.g., Hunkin et al., 2015) and the elderly (e.g., Bastin & Van der Linden, 2005; Overman & Stephens, 2013), two groups whose recognition performance is known to be strongly mediated by familiarity rather than recollection, also perform poorly on list-differentiation tasks.

Method

The method for Experiment 2 closely resembled that of Experiment 1, except that the recognition testing was controlled by a computer.

Subjects.—A fresh group of 24 college undergraduates were recruited for an experiment on hypnosis and learning. All the subjects in the hypnosis condition had scored in the high range on HGSHS:A (8–12) and SHSS:C (11–12) and had passed the suggestions for PHA on both scales. A second group of 24 unselected subjects went through the same procedures in the normal waking state, without any suggestions for amnesia. As before, the subjects received research participation credit for the HGSHS:A session and were paid for the two remaining sessions, each of which lasted 60 to 90 minutes.

Materials.—The wordlists employed in Experiment 2 were the same as those used in Experiment 1.

Procedure.—As in Experiment 1, the subjects in the hypnosis group first received the hypnotic induction of SHSS:C. They then memorized a list of 16 words consisting of four examples from each of four categories (List 1). After they reached a learning criterion of two successive correct repetitions, they were asked to learn a second, closely matched, list of 16 words drawn from the same four categories (List 2). Order of presentation of these two critical lists was counterbalanced across subjects. After reaching the criterion of learning, they received a suggestion for PHA; the suggestion included all the events of hypnosis, including the list-learning trials, but did not specifically mention that there had been two such lists. Following termination of hypnosis, the subjects proceeded through a series of memory tests.

Initial Free Recall.: The subjects were reminded that they had learned two wordlists while they were hypnotized and asked if they remembered what the words were.

They were then seated before a desktop computer that conducted the remainder of the memory tests. The category recognition and cued recall tests of Experiment 1 were eliminated in Experiment 2.

Item Recognition.: The subjects were presented with the 32 studied items from Lists 1 and 2 (critical targets), as well as 32 matched control items drawn from the same categories (critical lures), and another 64 matched items drawn from a different set of categories matched to the first set (32 neutral targets and 32 neutral lures). They were asked to indicate whether they recognized any item from the study phase, disregarding which list the item might have been on. In making their judgments, they were asked to press keys corresponding to a 4-point scale: S = *Certain that the item had been studied*; D = *Think that the item was studied, but not certain*; K = *Think that the item was not studied, but not certain*; L = *Certain that the item was not studied* (a printed card reminded subjects of the key assignments). These responses were given values of 3, 2, 1, and 0, respectively. The computer recorded both responses and response latencies.

List Differentiation.: After eliminating all items that had been rejected with a “0” rating, the subjects were presented with the remaining items (including critical lures, neutral targets, and neutral lures as well as critical targets). This time, the subjects were asked to indicate the list in which the item had been presented, first or second, using a variant of the confidence rating scale described above: “S” if they were certain that the item had been on List 1, and

"L" for List 2; "D" if they thought it was on List 1, or K for List 2; "F" if they were guessing that it was on List 1, and "J" for List 2. Note that subjects were forced to choose a list, even if they were guessing. Assignments to the correct list were assigned values of 3, 2, and 1, respectively, depending on the subject's level of confidence; similarly, assignments to the incorrect list were assigned values of −3, −2, and −1, respectively. In this way, a subject who assigned all recognized items from List 1 to List 1 would receive a confidence score of 3.00; a subject who incorrectly assigned all items from List 1 to List 2 would receive a score of −3.00; a subject who assigned items randomly to a list would receive a score of 0.00.

Final Free Recall.: The experimenter then administered the prearranged reversibility cue and administered a final oral recall test. The subjects were then debriefed and dismissed.

Results

Both groups of subjects were able to learn the two lists easily, averaging only 4.80 trials to criterion for List 1 and 3.98 trials for List 2 (Table 3). A 2 × 2 mixed-design ANOVA yielded significant main effects of both condition [hypnotic vs. nonhypnotic; $F(1, 46) = 27.60$, $MSE = 49.59$, $p < .001$, $\eta_p^2 = .38$] and list [first vs. second; $F(1, 46) = 14.32$, $MSE = 15.84$, $p < .01$, $\eta_p^2 = .24$]; the two-way interaction was not significant, $F1, 46) = 3.40$, $MSE = 3.76$, $p > .05$, $\eta_p^2 = .07$. The overall list effect probably reflected a variant on "learning to learn": the subjects had already learned the categories from the first list. Not too much should be made of the group difference, in view of the nonsignificant interaction.

Free-Recall Testing of Initial Amnesia and Reversibility.—Table 3 also presents the results of free-recall testing of initial amnesia and reversibility. On the initial free recall test, the unhypnotized subjects remembered 90% of the items from List 1 and 98% of the items from List 2, the difference perhaps reflecting retroactive interference from the second list onto the first. By contrast, and as expected, the hypnotic subjects performed much more poorly, recalling only 7–8% of the list items. On the free-recall test of reversibility, after the amnesia suggestion was canceled, recall by the hypnotic subjects was almost perfect, averaging 91 to 97% of the items; by comparison, the nonhypnotic subjects recalled 90 to 96% of the items. By the usual standards of free-recall testing, then, the hypnotic subjects showed a very dense but reversible PHA for the words memorized while they were hypnotized.

Recognition Confidence Ratings.—On the recognition test, the confidence ratings of the control subjects again clearly distinguished between critical and neutral categories—and, within the critical categories, between targets and lures (Table 3). The amnesic subjects, by contrast, had much more difficulty doing so. The confidence ratings were subjected to a 2 × 2 × 2 × 2 mixed-design ANOVA with one between-groups factor (condition, hypnotic vs. control) and three within-subject factors (category, critical vs. neutral; item, targets vs. lures; list, 1 vs. 2). The main effect of condition was not significant, $F(1, 46) = 1.26$. However, the more important condition × category interaction was significant: the hypnotic subjects were less able to distinguish between critical and neutral categories, $F(1, 46) = 16.48$, $MSE = 2.89$, $p < .001$, $\eta_p^2 = .26$. Similarly, the significant condition × item interaction indicated that the hypnotic subjects were also less able to distinguish between targets and lures, $F(1, 46) =$

47.68, $MSE = 7.44$, $p < .001$, $\eta_p^2 = .51$. The most important three-way interaction, condition × category × item, was also significant: the hypnotic subjects were especially unconfident in distinguishing between targets and lures within the critical categories, $F(1, 46) = 44.87$, $MSE = 7.13$, $p < .001$, $\eta_p^2 = .49$.

Concerning the remaining elements of the ANOVA, the main effect of category was significant, with items (both targets and lures) from the critical categories receiving higher ratings than those from the neutral categories, $F(1,46) = 1076.95$, $MSE = 188.88$, $p < .001$, $\eta_p^2 = .96$; in the same way, there was a significant main effect of items, with targets receiving higher ratings than lures, $F(1, 46) = 728.76$, $MSE = 113.69$, $p <.001$, $\eta_p^2 = .94$. Both main effects were qualified by a significant category × item interaction: confidence ratings were especially high for critical targets, compared to critical lures or targets and lures drawn from neutral categories, $F1, 46) = 725.39$, $MSE = 115.19$, $p < .001$, $\eta_p^2 = .94$. There was no significant main effect of list, $F(1, 46) = 2.23$, $p > .10$. Nor were any of the two-, three, or four-way interactions involving the list factor significant (all $F < 2.00$).

Recognition Criteria.—As in Experiment 1, the confidence ratings were employed to generate three criteria for the item recognition test: "strict," "moderate," and a "liberal." Because the list factor had no effects on the confidence intervals, either alone or in combination with other factors, and to simplify the presentation of results, the two lists were combined for further analysis of the item recognition test. The results of the recognition test, by criterion, are presented in Table 4.

The performance of the control subjects was virtually perfect under the strict criterion, leaving little room for improvement as the criterion was loosened: they correctly recognized 98% of the critical targets and incorrectly recognized only 5% of the critical lures; except for 1 subject who incorrectly recognized one neutral lure, they made no false alarms to either neutral targets or neutral lures, even under the liberal criterion. Because there was essentially no variance in the recognition performance of the controls, further analysis proceeded with only the hypnotic subjects.

A 2 × 2 × 3 within-subject ANOVA with two levels of category (critical vs. neutral), two levels of item (critical vs. lure), and three levels of criterion (strict, moderate, and liberal) revealed, as expected, significant main effects of category and item, and a significant interaction between category and item: items from critical categories were recognized more often than those from neutral categories, $F(1, 23) = 215.05$, $MSE = 12.09$, $p < .001$, $\eta_p^2 = .90$; targets were recognized more often than lures, $F(1, 23) = 104.23$, $MSE = 5.25$, $p < .001$, $\eta_p^2 = .82$, and critical targets were recognized more often than either critical lures, neutral targets, or neutral lures, $F(1, 23) = 105.49$, $MSE = 5.42$, $p < .001$, $\eta_p^2 = .82$. There was also a significant main effect of criterion: overall item recognition, including true recognition of targets and false recognition of lures, increased as the criterion was loosened, $F(2, 46) = 30.43$, $MSE = 2.67$, $p < .001$, $\eta_p^2 = .57$. This main effect was qualified by significant two-way interactions with the category and item factors: the increase in recognition was greater for items from the critical vs. neutral categories, $F(2, 46) = 12.62$, $MSE = .44$, $p < .001$, $\eta_p^2 = .35$, and for targets vs. lures, $F2, 46) = 8.14$, $MSE = .03$, $p < .005$, $\eta_p^2 = .26$. The three-way interaction was also significant: as the criterion for recognition was loosened, hits increased, but so did false alarms—first for critical lures, and then for neutral targets and lures as well, $F(2, 46) = 8.44$, $MSE = .03$, $p < .005$, $\eta_p^2 = .27$.

Planned comparisons confirmed that the hypnotic group correctly recognized a lower proportion of critical targets recognized under each criterion: strict, $t(46) = 7.88$, $p < .001$, $d = 2.32$; moderate, $t(46) = 5.18$, $p < .001$, $d = 1.41$; liberal, $t(46) = 2.18$, $p < .05$, $p < 0.53$. Similarly, the hypnotic subjects falsely recognized a greater proportion of critical lures: strict, $t(46) = 4.62$, $p < .001$, $d = 1.27$; moderate, $t(46) = 2.49$, $p < .05$, $d = 0.72$; liberal, $t(46) = 6.28$, $p < .001$, $d = 1.84$.

For the signal-detection analysis, correct recognitions of critical targets were counted as hits, and incorrect recognition of critical lures were counted as false alarms. This analysis was conservative: counting false recognition of neutral targets and or neutral lures would have decreased the proportion of false alarms and inflated the value of *d'*. For the control group, sensitivity changed very little (strict, $d' = 3.63$; moderate, $d' = 3.62$; liberal, $d' = 3.47$). For the hypnotic group, the strict criterion yielded a value of $d' = 2.37$, reflecting many misses but the virtual absence of false alarms. Under the moderate criterion, *d'* fell to 1.73, reflecting the substantial increase in false alarms. Even under the liberal criterion, however, with another increase in false alarms, *d'* was still 1.89. Although the numerical values differ from those obtained in Experiment 1, presumably owing to procedural differences between the two experiments, the same trend was apparent: loosening the criterion for recognition yielded an increase in both correct and incorrect recognition responses; however, hits outweighed false alarms under all criteria.

List Differentiation.—The subjects' confidence ratings on the list-differentiation task are presented in Table 3. Statistical analysis included only critical targets, because the remaining cells contained too much missing data to yield reliable results. As indicated earlier, a positive value indicates that items were correctly assigned to their appropriate list, while a negative value indicates that they were incorrectly assigned to the other list. Falsely recognized critical lures, neutral targets, and neutral lures, of course, did not appear on either list: on average, they should receive a confidence rating of zero, which indeed they do (unweighted $M = -0.001$).

For the list-differentiation task itself, a 2 × 2 mixed-design ANOVA with two levels of condition (hypnotic or control) and two levels of item (targets or lures) applied to the confidence ratings for the critical targets revealed a significant main effect of condition: the hypnotic subjects were less confident than the controls, $F(1, 46) = 16.65$, $MSE = 18.71$, $p < .001$, $\eta_p^2 = .27$. The main effect of list was not significant ($F < 1$), but the condition × list interaction was significant, $F(1, 46) = 7.05$, $MSE = 2.67$, $p < .05$, $\eta_p^2 = .13$: the controls were more confident about List 1 items, while the reverse was true for the hypnotic subjects.

As for accuracy, the confidence ratings were again used to create strict, moderate, and liberal criteria for list differentiation. The proportion of correct and incorrect assignments for critical targets under each criterion is shown in Table 4. A 2 (condition) × 3 (criterion) mixed-design ANOVA applied to the proportion of critical targets assigned to the correct list yielded, as expected, a significant main effect of criterion: list differentiation improved as the criterion was loosened, $F(1, 46) = 29.74$, $MSE = 0.25$, p .001, $\eta_p^2 = .39$. There was also a significant main effect of condition: overall, the control subjects were more accurate than the hypnotic subjects, $F(1, 46) = 22.18$, $MSE = .50$, $p < .001$, $\eta_p^2 = .33$. Most important was the significant condition × criterion interaction: as the criterion was loosened, accuracy improved for the hypnotic subjects but not for the controls, $F(2, 92) = 19.1$, $MSE = 0.16$, $p < .001$, $\eta_p^2 = .29$.

Response Latencies.—Table 5 shows the response latencies associated with the item recognition judgments. Again, ignoring the list factor, a 2 × 2 × 2 mixed-design ANOVA revealed a significant main effect of condition: overall, the hypnotic subjects took significantly longer to respond than did the control subjects, $F(1, 46) = 59.44$, $MSE = 30.03$, $p < .001$, $\eta_p^2 = .56$. There was also a significant main effect of category: overall, subjects responded more slowly to items from critical than neutral categories, $F(1, 46) = 107.27$, $MSE = 16.36$, $p < .001$, $\eta_p^2 = .70$; the main effect of item was not significant, $F(1, 46) = 3.62$, $MSE = .379$, $p > .05$; the category × item interaction was also not significant ($F < 1$). However, both the condition × category and the condition × item interactions were significant: the difference between critical and neutral categories was greater for the hypnosis subjects, $F(1, 46) = 10.77$, $MSE = 1.64$, $p < .005$, $\eta_p^2 = .19$, and the difference between targets and lures was greater for the control subjects, $F(1, 46) = 6.85$, $MSE = .72$, $p < .05$, $\eta_p^2 = .13$. These two-way interactions were qualified by a significant three-way interaction: the control subjects took longer to respond to critical lures, compared to critical targets, but showed no difference in response to neutral lures and targets; the response latencies of hypnotic subjects did not differentiate between targets and lures in either the critical or neutral categories, $F(1, 46) = 10.24$, $MSE = 1.10$, $p < .005$, $\eta_p^2 = .18$.

Table 5 also shows the response latencies associated with the list differentiation judgments. For simplicity in presentation the two lists were again combined, and analysis was confined to the critical targets, where every subject in both groups provided data. A one-way ANOVA showed that there was no difference in response latencies between the control and hypnosis groups ($F = 1.08$).

Experiment 3: Temporal Differentiation

As in Experiment 1, the hypnotic subjects in Experiment 2 showed very dense PHA as tested by free recall. The results of recognition testing again depended on the criterion adopted, with performance by the amnesic subjects approaching that of controls only under the most liberal criterion—but at the expense of a large proportion of false alarms. However, the subjects in Experiment 2 memorized two lists, and the amnesic subjects were both less confident, and less accurate, in assigning recognized items to their proper list. This suggested that successful recognition during PHA is typically mediated by an intuitive feeling of familiarity and that the subjects were relatively unable to recover aspects of the episodic, specifically temporal, context in which the recognized words were presented.

Experiment 3 examined another aspect of temporal context—whether amnesic subjects can recover the sequential relationships between list items. Although there is some debate about whether sequence and other time-related features are encoded automatically in memory

(Hasher & Zacks, 1979; Naveh-Benjamin, 1990), the temporal relations among events are important features of episodic context guiding the search through memory (Yntema & Trask, 1963). Prior research on PHA found that hypnotizable subjects who are able to recall at least the items of the hypnotizability scales, despite the suggestion for complete amnesia, nevertheless display a deficit in temporal organization—that is, they tend not to recall scale items in the order in which they occurred (Evans & Kihlstrom, 1973; Kihlstrom & Evans, 1979); they also show a disruption of serial organization when recalling a wordlist memorized during hypnosis (Kihlstrom & Wilson, 1984; for a review, see Kihlstrom, 2020a). Amnesic patients with damage to the hippocampus and other structures of the medial temporal lobe also have difficulty reconstructing the temporal order of events (Palombo et al., 2019; Palombo & Verfaellie, 2017; Shimamura et al., 1990), as do nonamnesic patients with damage to the prefrontal cortex (Schacter, 1987; Shimamura et al., 1990) and elderly subjects (Seewald et al., 2018). Accordingly, Experiment 3 tested the hypothesis that amnesic subjects would be unable to retrieve information about the temporal order in which recognized items occurred.

Method

The method for Experiment 3 generally followed that of Experiments 1 and 2. A new group of 24 college undergraduates was recruited for an experiment on hypnosis and learning. All the subjects in the hypnosis condition had scored in the high range on HGSHS:A (8–12) and SHSS:C (11–12) and had passed the suggestion for PHA on both scales. A second group of 24 unselected subjects went through the same procedures in the normal waking state, without any suggestions for amnesia. As before, the subjects received research participation credit for the HGSHS:A session. The subjects were paid for the two remaining sessions, each of which lasted 60 to 90 minutes.

Materials.—Following the model of Experiment 1, four-word lists were constructed from the Palermo and Jenkins (1964) normative study of word associations, following the procedure described by Kihlstrom (1980, Experiment 1). Two of the lists consisted of 15 stimulus cues and the association most frequently given to them; the other two lists consisted of a different 15 cues and their closest associates. The two sets of lists were closely matched in terms of the average stimulus-response probability. As in Experiments 1 and 2, one of these lists was arbitrarily designated the “critical targets” and was presented to the subjects during the learning phase of the experiment; the remaining lists served as controls: the list containing the associative responses to the studied items was designated the “critical lures”; the other two lists were designated “neutral targets” and “neutral lures,” respectively.

Procedure.—As in the previous experiments, the subjects in the hypnosis group first received the hypnotic induction of SHSS:C. They then memorized the list of target cues, employing an incremental learning procedure which virtually guaranteed that they would organize the studied items into a strict temporal sequence (Kihlstrom & Wilson, 1984; Mandler & Dean, 1969). On the first learning trial, the experimenter presented just a single word; on the second trial, the experimenter presented the first and second word on the list; on the third trial, the experimenter presented the first, second, and third word, and so on, maintaining a consistent sequence. If necessary, additional learning trials were presented until the subject met a criterion for learning of two successive repetitions (this occurred only once). After reaching the criterion of learning, the hypnotic subjects received the suggestion for PHA, termination of hypnosis, and a series of memory tests.

Initial Free Recall.: The subjects were reminded that they had learned a list of words while they were hypnotized and asked if they remembered what the words were. They were then seated before a personal computer which conducted the remainder of the memory tests.

Item Recognition.: The subjects were presented with the 15 studied critical targets, 15 associated but nonstudied critical lures, 15 matched neutral targets, and 15 critical lures. They were asked to indicate whether they recognized any item from the study phase, pressing keys to indicate their judgments according to a four-point confidence rating scale described in Experiment 2, where 3 = *certain that the item had been studied* and 0 = *certain that the item had not been studied*. Again, the computer recorded both responses and response latencies.

Temporal Sequencing.: Following the recognition test, the subjects completed a test of memory for temporal sequence. The computer presented pairs of critical targets, regardless of whether they had been recognized on the item recognition test; the subjects were informed that they had learned these words while they were hypnotized and asked to indicate whether each pair of words was presented in the same order in which they had been studied. Half the pairs were presented in the order in which the words had been studied; for the remainder, the presentation order was reversed. Four different types of pairs were presented: 14 *0-Lag* pairs, consisting of items that had appeared in immediately adjacent position on the study list (e.g., items presented in positions 4 and 5 or 8 and 7); 8 *1-Lag* pairs, consisting of items that had been separated by one item (e.g., items presented in positions 8 and 10 or 13 and 15); 8 *3-Lag* pairs, separated by three items (e.g., items presented in positions 4 and 8 or 9 and 5); and 8 *5-Lag* pairs, separated by 5 studied items (e.g., items presented in positions 8 and 14 or 13 and 7). For this purpose, the subjects employed a 0-to-3 confidence rating scale described above, where 3 = *certain that the order was correct* and 0 = *certain that the order was wrong*.

Final Free Recall.: The experimenter then administered the prearranged reversibility cue and administered a final oral recall test. The subjects were then debriefed and dismissed.

Results

The subjects in both groups learned the list readily: only 1 subject required a single additional learning trial to reach criterion (Table 6). As intended, the subjects in both groups employed temporal sequencing to organize their memory for the list. Temporal sequencing was quantified by the rank-order correlation (Spearman's *rho*) between the order in which the items were presented and the order in which they were recalled on the final learning trial (Evans & Kihlstrom, 1973; Kihlstrom & Evans, 1979; Kihlstrom & Wilson, 1984). The average value of *rho* was very close to the perfect value of 1.00 for both groups.

Table 6 shows the proportion of critical targets and lures remembered on each recall test of memory and the confidence ratings made on the recognition test.

Free-Recall Testing of Initial Amnesia and Reversibility.—On the initial free recall test of PHA, the hypnosis subjects displayed a dense amnesia, recalling only 1% of the studied items on average, while the control subjects recalled every item on the list. On the final free recall test, following administration of the reversibility cue, the hypnotic subjects had virtually complete recall of the studied items.

Item Recognition.—On the recognition test, the confidence ratings of the control subjects again clearly distinguished between critical and neutral items—and, within the targets, between studied targets and nonstudied lures (Table 6). Again, however, these distinctions were not as clear for the amnesic subjects. The confidence ratings were subjected to a 2 × 2 × mixed-design ANOVA with one between-groups factor (condition, control vs. hypnotic) and two within-subject factors (list: critical vs. neutral; item: targets vs. lures). As in Experiment 1, the main effect of condition was significant: the hypnotic subjects were again both less confident than the nonhypnotic subjects in endorsing critical targets, and less confident in rejecting critical lures, neutral targets, and neutral lures, $F(1, 46) = 15.42$, $MSE = 2.14$, $p < .001$, $\eta_p^2 = .25$. The main effects of list and item was also significant: overall, critical targets and associated lures received higher confidence ratings than neutral targets and lures, $F(1, 46) = 290.30$, $MSE = 53.76$, $p < .001$, $\eta_p^2 = .86$; and critical and neutral targets received higher confidence ratings than their associated lures, $F(1, 46) = 234.16$, $MSE = 38.29$, $p < .001$, $\eta_p^2 = .84$. More importantly, the list × item interaction was significant: all subjects gave higher confidence ratings to target cues than to either target associates, lure cues, or lure associates, $F(1, 46) = 289.21$, $MSE = 42.22$, $p < .001$, $\eta_p^2 = .48$. Most important, all the interactions involving the condition factor were significant. The hypnoti14c subjects were less able to distinguish between targets and lures, $F(1, 46) = 42.04$, $MSE = 7.78$, $p < .001$, $\eta_p^2 = .48$, and between cues and associates, $F(1, 46) = 96.61$, $MSE = 15.80$, $p < .001$, $\eta_p^2 = .68$. Most important of all, the hypnotic subjects were less able than the control subjects to distinguish between the target cues that they had studied and the other, unstudied items: target associates, lure cues, and lure associates, $F(1, 46) = 92.57$, $MSE = 13.59$, $p < .001$, $\eta_p^2 = .67$.

As in the previous experiments, the confidence ratings yielded three criteria for the item recognition test: strict, moderate, and liberal (Table 7). As expected, the performance of the control subjects was virtually perfect under the strict criterion, leaving little room for improvement as the criterion was loosened: they correctly recognized 98% of the target cues and incorrectly recognized only 1% of the target associates; they made very few false alarms to either lure cues or associates, even under the liberal criterion. Because there was essentially no variance in the recognition performance of the control subjects, analysis proceeded with only the hypnotic subjects.

A 2 × 2 × 3 within-subject ANOVA with two levels of list (critical vs. neutral), two levels of item (target vs. lure), and three levels of criterion (strict, moderate, and liberal) revealed, as expected, significant main effects of list and item and a significant list × item interaction: items from the critical lists were recognized more often than their neutral counterparts, $F(1, 23) = 28.19$, $MSE = 3.44$, $p < .001$, $\eta_p^2 = .55$; targets were recognized more often than lures, $F(1, 23) = 7.57$, $MSE = 0.82$, $p < .05$, $\eta_p^2 = .25$, and critical targets were recognized more often than either critical lures, neutral targets, or neutral lures, $F(1, 23) = 13.72$, $MSE = 1.33$,

$p < .001$, $\eta_p^2 = .37$. There was also a significant main effect of criterion: overall item recognition, including true recognition of critical targets and false recognition of critical lures, neutral targets, and neutral lures, increased as the criterion was loosened, $F(2, 46) = 81.54$, $MSE = 6.83$, $p < .001$, $\eta_p^2 = .78$. This main effect was qualified by a significant two-way interaction with the list factor: the increase in recognition was greater for critical than for neutral items, $F(2, 46) = 5.32$, $MSE = .10$, $p < .01$, $\eta_p^2 = .19$. The item × criterion interaction was not significant ($F = 1.74$); nor was the three-way interaction between list, item, and criterion, $F(2, 46) = 2.55$, $MSE = .04$, $p < .10$, $\eta_p^2 = .10$.

Planned comparisons confirmed that the hypnotic group correctly recognized a lower proportion of critical targets recognized under each criterion: strict, $t(46) = 9.71$, $p < .001$, $d = 2.78$; moderate, $t(46) = 5.98$, $p < .001$, $d = 1.69$; liberal, $t(46) = 3.18$, $p < .005$, $d < 0.89$. Similarly, the hypnotic subjects falsely recognized a greater proportion of critical lures: strict, $t(46) = 3.44$, $p < .001$, $d = 0.94$; moderate, $t(46) = 5.16$, $p < .001$, $d = 1.47$; liberal, $t(46) = 9.57$, $p < .001$, $d = 2.78$.

For the signal-detection analysis, correct recognitions of critical targets were counted as hits, and incorrect recognition of critical lures were counted as false alarms. For the control group, sensitivity was very high under the strict criterion, owing to the complete lack of false alarms ($d' = 6.43$), and dropped somewhat as a few false alarms crept in under the looser criteria (both $d' = 4.02$). For the hypnotic group, the strict criterion yielded a value of $d' = 0.86$, reflecting many misses even with relatively few false alarms. Under the moderate criterion, d' remained steady (0.86), as the increase in hits was accompanied by an increase in false alarms. Even under the liberal criterion, however, with another increase in false alarms, d' was still positive (0.69). As in the previous experiments, loosening the criterion for recognition yielded an increase in both correct and incorrect recognition responses; however, hits outweighed false alarms under all criteria.

Table 8 shows the response latencies associated with the item-recognition judgments. A 2 × 2 × 2 mixed-design ANOVA revealed a significant main effect of condition: overall, the hypnotic subjects took significantly longer to make their recognition judgments than did the control subjects, $F(1, 46) = 27.10$, $MSE = 61.61$, $p < .001$, $\eta_p^2 = .37$. This main effect was weakly qualified by a condition × item condition: the control subjects responded slightly more quickly to critical and neutral targets, while the hypnotic subjects responded slightly more quickly to critical and neutral lures, $F(1, 46) = 6.37$, $MSE = .39$, $p < .05$, $\eta_p^2 = .12$. There was also a significant main effect of list: overall, subjects responded more slowly to critical targets and lures, compared to their neutral counterparts, $F(1, 46) = 9.66$, $MSE = 1.20$, $p < .005$, $\eta_p^2 = .17$. The main effect of item was not significant ($F < 1$) nor were the remaining interactions: condition × list, $F = 2.80$; list × item ($F = 1.57$), and condition × list × item ($F < 1$).

Sequence Recognition.—The subjects' confidence ratings on the sequence recognition task are presented in Table 6. As indicated earlier, a rating of 3 indicates that subjects were confident that the item pairs were presented in their correct order, while a rating of 0 indicates that the subjects were confident that the presentation order was reversed. A 2 × 2 × 4 mixed-design ANOVA with two levels of condition (hypnotic or control), two levels of order (correct or reversed), and four levels of lag (0, 1, 3, or 5 items) yielded a highly significant effect of condition: the hypnotic subjects were much less confident in their sequence judgments than the controls, $F(1, 46) = 146.45$, $MSE = 93.58$, $p < .001$, $\eta_p^2 = .76$. There was also a small but significant main effect of order: on the whole, subjects were less confident when presented with the original item orderings, compared to pairs that were reversed, $F(1, 46) = 6.95$, $MSE = 2.56$, $p < .001$, $\eta_p^2 = .13$. The main effect of lag was not significant ($F < 1$) nor were any of the interactions significant (all $F < 1.95$).

As for accuracy, the confidence ratings were again used to create strict, moderate, and liberal criteria for list differentiation. In view of the null effects of the lag variable, Table 7 shows only the aggregate results for the original and reversed ordering. A 2 × 2 × 3 mixed-design ANOVA with one between-groups variable (condition: control or hypnosis) and two within-subject variables (order: original or reversed; criterion: strict, moderate, or liberal) yielded, as expected, a significant main effect of criterion: sequencing accuracy improved as the criterion was loosened, $F(2, 92) = 91.91$, $MSE = 2.10$, $p < .001$, $\eta_p^2 = .67$. There was also a significant main effect of condition, with the hypnotic subjects showing generally lower levels of accuracy, $F(1, 46) = 124.46$, $MSE = 6.96$, $p < .001$, $\eta_p^2 = .73$, and a significant condition × criterion interaction: the hypnotic subjects showed greater increases in accuracy than the controls, $F(2, 92) = 74.05$, $MSE = 1.70$, $p < .001$, $\eta_p^2 = .62$. The main effect of order did not reach conventional levels of statistical significance, $F(1, 46) = 3.55$, $MSE = 0.65$, $p > .05$, $\eta_p^2 = .07$; none of the remaining interactions were significant (maximum $F = 2,71$).

Table 8 also shows the response latencies associated with the list differentiation judgments. Again, combining the four lags, it is evident that response latencies on the sequencing task were considerably longer than those on the item-recognition task. However, a 2 (condition) × 2 (order) mixed-design ANOVA showed that neither main effect was significant: condition, $F < 1$; order, $F = 1.94$; nor was the condition × order interaction, $F(1, 46) = 3.24$, $p > .05$.

General Discussion

Taken together, these three experiments, employing continuous confidence ratings instead of the usual dichotomous yes/no judgments, confirm that subjects experiencing PHA can recognize items that they cannot recall. However, they also indicate that recognition does not abolish PHA entirely. Compared to nonamnesic controls, amnesic subjects were less confident both in their recognition of items memorized during hypnosis and in their rejection of similar items that had not been studied earlier. Employing strict and moderate criteria for recognition, amnesic subjects still failed to remember all the words they had learned. Even under the most liberal criterion, recognition fell short of perfect, as the further increase in hits was accompanied by a substantial increase in false alarms—especially to conceptually or associatively related lures. The amnesic subjects were not merely guessing, however, because hits exceeded false alarms even when the lures were members of the same natural category (Experiments 1 and 2) or close semantic associates (Experiment 3).

These findings demonstrate that PHA illustrates a number of important memory phenomena. Memory improves with cued recall and recognition testing, compared to traditional free-recall testing, in accordance with the principle of cue-dependency in memory (Tulving, 1974). The tendency toward false recognition of conceptually or associatively related lures is similar to the associative and categorical memory illusions documented in other studies of recognition (Knott et al., 2012; Park et al., 2005; Roediger & McDermott, 1995; Smith et al., 2000). Amnesic subjects may have the general idea of the nature of the to-be-remembered items—that they were parts of the human body or somehow related to *sleep*—without being able to remember specific details (Kihlstrom & Evans, 1978; Verfaellie & Cermak, 1994). The fact that targets that go unrecognized during PHA are recalled after the suggestion has been cancelled is an example of the recognition failure of recallable words, illustrating the encoding specificity principle (Tulving & Thomson, 1973).

Taken together, these results are consistent with the hypothesis that recognition during PHA is mediated largely by priming-based feelings of familiarity, rather than by conscious recollection of a prior episode. Under ordinary circumstances, recognition-by-recollection is associated with relatively high degrees of confidence and accuracy, while recognition-by-familiarity is marked by low levels on both dimensions. Moreover, recognition-by-familiarity should lead to a relatively high frequency of false alarms, especially to lures that are conceptually or associatively related to targets.

Additional support comes from the amnesic subjects' performance on the list- and sequence-discrimination tasks. In Experiment 2, the subjects memorized not one but two lists of conceptually related words. Despite relatively good performance on the item-recognition task (depending on the criterion adopted), the amnesic subjects were less confident, and less accurate, in assigning target items to the list on which they had been studied. In Experiment 3, the subjects memorized the items in a strict serial order. Again, despite relatively good recognition performance, they were less confident, and less accurate, in distinguishing pairs of items that were correctly or incorrectly ordered. Although they had access to information about the items themselves, they seemed to lack access to the kind of contextual information that ordinarily supports conscious recollection.

These findings can be understood in terms of a generic associative-network theory of memory such as Mandler's (Mandler, 1980) dual-process theory of recognition. Mandler argues that encoding an event in memory was a product of both automatic and effortful processes. Presentation of an item automatically activates nodes corresponding to pre-existing lexical knowledge stored in semantic memory and integrates them into a coherent representation. In the case of the experiments described here, the nodes would represent single words contained in the study lists—or perhaps their component sublexical phonemes and morphemes (Dorfman, 1994). In the latter case, the phonemic and morphological nodes would be integrated under a node representing the word. If the subjects had studied a list of sentences instead of single words, nodes representing the individual words would be linked together under a new node representing the sentence as a whole. In any event, activation will automatically spread from the node representing the studied item along previously established associative links to nodes representing related knowledge stored in memory—for example, from nodes representing studied words to nodes representing semantically associated words or words belonging to the same natural category.

Depending on task demands (in the case of these experiments, intentional as opposed to incidental learning), the automatic processes of activation and integration are followed by an effortful process of elaboration, which establishes additional links between the event and other stored knowledge—for example, elements of the context in which the study episode occurred (e.g., while the subject was hypnotized). If there were only a single list, nodes representing individual items would be linked to a “list marker” node representing the list as a whole; if subjects studied multiple lists, there would be separate nodes representing each individual list; if they studied a list of categorized items, there would be links to nodes representing the relevant superordinate concepts, as well as to other exemplars; if they studied list items in a consistent sequence, there would be associative links representing the order in which they occurred. In PHA, it appears that the links between item information and context information established during the encoding process are temporarily weakened or disabled during retrieval.

In some respects, the retrieval process recapitulates the process of encoding. Information supplied by, or inferred from, the retrieval cue contacts related information stored in memory. In free recall, cue information is quite impoverished: all that is specified is the spatiotemporal context in which the target events occurred (e.g., “Please tell me everything that happened since you began looking at the target….While you were hypnotized you learned some words. Can you tell me what the words were?”). Then, activation has to reach items associated with that context. If it does, the subject will be able to recall target items confidently and accurately. If the link between item and context is broken or weakened, recall will fail—as it does in PHA. If the subject does manage to recall some target items, they are likely to be disorganized, at least with respect to structures such as temporal sequence, which depends on preservation of links to contextual information.

In recognition testing, the retrieval process works in reverse: the cue will activate nodes corresponding to the item, but in PHA activation cannot spread to the context node. In this case, the residual activation accruing to the item node from the encoding process may give rise to a feeling of familiarity, and, if subjects are encouraged to act on these feelings, they will successfully recognize some, if not most, target items—albeit with low levels of confidence and accuracy. (The same residual activation may enable some list items to come to mind even on a free-recall test.) However, they will not experience the full-scale recollection that occurs when subjects access information about the episodic context in which items were encoded. Moreover, because activation spread to semantically related nodes during encoding, a reliance on recognition-by-familiarity will lead to incorrect recognition of semantically related lures—e.g., close associates or items belong to the same taxonomic category. And when specifically asked to retrieve context information, as in the list-differentiation and sequence-recognition tasks, they will perform relatively poorly, because that context information is relatively inaccessible.

Although it seems likely that their performance on the recognition tests was mediated largely by context-free judgments of familiarity rather than conscious recollection of the study episode, the amnesic subjects did perform better than chance—if also far less than perfectly—on the list-differentiation and temporal-sequencing tasks. It is possible that performance on these tasks can also be mediated, to some extent, by nonepisodic cues. For example, items on the most recently studied of two lists may retain relatively more activation, and thus seem more familiar, then those on the earlier list; and the association between pairs of items that are correctly ordered may seem more familiar than those that are not. But even those judgments, in the absence of decisive contextual information, will be relatively low in confidence and accuracy.

In these experiments, confidence ratings serve as proxies for recognition-by-familiarity, but other experimental approaches are possible (for a review, see Yonelinas, 2001). Employing signal-detection theory, separate receiver-operating characteristic (ROC) curves can indicate the balance between recollection and familiarity under different testing conditions. Recognition judgments made following deep encoding, which encourages elaborative processing, are more likely to be mediated by recollection, while those made following shallow encoding are more likely to be based on familiarity. Alternatively, the process-dissociation procedure can be used to estimate the contributions of controlled and automatic processing underlying recollection and familiarity, respectively.

Perhaps the most direct means of assessment is simply to ask subjects to report their recollective experience, following the "remember/know" (R/K) paradigm introduced by Tulving (1985). In research employing the R/K paradigm, it has become common to interpret remembering as recollection and knowing as familiarity (e.g., Gardiner, 1988; Yonelinas, 2002; Yonelinas et al., 2010). However, it is now clear that recognition-by-familiarity, based on an intuitive feeling of knowing, should be distinguished from recognition-by-knowing, based on more abstract semantic knowledge (Kihlstrom, 2020b). For example, "feeling" and "knowing" ratings can be dissociated from each other, just as each can be dissociated from remembering/recollection. PHA occurs when an item studied in hypnosis cannot be consciously remembered; but, even so, it can feel familiar; or, perhaps, amnesic subjects can simply *know* that an item occurred on the study list, much as they might know the names of the US presidents. Future research on the processes underlying PHA should clearly distinguish between remembering, knowing, and familiarity.

Although this paper is primarily concerned with the nature of posthypnotic amnesia, its findings are generally consistent with Hilgard's (1977) neodissociation theory of divided consciousness. In this view, hypnosis is an altered state of consciousness whose characteristic phenomena involve dissociations between conscious and unconscious streams of mental activity (Kihlstrom, 1984, 1992, 1997, 1998, 2005, 2018). In the case of posthypnotic amnesia, the dissociation is between explicit expressions of episodic memory, such as recall, which require conscious awareness of some past event, and implicit expressions of memory, such as priming effects, which do not. Recognition memory is perhaps an interesting test case, because it can be mediated either by conscious recollection of a prior experience or by a priming-based feeling of familiarity leading to the inference that such an experience occurred. The present results suggest that familiarity-based recognition, based on priming, is relatively unimpaired during posthypnotic amnesia.

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References

Allen JJ, Iacono WG, Laravuso JJ, & Dunn LA (1995). An event-related potential investigation of posthypnotic recognition amnesia. Journal of Abnormal Psychology, 104(3), 421–430. 10.1037/0021-843X.104.3.421 [PubMed: 7673565]

Allen JJB, Law H, & Laravuso JJ (1996). Items for assessing posthypnotic recognition amnesia with the HGSHS:A and the SHSS:C. International Journal of Clinical and Experimental Hypnosis, 44(1), 52–65. 10.1080/00207149608416067

Anderson JR, & Bower GH (1972). Recognition and retrieval processes in free recall. Psychological Review, 79(2), 97–123. 10.1037/h0033773

Anderson JR, & Bower GH (1973). Human associative memory. V. H. Winston & Sons.

Banks WP (1970). Signal detection theory and human memory. Psychological Bulletin, 74(2), 81–99. 10.1037/h0029531

Barber TX, & Calverley DS (1966). Toward a theory of "hypnotic" behavior: Experimental analyses of suggested amnesia. Journal of Abnormal Psychology, 71(2), 95–107. 10.1037/h0023096 [PubMed: 5910959]

Barnier AJ, Bryant RA, & Briscoe S. (2001). Posthypnotic amnesia for material learned before or during hypnosis: Explicit and implicit memory effects. International Journal of Clinical and Experimental Hypnosis, 49(4), 286–304. 10.1080/00207140108410079

Bastin C, & Van der Linden M. (2005). Memory for temporal context: Effects of ageing, encoding instructions, and retrieval strategies. Memory, 13(1), 95–109. 10.1080/09658210344000611 [PubMed: 15724911]

Battig WF, & Montague WE (1969). Category norms for verbal items in 56 categories: A replication and extension of the Connecticut category norms. Journal of Experimental Psychology Monograph, 80(3, Pt.2), 1–46. 10.1037/h0027577

Claparède E. (1951). Recognition and me-ness. In Rapaport D (Ed.), Organization and pathology of thought: Selected sources (pp. 58–75). Columbia University Press. (Original work published 1911) 10.1037/10584-000

Craik FIM, & Lockhart RS (1972). Levels of processing: A framework for memory research. Journal of Verbal Learning and Verbal Behavior, 11(6), 671–684. 10.1016/S0022-5371(72)80001-X

David D, Brown R, Pojoga C, & David A. (2000). The impact of posthypnotic amnesia and directed forgetting on implicit and explicit memory: New insights from a modified process dissociation procedure. International Journal of Clinical amd Experimental Hypnosis, 48(3), 267–289. 10.1080/00207140008415246

Dorfman J. (1994). Sublexical components in implicit memory for novel words. Journal of Experimental Psychology: Learning, Memory, and Cognition, 20, 1108–1125. 10.1037/0278-7393.20.5.1108

Dorfman J, Kihlstrom JF, Cork RC, & Misiaszek J. (1995). Priming and recognition in ECT-induced amnesia. Psychonomic Bulletin and Review, 2(2), 244–248. 10.3758/BF03210964 [PubMed: 24203659]

Evans FJ, & Kihlstrom JF (1973). Posthypnotic amnesia as disrupted retrieval. Journal of Abnormal Psychology, 82(2), 317–323. 10.1037/h0035003 [PubMed: 4754373]

Gardiner JM (1988). Functional aspects of recollective experience. Memory & Cognition, 16, 309–313. 10.3758/BF03197041 [PubMed: 3210971]

Hasher L, & Zacks RT (1979). Automatic and effortful processes in memory. Journal of Experimental Psychology: General, 108(3), 356–388. 10.1037/0096-3445.108.3.356

Hilgard ER (1977). Divided consciousness: Multiple controls in human thought and action. Wiley-Interscience.

Hunkin NM, Awad M, & Mayes AR (2015). Memory for between-list and within-list information in amnesic patients with temporal lobe and diencephalic lesions. Journal of Neuropsychology, 9(1), 137–156. 10.1111/jnp.12040 [PubMed: 24635875]

Jacoby LL, Wahlheim CN, & Yonelinas AP (2013). The role of detection and recollection of change in list discrimination. Memory & Cognition, 41(5), 638–649. 10.3758/s13421-013-0313-x [PubMed: 23529660]

Johnson MK, & Raye CL (1981). Reality monitoring. Psychological Review, 88(1), 67–85. 10.1037/0033-295X.88.1.67

Kihlstrom JF (1980). Posthypnotic amnesia for recently learned material: Interactions with “episodic” and “semantic” memory. Cognitive Psychology, 12(2), 227–251. 10.1016/0010-0285(80)90010-9 [PubMed: 7371378]

Kihlstrom JF (1984). Conscious, subconscious, unconscious: A cognitive perspective. In Bowers KS & Meichenbaum D (Eds.), The unconscious reconsidered (pp. 149–211). Wiley.

Kihlstrom JF (1992). Dissociation and dissociations: A comment on consciousness and cognition. Consciousness and Cognition, 1(1), 47–53. 10.1016/1053-8100(92)90044-B

Kihlstrom JF (1995). Memory and consciousness: An appreciation of Claparede and Recognition et Moiite. Consciousness and Cognition, 4(4), 379–386. 10.1006/ccog.1995.1045 [PubMed: 8750413]

Kihlstrom JF (1997). Consciousness and me-ness. In Cohen JD & Schooler JW (Eds.), Scientific approaches to consciousness (pp. 451–468). Erlbaum.

Kihlstrom JF (1998). Dissociations and dissociation theory in hypnosis: Comment on Kirsch and Lynn (1998). Psychological Bulletin, 123(2), 186–191. 10.1037/0033-2909.123.2.186 [PubMed: 9522684]

Kihlstrom JF (2005). Is hypnosis an altered state of consciousness or what? Contemporary Hypnosis, 22(1), 34–38. 10.1002/ch.20

Kihlstrom JF (2018). Hypnosis as an altered state of consciousness. Journal of Consciousness Studies, 25(11–12), 53–72. 10.1002/ch.20

Kihlstrom JF (2020a). Posthypnotic amnesia. In Groome D & Eysenck M (Eds.), Forgetting: Explaining memory failure. SAGE.

Kihlstrom JF (2020b). Varieties of recollective experience. Neuropsychologia, 137, . 10.1016/j.neuropsychologia.2019.107295

Kihlstrom JF, & Evans FJ (1978). Generic recall during posthypnotic amnesia. Bulletin of the Psychonomic Society, 12(1), 57–60. 10.3758/BF03329624

Kihlstrom JF, & Evans FJ (1979). Memory retrieval processes in posthypnotic amnesia. In Kihlstrom JF & Evans FJ (Eds.), Functional disorders of memory (pp. 179–218). Erlbaum.

Kihlstrom JF, & Register PA (1984). Optimal scoring of amnesia on the Harvard Group Scale of Hypnotic Susceptibility, Form A. International Journal of Clinical and Experimental Hypnosis, 32(1), 51–57. 10.1080/00207148408416000

Kihlstrom JF, & Shor RE (1978). Recall and recognition during posthypnotic amnesia. International Journal of Clinical and Experimental Hypnosis, 26(4), 330–349. 10.1080/00207147808411257

Kihlstrom JF, & Wilson L. (1984). Temporal organization of recall during posthypnotic amnesia. Journal of Abnormal Psychology, 93(2), 200–208. 10.1037/0021-843X.93.2.200 [PubMed: 6725753]

Kihlstrom JF, & Wilson L. (1988). Rejoinder to Spanos, Bertrand, and Perlini. Journal of Abnormal Psychology, 97(3), 381–383. 10.1037/h0092432 [PubMed: 3192837]

Knott LM, Dewhurst SA, & Howe ML (2012). What factors underlie associative and categorical memory illusions? The roles of backward associative strength and interitem connectivity. Journal of Experimental Psychology: Learning, Memory, and Cognition, 38(1), 229–239. 10.1037/a0025201

Lindsay DS (2008). Source monitoring. In Byrne J (Ed.), Learning and memory: A comprehensive reference (Vol. 2, pp. 325–348). Elsevier.

Lockhart RS, Craik FIM, & Jacoby LL (1976). Depth of processing, recognition, and recall. In Brown J (Ed.), Recall and recognition (pp. 75–102). Wiley.

Macmillan NA, & Creelman CD (2005). Detection theory: A user's guide (2nd ed.). Erlbaum.

Malmberg KJ (2008). Recognition memory: A review of the critical findings and an integrated theory for relating them. Cognitive Psychology, 57(4), 335–384. 10.1016/j.cogpsych.2008.02.004 [PubMed: 18485339]

Mandler G. (1980). Recognizing: The judgment of previous occurrence. Psychological Review, 87(3), 252–271. 10.1037/0033-295X.87.3.252

Mandler G, & Dean PJ (1969). Seriation: Development of serial order in free recall. Journal of Experimental Psychology, 81(2), 207–215. 10.1037/h0027767

McConkey KM, & Sheehan PW (1981). The impact of videotape playback of hypnotic events on posthypnotic amnesia. Journal of Abnormal Psychology, 90(1), 46–54. 10.1037/0021-843X.90.1.46 [PubMed: 7264054]

McConkey KM, Sheehan PW, & Cross DG (1980). Post-hypnotic amnesia: Seeing is not remembering. British Journal of Social and Clinical Psychology, 19(1), 99–107. 10.1111/j.2044-8260.1980.tb00934.x

Naveh-Benjamin M. (1990). Coding of temporal order information: An automatic process? Journal of Experimental Psychology: Learning, Memory, and Cognition, 16(1), 117–126. 10.1037/0278-7393.16.1.117

O'Connell DN (1964). An experimental comparison of hypnotic depth measured by self-ratings and by an objective scale. International Journal of Clinical and Experimental Hypnosis, 12(1), 34–46. 10.1080/00207146408409256

Orne MT (1962). On the social psychology of the psychological experiment: With particular reference to demand characteristics and their implications. American Psychologist, 17(11), 776–783. 10.1037/h0043424

Overman AA, & Stephens JDW (2013). Synergistic effects of encoding strategy and context salience on associative memory in older adults. Psychology and Aging, 28(3), 654–665. 10.1037/a0031441 [PubMed: 23437899]

Palermo DS, & Jenkins JJ (1964). Word association norms: Grade school through college. University of Minnesota Press.

Palombo DJ, Di Lascio JM, Howard MW, & Verfaellie M. (2019). Medial temporal lobe amnesia is associated with a deficit in recovering temporal context. Journal of Cognitive Neuroscience, 31(2), 236–248. 10.1162/jocn_a_01344 [PubMed: 30240314]

Palombo DJ, & Verfaellie M. (2017). Hippocampal contributions to memory for time: Evidence from neuropsychological studies. Current Opinion in Behavioral Sciences, 17, 107–113. 10.1016/j.cobeha.2017.07.015

Park L, Shobe KK, & Kihlstrom JF (2005). Associative and categorical relations in the associative memory illusion. Psychological Science, 16(10), 792–797. 10.1111/j.1467-9280.2005.01616.x [PubMed: 16181442]

Quamme JR, Frederick C, Kroll NEA, Yonelinas AP, & Dobbins IG (2002). Recognition memory for source and occurrence: The importance of recollection. Memory and Cognition, 30(6), 893–907. 10.3758/BF03195775 [PubMed: 12450093]

Radtke HL, Thompson VA, & Egger LA (1987). Use of retrieval cues in breaching hypnotic amnesia. Journal of Abnormal Psychology, 96(4), 335–340. 10.1037/0021-843X.96.4.335 [PubMed: 3693684]

Reder LM, Nhouyvanisvong A, Schunn CD, Ayers MS, Angstadt P, & Hiraki K. (2000). A mechanistic account of the mirror effect for word frequency: A computational model of remember-know judgments in a continuous recognition paradigm. Journal of Experimental Psychology: Learning, Memory, and Cognition, 26(2), 294–320. 10.1037/0278-7393.26.2.294

Roediger HL, & McDermott KB (1995). Creating false memories: Remembering words not presented in lists. Journal of Experimental Psychology: Learning, Memory, and Cognition, 21(4), 803–814. 10.1037/0278-7393.21.4.803

Schacter DL (1987). Memory, amnesia, and frontal lobe dysfunction. Psychobiology, 15(1), 21–36. 10.3758/BF03327261

Seewald PM, De Jesus SY, Graves LV, Moreno CC, Mattson SN, & Gilbert PE (2018). Age-related differences on a new test of temporal order memory for everyday events. Aging, Neuropsychology, and Cognition, 25(3), 319–332. 10.1080/13825585.2017.1298716

Shimamura AP, Janowsky JS, & Squire LR (1990). Memory for the temporal order of events in patients with frontal lobe lesions and amnesic patients. Neuropsychologia, 28(8), 803–813. 10.1016/0028-3932(90)90004-8 [PubMed: 2247207]

Shor RE, & Orne EC (1962). Harvard Group Scale of Hypnotic Susceptibility, Form A. Consulting Psychologists Press.

Smith SM, Ward TB, Tindell DR, Sifonis CM, & Wilkenfeld MJ (2000). Category structure and created memories. Memory & Cognition, 28(3), 386–395. 10.3758/BF03198554 [PubMed: 10881556]

Spanos NP, Bertrand LD, & Perlini AH (1988). Reduced clustering during hypnotic amnesia for a long word list: Comment on Wilson and Kihlstrom. Journal of Abnormal Psychology, 97(3), 378–380. 10.1037/h0092433 [PubMed: 3192836]

Spanos NP, James B, & De Groot HP (1990). Detection of simulated hypnotic amnesia. Journal of Abnormal Psychology, 99(2), 179–182. 10.1037/0021-843X.99.2.179 [PubMed: 2348012]

St. Jean R, & Coe WC (1981). Recall and recognition memory during posthypnotic amnesia: A failure to confirm the disrupted search hypothesis and the memory disorganization hypothesis. Journal of Abnormal Psychology, 90(3), 231–241. 10.1037/0021-843X.90.3.231 [PubMed: 7288018]

Tataryn DJ, & Kihlstrom JF (2017). Hypnotic tactile anesthesia: Psychophysical and signal-detection analyses. International Journal of Clinical and Experimental Hypnosis, 65(2), 133–161. 10.1080/00207144.2017.1276358

Tulving E. (1974). Cue-dependent forgetting. American Scientist, 62(1), 74–82.

Tulving E. (1976). Ecphoric processes in recall and recognition. In Brown J (Ed.), Recall and recognition (pp. 352–373). Wiley.

Tulving E. (1985). Memory and consciousness. Canadian Psychologist, 26(1), 1–12. 10.1037/h0080017

Tulving E, & Pearlstone Z. (1966). Availability versus accessibility of information in memory for words. Journal of Verbal Learning and Verbal Behavior, 5(4), 381–391. 10.1016/S0022-5371(66)80048-8

Tulving E, & Thomson DM (1973). Encoding specificity and retrieval processes in episodic memory. Psychological Review, 80(5), 359–380. 10.1037/h0020071

Tulving E, & Watkins MJ (1973). Continuity between recall and recognition. American Journal of Psychology, 86(4), 739–748. 10.2307/1422081

Underwood BJ (1969). Attributes of memory. Psychological Review, 76(6), 559–573. 10.1037/h0028143

Verfaellie M, & Cermak LS (1994). Acquisition of generic memory in amnesia. Cortex, 30(2), 293–303. 10.1016/S0010-9452(13)80200-6 [PubMed: 7924352]

Watkins MJ, & Gardiner JM (1979). An appreciation of generate-recognize theory of recall. Journal of Verbal Learning and Verbal Behavior, 18(6), 687–704. 10.1016/S0022-5371(79)90397-9

Weitzenhoffer AM, & Hilgard ER (1962). Stanford Hypnotic Susceptibility Scale, Form C. Consulting Psychologists Press.

Wickens TD (2002). Elementary signal detection theory. Oxford University Press.

Williamsen JA, Johnson HJ, & Eriksen CW (1965). Some characteristics of posthypnotic amnesia. Journal of Abnormal Psychology, 70(2), 123–131. 10.1037/h0021934 [PubMed: 14274316]

Wilson L, & Kihlstrom JF (1986). Subjective and categorical organization of recall during posthypnotic amnesia. Journal of Abnormal Psychology, 95(3), 264–273. 10.1037/0021-843X.95.3.264 [PubMed: 3745649]

Winograd E. (1968). List differentiation as a function of frequency and retention interval. Journal of Experimental Psychology, 76(2), 1–18. 10.1037/h0025380

Yntema DB, & Trask FP (1963). Recall as a search process. Journal of Verbal Learning and Verbal Behavior, 2(1), 65–74. 10.1016/S0022-5371(63)80069-9

Yonelinas AP (2001). Consciousness, control, and confidence: The 3 Cs of recognition memory. Journal of Experimental Psychology: General, 130(3), 361–379. 10.1037/0096-3445.130.3.361 [PubMed: 11561915]

Yonelinas AP (2002). The nature of recollection and familiarity: A review of 30 years of research. Journal of Memory and Language, 46(3), 441–517. 10.1006/jmla.2002.2864

Yonelinas AP, Aly M, Wang W-C, & Koen JD (2010). Recollection and familiarity: Examining controversial assumptions and new directions. Hippocampus, 20(11), 1178–1194. 10.1002/hipo.20864 [PubMed: 20848606]

Yonelinas AP, & Jacoby LL (1996). Noncriterial recollection: Familiarity as automatic, irrelevant recollection. Consciousness and Cognition, 5(1–2), 131–141. 10.1006/ccog.1996.0008

Table 1.

Experiment 1: Performance on Learning and Memory Tests

Test	Condition	
	Control	Hypnosis
Initial Learning		
Trials to Criterion	5.00 (2.08)	5.06 (1.41)
Proportion of Targets Remembered		
Initial Amnesia (Free Recall)	1.00 (0.00)	0.03 (0.04)
Cued Recall	1.00 (0.00)	0.11 (0.04)
Reversibility (Free Recall)	1.00 (0.00)	1.00 (0.02)
Recognition Confidence Ratings		
Category Recognition		
Critical	2.94 (0.25)	1.81 (0.40)
Neutral	0.06 (0.25)	1.38 (0.72)
Item		
Critical Targets	3.00 (0.00)	1.77 (0.24)
Critical Lures	0.00 (0.00)	1.10 (0.15)
Neutral Targets	0.00 (0.00)	0.44 (0.24)
Neutral Lures	0.00 (0.00)	0.50 (0.22)

Note: Standard deviations in parentheses

Table 2.

Experiment 1: Proportion of Items Recognized by Hypnotic Subjects Under Different Criteria

Category and Criterion	Item	
	Targets	Lures
Critical		
Strict	.27 (0.08)	.13 (0.04)
Moderate	.67 (0.11)	.36 (0.07)
Liberal	.84 (0.10)	.62 (0.10)
Neutral		
Strict	.00 (0.00)	.00 (0.00)
Moderate	.00 (0.02)	.00 (0.02)
Liberal	.44 (0.24)	.46 (0.23)

Note: Standard deviations in parentheses.

Table 3.

Experiment 2: Performance on Learning and Memory Tests

Test	Condition			
	Control		Hypnosis	
	List 1	List 2	List 1	List 2
Initial Learning				
Trials to Criterion	5.71 (1.73)	4.50 (1.22)	3.88 (0.85)	3.46 (0.78)
Proportion of Targets Remembered				
Initial Amnesia (Free Recall)	.90 (.08)	.98 (.04)	.08 (.09)	.07 (.10)
Reversibility (Free Recall)	.90 (.08)	.96 (.05)	.91 (.08)	.97 (.04)
Recognition Confidence Ratings				
Critical Targets	2.95 (.10)	2.94 (.09)	2.28 (.49)	2.25 (.41)
Critical Lures	0.21 (.16)	0.21 (.18)	0.66 (.44)	.61 (.47)
Neutral Targets	0.00 (.00)	0.00 (.00)	0.22 (.36)	0.21 (.35)
Neutral Lures	0.00 (.01)	0.00 (.00)	0.23 (.34)	0.23 (.35)
List Differentiation Confidence Ratings				
Critical Targets (24, 24, 24, 24)[a]	2.46 (0.49)	2.20 (0.71)	1.25 (1.09)	1.65 (1.04)
Critical Lures (21, 17; 23, 23)	0.11 (0.21)	−0.00 (0.19)	0.01 (0.49)	−0.02 (0.42)
Neutral Targets (0, 0; 12, 11)	-----	-----	−0.01 (0.20)	−0.05 (0.18)
Neutral Lures (1, 0; 13, 13)	−0.00 (0.01)	-----	−0.01 (.23)	−0.05 (0.26)

Note: Standard deviations in parentheses.

[a]Values in parentheses indicate the number of subjects in the control and hypnosis groups who provided data for Lists 1 and 2, respectively.

Table 4.

Experiment 2: Item-Recognition and List-Differentiation Performance Under Different Criteria

	Item			
	Control		Hypnosis	
	Item Recognition			
Category	**Targets**	**Lures**	**Targets**	**Lures**
Critical				
Strict	.98 (.03)	.05 (.04)	.50 (.29)	.01 (.02)
Moderate	.98 (.02)	.07 (.05)	.81 (.17)	.18 (.21)
Liberal	.98 (.02)	.09 (.06)	.96 (.05)	.45 (.27)
Neutral				
Strict	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.01)
Moderate	.00 (.00)	.00 (.00)	.01 (.01)	.01 (.02)
Liberal	.00 (.00)	.00 (.01)	.21 (.34)	.22 (.34)
List Differentiation				
	Correct	**Incorrect**	**Correct**	**Incorrect**
Critical Targets				
Strict	.85 (.09)	.08 (.07)	.52 (.31)	.08 (.07)
Moderate	.87 (.09)	.09 (.07)	.65 (.24)	.15 (.14)
Liberal	.89 (.09)	.09 (.07)	.73 (.17)	.23 (.18)

Note: Values are for List 1 and List 2 combined. Standard deviations in parentheses.

Table 5.

Experiment 2: Response Latencies on Memory Tests

Item	Condition	
	Control	Hypnosis
Item Recognition		
Critical Targets	1.18 (0.22)	2.43 (0.84)
Critical Lures	1.58 (0.36)	2.28 (0.47)
Neutral Targets	0.97 (0.17)	1.55 0(.53)
Neutral Lures	0.99 (0.11)	1.63 (0.55)
List Differentiation		
Critical Targets	3.26 (0.82)	3.54 (1.02)

Note: Response latencies in seconds; standard deviations in parentheses.

Table 6.

Experiment 3: Performance on Learning and Memory Tests

Test	Condition: Control		Condition: Hypnosis	
Initial Learning				
Trials to Criterion	16.00 (0.00)		16.04 (0.20)	
Temporal Organization (*rho*)	1.00 (.01)		0.99 (.05)	
Proportion of Targets Remembered				
Initial Amnesia (Free Recall)	1.00 (0.00)		0.01 (0.03)	
Reversibility (Free Recall)	0.99 (0.02)		0.99 (0.03)	
Item Recognition Confidence Ratings				
Critical Targets	2.95 (0.09)		1.65 (0.82)	
Critical Lures	0.01 (0.04)		0.93 (0.51)	
Neutral Targets	0.02 (0.06)		0.59 (0.36)	
Neutral Lures	0.02 (0.05)		0.68 (0.43)	
Sequence Recognition Confidence Ratings				
Item Separation	**Original**	**Reversed**	**Original**	**Reversed**
0-Lag	2.85 (0.28)	2.89 (0.19)	1.92 (0.71)	1.93 (0.49)
1-Lag	2.74 (0.44)	2.81 (0.38)	1.57 (0.74)	2.08 (0.45)
3-Lag	2.81 (0.40)	2.94 (0.21)	1.71 (0.50)	1.94 (0.68)
5-Lag	2.81 (0.46)	2.91 (0.22)	1.75 (0.56)	1.96 (0.57)

Note: Standard deviations in parentheses.

Table 7.

Experiment 3: Item-Recognition and List-Differentiation Performance Under Different Criteria

	Item			
	Control		Hypnosis	
	Item Recognition			
Criterion	**Targets**	**Lures**	**Targets**	**Lures**
Critical				
Strict	.98 (.03)	.00 (.00)	.25 (.37)	.06 (.09)
Moderate	.98 (.03)	.01 (.02)	.56 (.35)	.24 (.22)
Liberal	.98 (.03)	.01 (.02)	.84 (.22)	.62 (.31)
Neutral				
Strict	.01 (.02)	.00 (.01)	.01 (.02)	.02 (.04)
Moderate	.01 (.02)	.00 (.01)	.12 (.13)	.15 (.17)
Liberal	.01 (.02)	.02 (.04)	.46 (.29)	.51 (.30)
Sequence Recognition				
Critical Targets Only	**Original**	**Reversed**	**Original**	**Reversed**
Strict	.93 (.10)	.95 (.07)	.32 (.23)	.36 (.25)
Moderate	.94 (.09)	.96 (.05)	.66 (.19)	.71 (.18)
Liberal	.95 (.07)	.98 (.03)	.89 (.12)	.91 (.10)

Note: Values for sequence recognition are for all lags combined. Standard deviations in parentheses.

Table 8.

Experiment 3: Response Latencies on Memory Tests

Item	Condition			
	Control		Hypnosis	
Item Recognition				
Critical Targets	1.18 (0.48)		2.53 (1.21)	
Critical Lures	1.22 (0.37)		2.31 (1.09)	
Neutral Targets	1.09 (0.31)		2.19 (0.94)	
Neutral Lures	1.17 (0.35)		2.17 (1.00)	
Sequence Recognition				
	Original	**Reversed**	**Original**	**Reversed**
Critical Targets	3.85 (0.92)	4.26 (1.45	3.91 (1.38)	3.86 (1.38)

Note: Response latencies in seconds; standard deviations in parentheses.