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Temporal Organization of Recall During Posthypnotic Amnesia

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Amnesia suggestions were administered to 35 subjects of low, medium, and high hypnotic susceptibility who had learned a word list while hypnotized The method encouraged subjects to organize the words sequentially. Organization of recall was measured on recall trials conducted before, during, and after suggested amnesia. Highly hypnotizable subjects showed a breakdown in temporal organization during amnesia, followed by a recovery of this organization after the suggestion was canceled Posthypnotic amnesia apparently involves a disruption in the contextual relationships among memory items.

Posthypnotic amnesia is observed when, following the administration of appropriate suggestions, hypnotizable subjects cannot remember the events and experiences that transpired while they were hypnotized. The amnesia is temporary, and memory is restored after a prearranged cue has been given to cancel the suggestion. The property of reversibility indicates that the amnesia involves a disruption in memory retrieval rather than of encoding or storage. Current theories in cognitive psychology agree that information is stored in memory in an organized fashion and that following the organization imposed on the items at the time of encoding is the key to successful retrieval. From this point of view, posthypnotic amnesia may reflect a disruption in the process of organized memory retrieval. Investigating the disorganization hypothesis poses a problem in that the most highly hypnotizable subjects typically show levels of amnesia that are too dense to permit examination of the organization of recall. That is, they either remember none of the critical items or recall too few to permit such an analysis to be meaningful.

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A series of investigations by Kihlstrom and Evans (1979; Evans & Kihlstrom, 1973) examined several features of the organization of recall for suggestions administered during standardized hypnotic testing procedures. In this analysis, subjects who recalled fewer than three of the nine critical suggestions—thus precluding meaningful analysis of the organization of recall—were excluded from consideration. For the remaining subjects, a variety of evidence indicates that relatively hypnotizable individuals often manifest partial responses to the amnesia suggestion, even though they may successfully recall many or most of the critical items, whereas insusceptible subjects typically give no signs of recall difficulty (Kihlstrom & Evans, 1979). Accordingly, in these studies organization was compared in hypnotizable and in insusceptible subgroups. The analysis of organization focused on spatiotemporal relationships because such contextual features are central elements of memories for personal experiences—known as *episodic* memories (Jacoby & Craik, 1979, Tulving, 1972). Introspection suggests that the most salient organizational rubric for such material has to do with the temporal sequence in which the events take place. These intuitions are supported by evidence that seriation is the preferred method of organizing both lists of items and of narrative prose (G. Mandler, 1969, 1979; G. Mandler & Dean, 1969; J. Mandler, 1979). This extends even to material that is highly structured along other lines, such as categorized wordlists (G. Mandler, 1969). The experiences of a hypnotic testing session can be considered either as a list of discrete

items that subjects must recall after a single presentation or as an organized story that they must tell. In either case, temporal sequence is the dominant organizational feature of the material to be remembered. Accordingly, the analysis focused on the extent to which output order corresponded to the order in which the items actually occurred during the hypnosis session. Examining three different hypnotizability scales administered to a group of subjects, Evans and Kihlstrom (1973) found that levels of temporal organization during amnesia were consistently lower in hypnotizable compared to insusceptible subjects. These findings were replicated by Kihlstrom and Evans (1979) in two further samples of subjects who received a total of three different scales. Temporal disorganization was not observed in a fourth sample, for whom the amnesia suggestion was deleted from the hypnotic procedure. Thus, the temporal disorganization appeared tied to suggested amnesia rather than to any effect of hypnosis alone or to the cognitive styles of highly hypnotizable individuals

Similar disorganization effects have been observed in conceptual replications involving conventional verbal-learning procedures. For example, Spanos and Bodorik (1977) taught hypnotized subjects a wordlist consisting of three items drawn from each of three categories, followed by amnesia suggestions and recall tests administered during (rather than after) hypnosis. Compared to levels established on the criterion learning trial, the subjects showed a decrement in category clustering during the time that the amnesia suggestion was in effect, followed by a return to baseline levels after the suggestion was canceled. These findings have been replicated a number of times using a nine-item wordlist (Radtke-Bodorik, Spanos, & Haddad, 1979; Spanos, Radtke-Bodorik, & Stam, 1980) Coe and his colleagues (Coe, Taul, Basden, & Basden, 1973) failed to obtain the effect with a 35-item categorized wordlist, but this was probably due to poor learning: Subjects were given only three study trials. A subsequent experiment, which permitted somewhat better mastery of a long list, did show the effect (Radtke-Bodorik, Planas, & Spanos, 1980). It is interesting that disorganization is not consistently found in unhypnotized subjects who are strongly motivated to forget the critical material (Radtke-Bodorik et al., 1979, 1980; Spanos & Bodorik, 1977; Spanos et al, 1980) nor is it found in subjects who are specially motivated to simulate amnesia (Spanos et al., 1980).

Somewhat paradoxically, however, the initial finding of temporal disorganization itself has been cast into doubt. Two investigations largely failed to replicate the effect (Radtke & Spanos, 1981; St. Jean & Coe, 1981), although a more recent attempt was successful (Geiselman et al., 1983) More important, Radtke and Spanos (1981) offered a critique of the methodology employed in these studies, leading them to conclude that the temporal disorganization effect has not yet been convincingly demonstrated. Their critique focused on five points: (a) There was no assessment of the degree of initial learning, making it difficult to assess the degree of amnesia displayed by the subjects, (b) the memory task was somewhat ambiguous in that it may have been unclear to some subjects what they were supposed to be remembering, (c) the time period allotted for recall may have been too short, (d) there was no assessment of the recovery of memory, and of organization, after the amnesia was reversed, and (e) the rho-score statistic used to quantify temporal disorganization was unconventional and has certain undesirable psychometric properties—although other commentators have disagreed (Pellegrino & Huber, 1982). Although these methodological problems cannot account for the failures to replicate, the criticisms are valid in their own right and deserve to be addressed

The purpose of this study was to document the phenomenon of temporal disorganization in recall during posthypnotic amnesia, employing a procedure that was free of the methodological shortcomings described earlier. For this purpose, the paradigm was switched from one involving incidental memory for personal experiences to one involving intentional memory for word list items. In addition to replicating the effect, the change in procedure permitted a more thorough consideration of the phenomenon from the perspective of contemporary theories of memory. It was predicted (a) that hypnotizable subjects would show a disruption in temporal sequencing during the time that the amnesia suggestion was in effect and (b) that the amount of dis-

organization would be correlated with the extent of the recall deficit observed.

Method

Subjects

The 35 participants in this experiment were drawn from a pool of University of Wisconsin students who had previously received an administration of the Harvard Group Scale of Hypnotic Susceptibility, Form A (HGSHS A) followed by the Stanford Hypnotic Susceptibility Scale, Form C (SHSS C) On the basis of their SHSS C scores the subjects were classified as low (0–4), medium (5–7), or high (8–10) in hypnotizability, with 10 subjects in each of the low and medium groups, and 15 subjects in the high group Subjects were sampled for this experiment from larger pools within each stratum Subjects of very high hypnotizability (scoring 11–12 on the 12-point SHSS C) were eliminated from the experiment because of their typically dense amnesia (Kihlstrom, 1980) In the experiment itself all subjects were treated as if they were hypnotizable They were paid $4 for a single experimental session that lasted 60 min

Stimulus Materials

A 16-item word list was drawn up consisting of the third most frequently given instances of the first 16 categories of Battig and Montague (1969) A category was excluded if the target item was not a noun or if it rhymed with or had the same first letter as another word in the stimulus list

Procedure

Subjects were recruited for an experiment on hypnosis and learning, and were treated as if they were hypnotizable At the beginning of the experimental session, each subject was hypnotized using the standard induction procedure of SHSS C The word list was read to the subjects at a rate of one word every 3 s, each subject received a different random order of the words Following the procedure of G Mandler and Dean (1969), the list was incremented by one word on each trial, with the new item presented at the end of the list Thus on Trial 1 the subjects were read the first word, on Trial 2 they were read the first word and then the second word, and so on On Trial 16 and on subsequent trials, the list was presented in its entirety, in a standard order Oral recall followed each trial until the subjects indicated that they had reached an impasse, thus there were no time constraints placed on the subjects' recall Study–test cycles continued beyond Trial 16, if necessary, until the subject reached a criterion of two successive perfect repetitions Subjects were instructed simply to recall all the words they could, they were not given specific instructions for serial recall The experimenter then administered the following amnesia suggestion

> Now remain deeply relaxed and pay close attention to what I am going to tell you next In a moment I shall count backwards from 20 to 1 and at 1, not sooner, you will open your eyes and no longer be hypnotized . 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 After waking you will have no memory that I told you these words, or what the words were You will not be able to remember them until I say to you, "Now you can remember everything" Then you will be able to remember everything, including the fact that you learned some words and what they were But you will not be able to remember these things until I say to you, "Now you can remember everything" (Kihlstrom, 1980, p 232)

After awakening from hypnosis the subjects were asked to recall any words that they remembered learning during the experiment Then the experimenter administered the prearranged reversibility cue to cancel the amnesia suggestion, followed by a final recall test Again, there was no instruction concerning the order of recall on either of these tests Finally, the subjects were interviewed concerning their experiences during the session, debriefed, and dismissed

Results

The subject selection procedure insured that the three groups would differ substantially in hypnotizability, as measured by SHSS C, and the experimental procedure guaranteed that all subjects would show perfect mastery of the word list before amnesia was suggested. In addition to the 35 subjects who were included in the data analysis, 3 subjects of high hypnotizability were excluded because they had recalled too few items during the amnesia test (<3) to permit analysis of organization, 1 subject of medium hypnotizability was excluded for failing to show serial organization during the acquisition phase.

Initial Learning

There were no group differences in the number of trials required to reach criterion during the acquisition phase (overall M = 17.57, SD = .95; $F(2, 32)$ = 1.41, *ns*). A generalized index of the subjective organization of recall is the pair frequency (PF) measure of bidirectional intertrial repetitions, a statistic based on the number of words appearing in the same adjacent output positions on two successive recall trials. The formula includes a correction for chance, and Sternberg and Tulving (1977) have shown that PF is superior on psychometric grounds to all other available indices of organization. The degree of subjective organization in recall at the conclusion of

the acquisition phase was determined by calculating PF from the penultimate and final learning trials. The three groups were equivalent on this measure as well (overall M = 12.67, SD = .92; $F(2, 32)$ = 1.49, *ns*). For both the amnesia and the reversibility tests, PF was calculated using the order of recall on the final trial of the acquisition phase as the criterion of subjective organization established at the time of acquisition.

Choosing an Index of Temporal Organization

Pair frequency is a generalized index of subjective organization, sensitive to the presence of any structure consistently imposed on recall output; however, it does not in itself reveal the nature of the subject's organizational scheme This can only be determined by examining the output protocols directly or by testing the output against an explicit model specified by the experimenter's hypothesis. To test for temporal organization, the order of recall on any trial was compared to the order of input during acquisition (G. Mandler, 1969, G. Mandler & Dean, 1969; Pellegrino & Battig, 1974; Pellegrino & Ingram, 1979). This analysis employed unidirectional intertrial repetitions (ITR), a variant of PF. Consistent with the hypothesis of temporal organization, which states that subjects begin their recall at the beginning of their lists and proceed to the end, only forward repetitions were counted. There were very few backward repetitions observed, and no instances of significant backward sequencing, which might also be construed as reflecting temporal organization (Radtke & Spanos, 1981) As with the bidirectional PF measure, high values of ITR indicate a high degree of organization—in this application, specifically *temporal* organization—in recall. For a list of 16 items, the maximum value of both PF and ITR is 13.13.

However, the value of PF, ITR, and related measures is dependent on the number of items recalled. Consider a hypothetical subject in this experiment, who recalls all 16 items in perfect temporal sequence on the last trial of the acquisition phase. According to the formula given by Sternberg and Tulving (1977), the corresponding value of ITR is 13.13. Assume, further, that the subject recalls only the first 5 items on the initial amnesia test, followed by the first 15 items on the reversibility test; in both these cases, the sequence of items is exactly the same as that employed during acquisition. The corresponding values of PF are 3.5 and 12.3—an apparent loss and (substantial) recovery of subjective organization, even though the output order of the recalled items has not changed at all As another illustration of this problem, the maximum values of PF for lists of 5, 10, and 15 items, respectively, are 2.40, 7.20, and 12.13. This situation raises the possibility that any diminution of organization observed during amnesia might be an artifact of ceiling effects produced by the limited number of items recalled. The problem may be corrected by calculating the ratio of the obtained PF to the maximum possible PF, given the number of items recalled (Pellegrino, 1971; Pellegrino & Battig, 1974; Pellegrino & Huber, 1982). Although the correction is controversial (Pellegrino, 1971; but see Sternberg & Tulving, 1977), it seemed appropriate to analyze the data using both the original and the adjusted ratio measures. In the case of the example given above, these corrected PF scores all equal 1.00, reflecting their perfect sequential organization despite reduced levels of recall.

Furthermore, the ITR measure of serial organization is sensitive only to sequential dependencies among immediately adjacent items. Thus, if a list consisting of items ABCDEF has been encoded in that order, sequences such as AB and DE count as instances of seriation, whereas sequences such as AC and DF do not. It may be argued, however, that the sequential relationships between items in such nonadjacent pairs have been preserved and should be considered in any analysis of temporal organization. This can be accomplished by recalculating ITR, considering only those items that are recalled during the amnesia test, and treating unrecalled items as if they had not been presented at all.

Finally, following the procedure of the earlier studies (Evans & Kihlstrom, 1973; Geiselman et al., 1983; Kihlstrom & Evans, 1979; Radtke & Spanos, 1981; St. Jean & Coe, 1981), Spearman's rank–order correlation coefficient (rho) was calculated between the order in which items were recalled on the three tests and the order in which those items had been

presented during the acquisition phase. A rho score of 1.00 records a perfect correspondence between the order of presentation and the order of recall. Kendall's tau statistic was also calculated, again expressing the degree of correlation between these two orderings. Tau is scaled differently than rho, but again a score of 1.00 indicates perfect sequential ordering Neither rho nor tau require a correction for ceiling effects, and both are sensitive to sequential relationships among both adjacent and nonadjacent items.

By any measure, the results revealed—as expected—a uniformly high degree of temporal organization in recall on the final trial of the acquisition phase (raw ITR, overall M = 12.70; adjusted ITR, overall M = .96; rho, overall M = 1.00; tau, overall M = 1.00; all Fs < 1). Thus the three groups were comparable in terms of the degree of initial learning. Recall was highly organized, and the structure imposed by the subjects on their lists was uniformly temporal in nature, as required by the experiment.

Hypnotizability, Recall, and Temporal Organization

Although the temporal disorganization hypothesis is applicable to posthypnotic amnesia generally, it can only be tested in cases of partial as opposed to complete amnesia (Kihlstrom & Evans, 1976) for the simple reason that it is impossible to measure the organization of recall in subjects who remember little or nothing of what they have learned. Because posthypnotic amnesia is correlated with hypnotizability (Hilgard, 1965; Kihlstrom, 1980), hypnotizable subjects should show greater disorganization than those who are insusceptible to hypnosis. Table 1 presents the average number of items recalled, and the average values for PF and each index of temporal organization, for the hypnotizability groups on each of three tests of recall as compared to the order of input: Test 1, the final trial of the acquisition phase; Test 2, during suggested posthypnotic amnesia; and Test 3, after the amnesia suggestion was canceled by the prearranged reversibility cue.

A 3 × 3 mixed-design analysis of variance (ANOVA) with one between-subjects factor (hypnotizability) and one within-subjects factor (repeated recall tests) applied to the number of items recalled yielded significant main effects of both hypnotizability, $F(2, 32) = 25.48$, $p < .001$, and trials, $F(2, 64) = 49.64$, $p < .001$, as well as a significant interaction between these factors, $F(4, 64) = 30.15$, $p < .001$. A planned comparison confirmed a significant decrement in recall on Trial 2 among subjects of high hypnotizability, $F(2, 32) = 30.80$, $p < .001$

Although the PF scores are technically indices of subjective organization rather than of seriation, they amount to the same thing in this data because order of recall on each trial of the acquisition phase corresponded so closely to order of presentation. The 3 × 3 mixed-design ANOVA applied to the raw PF scores revealed significant main effects of hypnotizability, $F(2, 32) = 11\ 86$, $p < .001$, and trials, $F(2, 64) = 37.82$, $p < .001$, as well as a significant interaction, $F(4, 64) = 11\ 97$, $p < .001$ A planned contrast examined the extent to which the hypothesized pattern of loss followed by recovery of subjective organization occurred in each group. In this contrast, organization on Test 2 (during amnesia) was compared to the average organization displayed on Tests 1 and 3 (before and after amnesia). A one-way factorial ANOVA confirmed a significant decrement in subjective organization on Test 2 among the highly hypnotizable subjects, $F(2, 32) = 11.92$, $p < .001$. The 3 × 3 ANOVA applied to the adjusted PF scores confirmed the effects· hypnotizability, $F(2, 32) = 7.78$, $p < .005$; trials, $F(2, 64) = 23\ 90$, $p < .001$; and interaction, $F(4, 64) = 6.35$, $p < .005$. The contrast was also significant, $F(2, 32) = 7\ 02$, $p < .005$.

Seriation was explicitly assessed by the ITR measure, counting all items recalled on Trial 1. The 3 × 3 mixed-design ANOVA applied to these scores revealed significant main effects of both hypnotizability, $F(2, 32) = 7.91$, $p < .005$, and trials, $F(2, 64) = 38\ 17$, $p < .001$, as well as a significant interaction, $F(4, 64) = 13.29$, $p < .001$. The planned contrast confirmed a significant deficit in temporal sequencing on Test 2 among the highly hypnotizable subjects, $F(2, 32) = 14.27$, $p < .001$. The same ANOVA performed on the adjusted ITR scores confirmed all of these effects: hypnotizability, $F(2, 32) = 6.25$, $p < .01$; trials, $F(2, 62) = 30.41$, $p < .001$; interaction, $F(4,$

62) = 11.47, $p < .001$; and contrast, $F(2, 32) = 11.85$, $p < .001$.

For the raw ITR measure considering only common items, the 3 × 3 ANOVA showed significant main effects of both hypnotizability and trials (both $ps < .001$) and a strong trend toward an interaction between these two factors, $F(4, 64) = 2.86$, $p < .10$. For the adjusted scores, the main effects were retained, and the interaction became significant, $F(4, 64) = 7.17$, $p < .001$ Again, both planned comparisons showed that the predicted pattern of loss followed by recovery of temporal organization was greater in hypnotizable than in insusceptible subjects: raw, $F(2, 32) = 2.86$, $p < .10$, adjusted, $F(2, 32) = 8.52$, $p < .005$

The 3 × 3 ANOVAs applied to the rho and tau scores yielded similar significant main effects (all $ps < .05$). In particular, the interaction of hypnotizability and trials was significant in both cases: rho, $F(4, 64) = 3.18$, $p < .005$; tau, $F(4, 64) = 4.18$, $p < .005$ The planned contrast was also significant for both measures: rho, $F(2, 32) = 3.28$, $p < .05$); tau, $F(2, 32) = 4.51$, $p < .05$.

Temporal Organization and Amnesia

According to the hypothesis of this study, disorganized retrieval is held to be correlated with posthypnotic amnesia. Although some subjects might manage to remember the entire list correctly but still show disorganized recall, disorganization should be most clearly apparent in those who show a recall decrement on the amnesia test. This question could be addressed by a set of three-way ANOVAs, adding an amnesia factor to the hypnotizability and trials factors of the previous ones. However, any dichotomous criterion for amnesia must

Table 1
Organization of Recall for Subjects Classified by Hypnotizability

	Low			Medium			High		
Variable	T1	T2	T3	T1	T2	T3	T1	T2	T3
Number of items recalled	16 00 (.00)	15 10 (1.29)	15 60 (70)	16.00 (.00)	14 60 (2 99)	15 90 (32)	16 00 (.00)	7 33 (4 47)	15.80 (52)
Raw PF, all items	12 90 (63)	10 61 (2 88)	12 25 (1 14)	12 90 (0 63)	10 68 (4 64)	12 71 (1 23)	12.37 (1 16)	3 17 (4 47)	11 79 (1 93)
Adjusted PF, all items	99 (05)	85 (19)	.96 (07)	.99 (05)	84 (30)	.98 (08)	94 (10)	42 (37)	.91 (14)
Raw ITR, all items	12.80 (0 95)	10 41 (2 88)	11 86 (1 76)	12.80 (95)	10 58 (4 86)	12 52 (1 83)	12 57 (1.13)	2 86 (4 70)	12.13 (2.20)
Adjusted ITR, all items	.98 (.07)	.83 (.20)	93 (12)	98 (.07)	.82 (35)	96 (13)	93 (12)	.28 (42)	.96 (.05)
Raw ITR, common items	12.31 (1 29)	10.51 (3 08)	11 91 (1 60)	11 43 (3 71)	10 72 (4 75)	11 43 (3 71)	4.69 (4 29)	2 43 (5.20)	4.69 (4.29)
Adjusted ITR, common items	1 00 (.00)	.84 (21)	1 00 (00)	94 (18)	.84 (.36)	.94 (18)	1 00 (.00)	19 (77)	1.00 (00)
Rho correlation, common items	1 00 (.00)	97 (.08)	1 00 (00)	1 00 (.00)	90 (.29)	1.00 (.01)	1.00 (01)	.65 (.41)	.98 (.11)
Tau correlation, common items	1 00 (.01)	97 (.08)	.99 (01)	1 00 (.01)	90 (.29)	99 (03)	99 (02)	60 (.41)	.95 (.16)

Note T1 = Trial 1; T2 = Trial 2, T3 = Trial 3 PF = pair frequency, ITR = intertrial repetitions PF is a measure of subjective organization, all other indices are measures of serial organization Adjusted values (in parentheses) represent the proportion of observed to maximum possible organization, given the number of items recalled

be arbitrary to some extent (Kihlstrom & Register, 1984; Radtke & Spanos, 1981), and, in addition, the correlation between hypnotizability and amnesic status makes these factors nonorthogonal. Accordingly, each of the indices of organization were correlated with two continuous measures of amnesia: (a) recall deficit, measured by the difference in items recalled between Trial 1 (before amnesia) and Trial 2 (during amnesia); and (b) reversibility, measured by the corresponding difference between Trial 3 (after amnesia) and Trial 2 (during amnesia). High scores indicate greater amnesia, so the prediction is of a negative correlation with recall organization. The two amnesia indices themselves were highly correlated ($r = .99$, $p < .001$). Table 2 shows that all of the relevant correlations are highly significant (all $ps < .001$).

Table 2
Relation Between Organization and Recall During Posthypnotic Amnesia

Index of recall organization	Index of amnesia: Recall deficit[a]	Index of amnesia: Reversibility[b]
PF, subjective		
Raw value[c]	−.96	−.94
Adjusted value[c]	−.76	−.77
ITR, serial		
All items, raw[c]	−.95	−.94
All items, adjusted[c]	−.83	−.81
Common items, raw[d]	−.95	−.94
Common items, adjusted[d]	−.71	−.71
Rank order, serial		
Rho correlation[d]	−.57	−.57
Tau correlation[d]	−.63	−.63

Note $N = 35$, all $ps < .001$
[a] Recall on Trial 1 − Recall on Trial 2 [b] Recall on Trial 3 − Recall on Trial 2. [c] Considers all items recalled on Trial 1 [d] Considers only items recalled on both Trials 1 and 2

Discussion

The present findings confirm earlier observations of temporal disorganization in recall during posthypnotic amnesia (Evans & Kihlstrom, 1973; Kihlstrom & Evans, 1979) During the acquisition phase, the subjects organized the items into a consistent temporal sequence, arranging them in order of presentation. Although the levels of temporal organization largely continued to exceed what would have been expected by chance alone, they were significantly diminished during the time that the amnesia suggestion was in effect. Temporal sequencing reverted to its high baseline level after the amnesia suggestion was canceled by the prearranged reversibility cue. This breakdown and recovery of temporal organization was displayed in 13 of the 15 partially amnesic subjects (1/1 lows, 2/2 mediums, and 10/12 highs). That some degree of temporal organization is maintained is not surprising, as these subjects are after all only partially amnesic. In theory, a complete disorganization would have resulted in a total recall failure. However, confident generalization from partial to more complete forms of amnesia requires converging evidence from other experimental paradigms.

These results may be viewed from within standard network models of memory, such as ACT (Anderson, 1980, 1983). Such models construe memory as a network consisting of nodes representing concepts and associative links representing the relations between concepts. Encoding an event involves activating nodes in this preexisting network and linking them together to form one or more propositions. Some of these propositions represent the relationships among features of the event, including the context in which it occurs, whereas others express the relationships between the events themselves. Links between the event and the spatiotemporal context in which it occurs are critical for the formation of episodic memories. Retrieval of such a trace begins with a query to the memory system Nodes corresponding to cue information provided by the query are activated, and activation spreads out along the associative pathways fanning out from each node. Where activated pathways intersect, given a superthreshold level of activation, the resulting proposition (or part thereof) is checked against the specifications of the query. Where there is a sufficient match between cue and trace information, the proposition is retrieved. The retrieval process is held to be highly dependent on the presence of a rich associational structure uniting the propositions and concepts in memory as well as sufficient and appropriate information supplied by the query. Finally, successful retrieval

of an item in episodic (as opposed to semantic) memory requires reconstruction of the context in which the event occurred.

Items in memory are linked together into an associational structure that forms the basis for organized retrieval (Smith, 1980). Each memory consists of a number of elements, or attributes, which permits use of a wide variety of organizational schemes (Bower, 1970, 1972, G Mandler, 1967, 1970; Puff, 1979; Tulving & Bower, 1975; Tulving & Donaldson, 1972; Underwood, 1969). In the present experiment, the primary relationships are temporal in nature, resulting in the "first . . . then" sequence characteristic of proordinate (G Mandler, 1979), schematic (J. Mandler, 1979), or scriptal (Schank & Abelson, 1977) organization. Thus, according to models such as ACT, propositions are formed during encoding that specify the forward associations between adjacent items (and, perhaps, nonadjacent ones as well). Activation spreads from concepts representing cues provided by the query to the first item in the list, and then to successive items in sequence. Almost all subjects recalled the first item on their list (10/10 lows, 9/10 mediums, and 11/15 highs), and almost all recalled it first (10/10 lows, 9/9 mediums, 10/11 highs) This is not surprising in view of the strength of activation accruing to this particular item by virtue of its presentation and recall on every trial of the acquisition phase. After the first item, however, the sequence of items as originally encoded is not well preserved, so that both adjacent and nonadjacent items, if they are recalled at all, are not recalled in their proper chronological sequence.

Posthypnotic amnesia is a prima facie example of dissociation, as represented by the subjects' frank failures to remember the target material, and their loss of strategic control over the process of retrieving and reconstructing memories (Hilgard, 1977; Kihlstrom, in press). One mechanism for this dissociation appears to be a disruption of the contextual links between semantic representations of events Other potential sources of dissociation, such as the disruption of the links between events and representations of the local context in which they occurred, remain to be explored with other paradigms. Both conditions would result in memory traces that, although remaining activated, would be functionally isolated from each other and from the continuous stream of autobiographical memory. Similar dissociations produced by the loss of contextual information have also been implicated in a wide variety of other organic and functional amnesias (Schacter & Tulving, 1982) Such dissociations can also be modeled within a network model of memory, so that further research can be guided by formal theory rather than merely by intuition.

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