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A Process Model of Posthypnotic Amnesia

L. ROWELL HUESMANN, C. LAWRENCE GRUDER, AND GARY DORST

University of Illinois at Chicago

The existing empirical evidence on the locus of the "posthypnotic amnesia" effect within the human information processing system is reviewed. Two new experiments are introduced to clarify the locus and the mechanism producing the effect. On the basis of the review and these experiments, an information-processing model is constructed that emphasizes the inhibition of verbal output as the central process. According to this model, hypnotically susceptible subjects fail to report "forbidden" material because it has been tagged as "forbidden" in response to the hypnotic suggestion for forgetting. This material is retrieved by these subjects and can play an active role in information processing, but it cannot be reported. The implications of this theory for related hypnotic effects on memory are discussed. © 1987 Academic Press, Inc.

Although hypnotism was one of the earliest tools employed by psychologists, and a large body of research on hypnosis has accumulated, no clear consensus has emerged about the processes through which hypnosis affects information processing and human memory. A number of factors have contributed to this state of affairs. Until recently, hypnosis has remained outside the mainstream of experimental psychology despite the attentions of prominent experimentalists (e.g., Hilgard, 1965, 1977; Hull, 1933). The methodologies employed by many researchers have been seriously flawed and their results lend themselves to multiple interpretations. This situation has been changing, however, and a number of well-designed experiments has emerged recently concerned with the effects of hypnosis on memory and information processing. The focus of most of this recent research has been the use of hypnosis to degrade memory (hypnotic amnesia), though some has also been concerned with the use of hypnosis to enhance a person's memory (hypnotic hypermnesia) and the use of hypnosis to induce a person to relive earlier experiences (hypnotic age regression). While hypermnesia and age regression may have captured more public attention because of their potential applications in the legal and clinical areas, posthypnotic amnesia seems to be a more robust and replicable phenomenon. In this article we attempt to integrate the recent research on posthypnotic amnesia with two new ex-

Requests for reprints should be sent to L. Rowell Huesmann, Department of Psychology, University of Illinois at Chicago, Box 4348, Chicago, IL 60680.

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periments to develop an information-processing model consistent with most existing data.

Posthypnotic Amnesia

While initial interest in posthypnotic amnesia was stimulated by the observation that hypnotized subjects do not recall very well what happens during hypnosis (Hilgard, 1977), experiments have shown that such an amnesia *must* be suggested for it to occur at a level greater than in a nonhypnosis control group (Evans & Thorn, 1966; Hilgard & Cooper, 1965). In the most common paradigm, subjects are told during hypnosis that they will not be able to remember specific material after they "awaken." Most often the phenomenon is demonstrated as follows. Subjects are selected who are highly hypnotically susceptible by administering a pretest (e.g., the Harvard Group Scale of Hypnotic Susceptibility, Shor & Orne, 1962) to a large number of subjects in a group setting. An hour-long tape recording is played, including suggestions for a number of behaviors such as relaxation, arm levitation, sleep, posthypnotic behavior, and posthypnotic amnesia for what they heard and did during the session.

In some studies the subjects' memory for what occurred during the session serves as the dependent variable and is related to other subject characteristics. In other studies those who respond most readily to the suggestions during this session are selected to become an experimental group. During the subsequent experiment they listen to another taped hypnotic induction procedure lasting about 30 min. The setting is usually a dim and quiet room. After hypnosis has been induced, the to-be-remembered material is presented and they memorize it to a specified criterion. Then the amnesia suggestion is made: subjects are told they will not be able to remember the material when they awake from hypnosis until they hear a releaser signal (e.g., three hand claps). After being awakened, subjects are asked to recall the to-be-remembered items. Typically, they report at that time a much smaller proportion of the to-be-remembered items than they report later after the releaser signal is given (Barber & Calverley, 1962; Cooper, 1972; Kihlstrom & Shor, 1978; Nace, Orne, & Hammer, 1974; Williamsen, Johnson, & Eriksen, 1965). Furthermore, they perform distinguishably differently from two types of control subjects commonly used (Sheehan, 1973)—high susceptibles who were not hypnotized and low susceptibles who were told to behave as they thought hypnotized subjects would behave (simulators).

To many cognitive psychologists (Roediger, 1978), several aspects of this methodology may appear unsatisfactory. First, subjects are often not assigned randomly to the experimental and control groups, but rather on the basis of their susceptibility to suggestions. Thus, it is difficult to know what portion of the effect is due to the experimental treatment and what

portion to the subjects' susceptibility. Susceptibility, in fact, has been shown to be directly related to degree of forgetting within hypnotized groups (Hilgard, 1965; Kihlstrom & Evans, 1976). Second, order of recall and time of recall are often confounded with recall conditions (prerelease–postrelease); within this design. Finally, the subjects' failure to report a to-be-remembered item is open to interpretations other than what most memory psychologists would call amnesia.

Nevertheless, posthypnotic amnesia, as it has been defined in the literature, is a robust and easily replicable phenomenon. Not only do subjects report they cannot recall the to-be-remembered material, they appear to believe they cannot recall it (Evans, Kihlstrom, & Orne, 1973). What they do report appears disorganized (Evans & Kihlstrom, 1973; Kihlstrom & Evans, 1979; Spanos & Bodorik, 1977; Spanos, Radtke-Bodorik, & Stam, 1980), and their deficit in reported recognition seems to be less than their deficit in reported recall (Kihlstrom & Shor, 1978). The deficit in reported recall remains even if the subjects are given cues to the material during the hypnotic session (McConkey & Sheehan, 1981; McConkey, Sheehan, & Cross, 1980).

The current theoretical explanations for posthypnotic amnesia fall into four main groups: dissociation, disrupted memory search, distracted attention during recall, and inhibition of output. Since the amnesia suggestion occurs after learning, and the presentation of a releaser cue reverses the amnesia almost entirely (Kihlstrom & Evans, 1977), posthypnotic amnesia cannot be due to changes in the encoding, organization, or storage of the to-be-remembered material. Neither can it be due to any permanent structural change or ablation of the material. The material is clearly *available* but may not be *accessible* (Tulving & Pearlstone, 1966).

Dissociation

The strong form of dissociation is generally credited to Janet (1901). This theory proposes that there is a complete functional split in the information-processing system so that one portion of the system is unaware and unaffected by processing and memories in the other portion. Recently a neodissociationist view has emerged that is more closely connected with current models of cognition (Hilgard, 1976a, 1976b, 1977; Kihlstrom, Evans, Orne, & Orne, 1980; Kihlstrom, 1978b, 1981). According to this view, dissociation is a fractionation of the mind that requires effort. This fractionation allows one part of the mind to function relatively independent of other parts or to be controlled separately by external stimuli (e.g., the hypnotist) without other parts being aware or affected. However, the exact processes through which this might happen have not been well specified. Hilgard (1977) suggested, for example, that hypnotic amnesia might be produced by having the subroutines for retrieval opera-

tions separated from executive control and assigned to the control of the hypnotist. But the data from experiments argue against such a complete separation, since some material is usually retrieved despite the amnesia suggestion. Kihlstrom and Shor (1978, p. 346) describe posthypnotic forgetting as due to a "dissociation of particular memories from conscious control." But again it is not well specified what such dissociation means in information-processing terms.

Perhaps the most telling criticism of the dissociation models stems from experiments showing that the to-be-remembered items, which subjects report not being able to recall, still remain active in the cognitive system. In fact, no deficit has been found in the memory for to-be-remembered items on any dependent measure except verbal report. Fifty years ago, Hull (1933) and his colleagues showed that relearning of a skill that hypnotic subjects were told to forget occurred more rapidly than if the skill had never been learned. More recently, Graham and Patton (1968) and Coe, Basden, Basden, and Graham (1976) have reported that retroactive interference in list learning is not reduced at all by telling a hypnotized subject to forget the interpolated list. Similarly, the priming effect of one presentation of a word on its subsequent generation in a word association task is not reduced by hypnotic amnesia for the word (Kihlstrom, 1980). Finally, conditioned GSR responses to posthypnotically unrecognizable words remain significantly different from responses to neutral words (Bitterman & Marcuse, 1945). Thus, while verbal report measured through either recall or recognition is reduced by a hypnotic suggestion for amnesia, more subtle measures of retrieval from memory show no deficit.

These results require one to reconsider the unavailability (Tulving & Pearlstone, 1966) of posthypnotically "forgotten" information. Recently, a consensus has emerged among cognitive researchers that there are two types of processes capable of accessing memory structures—controlled (Schneider & Shiffrin, 1977), effortful (Hasher & Zaks, 1979) processes of which the subject is aware (Posner & Snyder, 1975) and automatic processes performed without awareness. The data reported above suggest that posthypnotic deficits in memory are only detectable from the output of controlled, effortful retrieval processes of which the subject is aware. It is arguable whether one should call such a phenomenon dissociation.

The dissociation model also has had difficulty in explaining the effects of hypnosis on automatic processes in divided attention experiments (Messerschmidt, 1927; White & Shevach, 1942). In fact, when hypnotic suggestions are used to keep a secondary task out of awareness, performance on the primary task is often impaired compared to a waking divided attention condition (Knox, Crutchfield, & Hilgard, 1975; Ste-

venson, 1976). These results are consistent with the concept that the subject must devote effort to complying with hypnotic suggestions. However, these performance data reveal neither evidence of dissociation as a result of hypnosis nor evidence that, as dissociation theories would predict, divided attention performance improves with hypnotic susceptibility (Bowers & Brennenman, 1981).

It is very difficult to reconcile such results with either the classical or the neodissociationist model. One possibility is simply to call such findings a paradox of posthypnotic amnesia "that the subject knows but does not know, remembers but does not remember" (Kihlstrom, 1978b, p. 12). This approach plays on the multiple meanings attached to *know* and *remember*, but it hardly explains why verbal report fails and other measures of memory show no deficit. Alternatively, one may simply define a failure to report as equivalent to failure in memory—"in the first place, there is a frank failure of memory, as indexed by the subject's inability to recall or even recognize events which occurred or items which were learned when he or she was hypnotized" (Kihlstrom, 1978b, p. 11). This view is inconsistent, however, with most models of memory, including those cited by dissociationists (Anderson & Bower, 1972). In these models, the retrieval process comprises a number of distinct stages (e.g., activation, search, matching), terminating in an overt performance (e.g., verbalization) in response to a task demand. The subject's failure to verbalize could be due to a failure in any one of the retrieval processes or in the performance process.

Another argument has been that there is no contradiction between a subject's statement that he/she cannot recall or recognize material and the evidence provided by more subtle procedures that the material demonstratively affects cognition (Kihlstrom, 1978a). Usually, the evidence cited in support of this position is the multitude of experimental data showing that nonhypnotized subjects who cannot recall material outright can access it when given cues (Tulving & Osler, 1968; Tulving & Pearlstone, 1966), can access partial information about the material (Brown & McNeill, 1966), and, of course, may recognize it (Mandler, Pearlstone, & Koopmans, 1969). Thus, some argue, unrecalled material in normal and posthypnotic forgetting is not necessarily "functionally ablated," and should be described as "forgotten" even if it interferes with new learning or reveals itself in other ways.

The position that posthypnotic amnesia parallels normal forgetting is not strongly supported by empirical data, however. For example, one would expect to find that posthypnotic subjects' forgetting should be "breached" when appropriate recall cues are given just as normal subjects' forgetting can be breached (Tulving & Pearlstone, 1966). But a number of studies performed to demonstrate the power of posthypnotic

forgetting have shown than it cannot be breached in the normal way (Kihlstrom et al., 1980; Pettinati, Evans, Orne, & Orne, 1981). Subjects even deny recall and recognition after being shown tapes of themselves learning the material as a cue for recall (McConkey et al., 1980). Thus, the analogy with normal forgetting fails. The only escape from this dilemma for the dissociationists is to define unawareness as the only necessary characteristic of dissociation. While Hilgard (1977) and Kihlstrom (1978b) seem to assert that unawareness is the only essential attribute of dissociation, the explanatory value of this reinterpretation of dissociation is questionable.

Disrupted Search

In the previous section we have argued that, within the context of current thinking on human information processing, the concept of dissociation is outmoded as an explanation of observed cognitive deficits. This does not mean that the term cannot be used validly as a descriptor. However, a number of other models have been proposed which provide more compelling process explanations of posthypnotic amnesia.

According to the disrupted search model (Evans & Kihlstrom, 1973; Kihlstrom, 1975, 1977; Kihlstrom & Evans, 1976), the memory activation process required to begin retrieval is deliberately disrupted or blocked by the subject's executive program. Since this disruption requires effort, it will be imperfect and some forbidden material will be retrieved. The exact form that the disruption takes would have to depend upon the general model of memory one adopts. One possibility is that the appropriate retrieval cues or commands are not issued by the executive program. Another is that activation is interrupted by the executive whenever it detects the search coming close to forbidden areas. In either case, it is the activation and search processes that are disrupted.

According to the more influential theories of memory processing (Anderson, 1976; Anderson & Bower, 1972; Craik & Lockhart, 1972; Gillund & Shiffrin, 1984; Norman & Rumelhart, 1975; Raaijmakers & Shiffrin, 1981), such activation and search may be less important in recognition (though search certainly plays a role in both) than in recall because the recognition probe activates memory structures by itself. Therefore, the disrupted search model predicts that hypnotic suggestions for forgetting should have less effect on recognition than on recall. Although experiments comparing posthypnotic recognition and recall (Barber & Calverley, 1966; Williamsen et al., 1965) have confirmed this prediction, recognition is nevertheless substantially reduced by hypnotic suggestions for forgetting (Barber & Calverley, 1966; Kihlstrom & Shor, 1978; Williamsen et al., 1965). Furthermore, while one would expect from the

disrupted search model that the ratio of loss in recall to loss in recognition should increase as the hypnotic susceptibility of the subjects increases and search is more disrupted, such is not the case (Kihlstrom & Shor, 1978; St. Jean & Coe, 1981).

The other empirical evidence frequently cited in support of the disrupted search model is that the fragmentary material recalled following a hypnotic suggestion for forgetting seems disorganized. Disorganization has been reported in temporal order (Evans & Kihlstrom, 1973; Kihlstrom & Evans, 1979) and in categorical organization (Radtke-Bodorik, Planas, & Spanos, 1980; Spanos & Bodorik, 1977; Spanos & D'Eon, 1980; Spanos, Radtke-Bodorik, & Stam, 1980). On the basis of such evidence, Kihlstrom and Evans (1979) concluded that posthypnotic amnesia stems from a "disorganization" of the process of memory search. Although St. Jean and Coe (1981) questioned the replicability of the temporal disorganization effect, Kihlstrom and Wilson (1984) reproduced the effect. Yet the line of evidence leading from the structural disorganization of retrieved material to the functional disorganization of memory processes is not clear. Organized processes can produce disorganized material and random processes may repoduce structured data (Knuth, 1969).

Much of the disorganization data can be challenged on methodological grounds as well. Because very high recall is considered evidence of lack of susceptibility to hypnosis, and very low recall prevents the measurement of clustering, subjects with very high or very low recall are usually eliminated before organization is measured in the hypnosis condition (Kihlstrom & Evans, 1979; Spanos, Radtke-Bodorik, & Stam, 1980). It can be argued that this selection process assures a lower average clustering score for the hypnosis condition than for the control conditions. This follows from the fact that subjects with moderate recall usually have lower clustering scores than subjects with very low or very high recall scores. Subjects with very high recall usually have recalled well because they have organized the material effectively. Those with very low recall, on the other hand, frequently display high clustering scores simply by virtue of having so little material to organize. Although some investigators have attempted to surmount this methodological problem by matching subjects on recall (Evans & Kihlstrom, 1980), the results of those studies are open to numerous interpretations. Thus, the disorganization that has been found in posthypnotic amnesia subjects might have been due, at least in part, to this selection artifact, and the results are therefore not especially informative concerning the disrupted search model. Finally, it is hard to reconcile the disrupted search model with the previously reported failure of subjects to substantially improve posthyp-

notic recall when the cues present during encoding are reintroduced during recall (McConkey et al., 1980).

Distracted Attention

Spanos and his colleagues (Spanos & D'Eon, 1980; Spanos, Radtke-Bodorik, & Stam, 1980; Spanos, Stam, D'Eon, Pawlak, & Radtke-Bodorik, 1980) have proposed a quite different model to explain these and other posthypnotic amnesia data. Originally, Spanos and Bodorik (1977) had hypothesized that the very low level of arousal present during hypnosis interferes with retrieval. Two problems immediately are apparent with this model. First, the retrieval deficit occurs posthypnotically after the period of obvious low arousal is over. Second, the evidence has accumulated steadily that the deficits in information processing produced by hypnosis require effort and arousal (Bowers & Brennenman, 1981; Coe, 1978; Hilgard, 1977; Spanos, Radtke-Bodorik, & Stam, 1980). Empirically, the amount of forgetting has not been greater for low-arousal hypnotic subjects (Spanos, Radtke-Bodorik, & Stam, 1980). These contradictions led Spanos to reject the arousal model in favor of a distracted attention model.

To interpret such a model in information processing terms requires a definition of attention. Let us define attention as the concentration of mental effort indicated by the current contents of working memory and the currently active information processing routines. In their formulation of a distracted attention model, Spanos, Radtke-Bodorik, and Stam (1980) assert that hypnotic subjects who have been given a suggestion for forgetting "attend to activities other than the recall of the target material" during the posthypnotic period. Their underlying assumption is that retrieval from memory requires a decision to retrieve coupled with a commitment of mental effort. This effort might consist of activating search in general or of directing memory search by sending cues to the memory system. If the subject directs his/her attention elsewhere, retrieval will not occur.

One problem with this model is that memory activation can clearly occur without the subject being aware of it or committing effort to it. While the effortful processes used in recall may not escape awareness, certain processes that enhance recall do operate automatically out of awareness (Hasher & Zacks, 1979; Schneider & Shiffrin, 1977). For example, dichotic shadowing studies have shown that memory is activated by meaningful words even if attention is directed away from the words (Lewis, 1970; Moray, 1969; Triesman, Squire, & Green, 1974; Von Wracht, Anderson, & Stenman, 1975). Such automatic memory activation could account for the posthypnotic interference and enhancement

effects described above. But then why should posthypnotic recall not benefit from the same activation?

A different type of distracted attention model can surmount these difficulties. Assume that material retrieved from long-term memory must enter attention (working memory) before it can be output. Entrance normally could be automatic for sufficiently activated material. One way to deny admission of such material to working memory is to overload working memory with entries from sensory systems and other memories. The forbidden to-be-remembered material is activated but not admitted to attention because the subject has directed his/her attention elsewhere. In this "overloaded attention" model the working memory (primary memory, short-term memory) has a limited capacity and material outside that memory is outside attention (Norman, 1968; Waugh & Norman, 1965). If one assumes that attention to material is a minimum requirement for awareness, the subject would not be aware that the forbidden material had been retrieved if its admission into working memory were blocked by the memory's overloading.

Several aspects of this "overloaded attention" model are particularly attractive. A fundamental component of all hypnotic induction procedures is focused attention (Hilgard, 1977). Only those subjects who can easily focus their attention are used in the standard hypnosis experiment as only they can pass the preexperimental screening for susceptibility. While a subject's focused attention *during hypnosis* cannot be a direct cause of *posthypnotic* recall deficits, the fact that a subject is highly hypnotically susceptible means that the subject has the ability to focus and perhaps overload his/her attention.

According to this overloaded attention model, one would expect to find a positive relation between hypnotic susceptibility and degree of recall failure. Such is the case (Kihlstrom & Evans, 1976). In addition, partial recall would not be organized about categories since it represents time-dependent interruption in a continuous process. Since the hypnotic effect does not operate on the memory search component, recognition should be seriously affected as well. However, recognition should remain superior since superior search cues are being provided. All of these predictions are consistent with the data reported above.

The distracted attention models fit the data from studies of hypnotic analgesia as well as memory failure. For example, one could argue that the subjective experience of pain is lessened in hypnotic analgesia because the subject's attention is focused away from the sensory impulses entering the information processing system (Karlin, Morgan, & Goldstein, 1980).

Although the distracted attention model can adequately explain post-

hypnotic failures in recall and recognition, data from the studies showing that posthypnotically forgotten material inhibits recall of interfering material and enhances performance on new learning tasks (Graham & Patton, 1968; Hull, 1933; Messerschmidt, 1927) or influences behavior in other ways (Kilhstrom & Evans, 1978) are less easily handled. One must argue, as the neodissociationists do, that the stored material need not enter working memory in order to have these subtle effects but only needs to be activated in long-term memory. Such an explanation would suffice, but no data directly support it, and at least some data from interference studies with normals suggest that interference effects are due to inappropriate cues being present in working memory during recall or relearning (Tulving, 1974; Tulving & Psotka, 1971). An even more serious flaw in these distracted attention models concerns their selectivity. In order for some retrieved memories to enter attention while the forbidden information is denied requires a selective distracted attention model. Somehow the forbidden material must be detected before attention is directed at it so attention can be directed away from it.

Output Inhibition

An alternative to the distracted attention model of posthypnotic amnesia is the verbal inhibition model proposed by Coe (1978) and others. These researchers argue that subjects actually recall the to-be-remembered material but simply inhibit their verbal report. Coe and his colleagues have emphasized the role of the hypnotic context in causing "keeping of secrets." As a result, the verbal inhibition model has been characterized as noncognitive (Kihlstrom, 1978a). Nevertheless, it has a very clear information-processing interpretation that is consistent with recent theorizing in cognitive psychology. The to-be-remembered material is activated and retrieved into working memory (attention). There it is processed by a routine that checks to see if it is forbidden material. If it is forbidden, it is denied output and perhaps admission into awareness. Such a model solves one thorny problem that none of the previous cognitive models could handle very well. How can forbidden material be denied retrieval selectively? It is a paradox comparable to the paradox of selective attention or input (Broadbent, 1973). To decide not to process information, one must obviously process the information to some extent. The only alternative is the kind of classical dissociation in which part of memory is excised. But, as demonstrated above, a mass of evidence argues against such functional ablation. The verbal inhibition model handles the paradox by assuming the forbidden information does not reach working memory where it is processed to see if output is allowed. Is the subject aware of such information? The evidence from postexperimental reports is that some subjects are aware of having retrieved the

forbidden material and simply do not output it, but many others are not aware of having retrieved it (Coe, 1978; Kihlstrom et al., 1980; Spanos, Radtke-Bodorik, & Stam, 1980). Furthermore, many of those who are aware of the material report that they could not say it no matter how hard they tried.

Locus of the Posthypnotic Effect and Active Use of Forbidden Material

When the above theories of posthypnotic amnesia are compared in an information-processing framework, it becomes apparent that they can be distinguished by how close they identify the locus of the amnesia effect to the final response called output. Classical dissociationists invoked a fractionation of memory and neodissociationists proposed that memory retrieval routines were separated from executive control. In the disrupted search model the locus of the posthypnotic effect is somewhat less remote from the response. Search of memory is interrupted whenever forbidden material might be activated. In the distracted attention models the locus of the effect is closer to response at the level of working memory. Working memory and attention are directed at extraneous stimulation or memories so that cues that might activate forbidden material are kept out of attention. In the output inhibition model, the locus of the amnesia is closest to the response. Forbidden memories are activated, retrieved, entered into working memory, and processed, but are denied output.

These differences in the locus of the posthypnotic effect—at what point it causes the deficit in memory—have implications for the nature of the behavioral phenomena that result. One category of phenomena can be characterized as involving "passive" processes because they do not require activation of the forgotten material into working memory where it would then be used to produce verbal output. This category includes such phenomena as retroactive and proactive interference. These passive processes can be contrasted with "active" ones in which the forgotten material is used generatively. One example of such an active process is when a subject generates a to-be-remembered sentence in normal speech. Another, less obvious, example is when a subject generates a behavior which itself requires knowledge and processing of the to-be-remembered material. The premise underlying such active processing is that the material must enter working memory and attention (though not necessarily awareness).

If the posthypnotic suggestion to forget has its effect in long-term memory, as in the dissociation models, then the forbidden material would not be activated at all and could only be revealed passively, as in interference effects. It seems appropriate to label this *amnesia*. The distracted attention model has the same implication: to the extent that attention is not always completely distracted, some of the forbidden material might

enter working memory and thus could be reported and actively employed, but that which does not enter could legitimately be said to be unretrievable. Finally, the output inhibition model assumes that material is activated and retrieved into working memory, but, upon its detection as forbidden material, it is denied output and excluded from awareness. Since the material does enter working memory, it could actively influence behavior even though it is neither recalled nor recognized.

Unfortunately, none of the existing empirical studies has examined the effect of hypnotic suggestions for forgetting on any active processes other than recall and recognition. The problem is to develop an experimental paradigm that can distinguish between active use, passive use, and recall. One would like a paradigm in which use of the forbidden material should be possible without the subject's awareness, and in which the demand characteristics for poorer performance produced by the forgetting suggestions would be unlikely to suppress active use if the material were retrieved.

EXPERIMENT 1

In Experiment 1 we have constructed such an experimental paradigm. First, subjects are asked to solve a number of problems which require a particular solution algorithm (the "set"). Once the algorithm is learned, most subjects should solve all problems with that algorithm even when much simpler solutions are available. This is the *Einstellung* effect (Luchins, 1942). Then some subjects are given a hypnotic suggestion to forget all the problems and to forget the solution algorithm. The dependent measure is how these subjects perform posthypnotically on new problems. On the one hand, if a subject retrieves the old learned algorithm, the subject should display the *Einstellung* effect—that is, the subject should actively use the old algorithm and not be able to solve the problems by new, simpler methods. If a new problem can only be solved by a simpler algorithm, the subject should have great difficulty with it. On the other hand, if the algorithm is still present in memory but it is not retrieved into attention and working memory, the subject should solve new problems by the simpler methods used by most control subjects. Then, after the releaser signal is given, the subject should use the old, long method again. This design has the advantage that retrieval failure reveals itself in improved performance and retrieval success reveals itself in decreased performance. Furthermore, recall of the problems can be tested independently of the measure of active use of the forbidden material. In this experiment, as in Luchins' (1942) study, "water jar" problems are used as the experimental task.

TABLE 1
Design of the "Water Jar (WJ)" Experiment

Time in minutes	Group			
	Hypnotic amnesia	Hypnotic release	Control WJ task	Control anagram
8	2 WJ problems (sample)	2 WJ problems (sample)	2 WJ problems (sample)	2 WJ problems (sample)
27	Hypnotic trance induction	Hypnotic trance induction	Music	Music
13	5 WJ problems (learning) Amnesia suggestion	5 WJ problems (learning) Amnesia suggestion	5 WJ problems (learning)	5 Anagrams (learning)
2	End trance	End trance Release amnesia	Rest	Rest
12	4 WJ problems (test)	4 WJ problems (test)	4 WJ problems (test)	4 WJ problems (test)
3	Recall task Release amnesia	Recall task		

Method

The experiment required four groups of subjects: (1) a group that received the learning "set" and a hypnotic suggestion to forget it, (2) a similar group that differed only in being released from the forgetting suggestion before testing, (3) a control group that received the learning "set" but no suggestions for forgetting, and (4) a control group that did not receive the learning "set" but worked on anagrams during the learning period. The design is diagrammed in Table 1.

Subjects. The subjects for the experiment were 49 introductory psychology students who scored 6 or higher on the Harvard Group Scale of Hypnotic Susceptibility (Shor & Orne, 1962). They represented approximately the upper 25% of the sample that were pretested for susceptibility. Each subject was randomly assigned to one of four experimental groups, yielding 13 in each of three groups and 10 in the untreated control group.

Materials. The problems used were "water jar" problems taken from Luchins' (1942) investigation of the *Einstellung* effect. They are listed in Table 2. The first two sample problems are solvable with a few simple operations. The next four problems are only solvable by one particular "long" method, i.e., "fill the largest jar (the second jar). Pour from it into the third jar twice and then pour from it into the first jar. The remainder in the second jar will be the desired amount." These four problems are designed to establish a "set" for solving the problems. The fifth problem is a test to check if the set has been formed. It could be solved either by the same "long" method or by a simpler "short" method. Of the four test problems that follow, the first two and the last can be solved by either the long or a short method; the third cannot be solved by the long method.

Procedure. Subjects were run in groups of four to six in a small, quiet room. The procedure for each group is diagrammed in Table 1. After a brief introduction, each subject was given two sample water jar problems to solve. The subject was shown how to solve them if he/she experienced difficulty. Then the procedure diverged for each group. The two control groups relaxed and listened to music for 27 min. The two hypnotic groups listened for the same amount of time to a tape-recorded induction procedure adapted from Barber (1969). This procedure began with suggestions for focused attention and proceeded to suggestions

TABLE 2
The "Water Jar (WJ)" Problems

Function	Problem: Given jars of size			Problem: Measure out	Solution
Sample					
1	29	3		20	29 − 3 − 3 − 3
2	9	2		7	9 − 2
Form "set"					
1	14	163	25	99	163 − 25 − 25 − 14
2	18	43	10	5	43 − 10 − 10 − 18
3	9	42	6	21	42 − 6 − 6 − 9
4	20	59	4	31	59 − 4 − 4 − 20
Manipulation check					
1	23	49	3	20	49 − 3 − 3 − 23 23 − 3
Test					
1	15	39	3	18	39 − 3 − 3 − 15 15 + 3
2	18	48	4	22	48 − 4 − 4 − 18 18 + 4
3	28	76	3	25	No long solution 28 − 3
4	14	36	8	6	36 − 8 − 8 − 14 14 − 8

for sleep and various motor actions, e.g., arm levitation, muteness, and immobility. All hypnotic subjects showed these behaviors. At the end of the 27 min, the subjects in the hypnotic groups and water jar control groups received the water jar problems and solved them over 13 min. These problems were intended to create a "set" to solve the problems by the "long" method. The instructions were tape-recorded, and the solution to each problem was explained before the next problem was presented. During this time the anagram control group solved anagrams for 13 min. Next, the hypnotic groups were given the posthypnotic amnesia suggestion and were brought out of hypnosis while the two control groups rested. The amnesia suggestion was,

> I want you to forget the problems you just worked on. You will not remember working on these problems. You will forget how you solved them. I want you to forget everything about the problems. You will be completely unable to recall anything that happened while your eyes were open just now. You won't know why, and it won't bother you. But you will not be able to remember anything about the problems and their solution. Everything will be gone, completely gone from your memory. You will be unable to think of, recall, or remember the problems in any way. When the experimenter claps his hands three times, like this (*clap, clap, clap*) you will be able to remember the problems.

During this time the two nonhypnotic groups simply rested.

At the beginning of the test session, the hypnotic release group heard three claps to release their amnesia. All groups were given the four water jar test problems via a 12-min tape recording. Three minutes were allowed for each problem and solutions were not pre-

sented. For the two hypnotic groups the test period was followed by a recall task in which the subjects were asked to write down any problem or rules for solving a problem that they remembered from the learning period. Credit was given for every problem or rule mentioned that could be recognized as having been used in the learning period. Finally, the unreleased hypnotic group was released from the amnesia. All subjects were debriefed.

Results

All but one of the subjects receiving the water jar training sequence solved the manipulation-check problem by the long method, which indicates that the set solution was successfully established.[1]

It is also important to demonstrate that the amnesia suggestion in fact decreased subjects' verbal recall of what happened during the hypnosis session. This was tested by asking subjects to write down any problem or rules for solving a problem that they remembered from the learning period. For the conditions in which recall was tested, recall credit was given if either the complete problem statement was reported or a partial problem statement coupled with the solution method was reported. Thus, both recall of the long solution method and specific problem characteristics contributed to recall scores. A subject's score could range from 0 to 5 problems recalled.

As Table 3 shows, the mean recall score for the amnesia group was 0.46 compared with 2.31 for the amnesia release group. This highly significant difference indicates that the amnesia sugggestion decreased hypnotically susceptible subjects' recall, as expected.

The problem-solving data for all groups are also presented in Table 3. First, let us examine the unhypnotized "water jar" control group and compare it with the unhypnotized "anagram" control group. These results are typical of the *Einstellung* effect. Every subject in the anagram control group solved every water jar test problem by the short method. On the other hand, every subject in the water jar control group, which had learned the long method originally, solved each of the first two test problems by the long method. Only when the third problem, unsolvable by the long method, was presented did these subjects use the short method. But even then, almost half these subjects could not solve this problem at all, so strong was this fixation on the long solution method. For the final problem, solvable by either method, about half the water jar control subjects used each method.

Now let us compare these results with those of the hypnotized groups. The hypnotic amnesia group was instructed to forget everything about the water jar problems and their solution. When asked to recall the

[1] The one subject who used a short solution was in the amnesia group. He was retained in the experiment since his having learned the set less well should only have made it easier for him to "forget" the set.

TABLE 3
Proportion of Problems Solved in the Water Jar Experiment

Test problem	Group			
	Hypnotic amnesia[a]	Hypnotic amnesia release[a]	Control WJ task[a]	Control anagram[b]
1 and 2:				
Long method	25/26	23/26	26/26	0/20
Short method	0/26	0/26	0/26	20/20
3:				
Short method	5/13	8/13	7/13	10/10
4:				
Long method	11/13	8/13	7/13	0/10
Short method	2/13	5/13	6/13	10/10
Mean number of problems recalled out of 5	0.46	2.31 ($t(24) = 4.97$, $p < .001$)		

[a] $n = 13$.
[b] $n = 10$.

problems, in fact, they reported very little—on the average only one-half problem per subject. Yet their performance on the problems is almost indistinguishable from the water jar control group and quite significantly different from the anagram control group. Every subject but one solved both of the first two test problems by the long method they had been instructed to forget. This indicates "active" retrieval of the method. Subjects who did not retrieve the method would solve the problems like the anagram control group did. Similarly, over half of the hypnotic amnesia subjects failed to solve the third problem (for which no long solution exists), when these subjects should have had no more difficulty than anagram subjects if they had not retrieved the long method. The only difference—and a nonsignificant one—between the hypnotic amnesia group and the water jar control group occurred on the fourth test problem on which more of the amnesia group used the long solution.

The amnesia release group performed indistinguishably from the water jar control group and the amnesia group except on the verbal recall task. Their performance on the test problems was no different, indicating they retrieved the solution method no better than the unreleased group. However, their self-reported recall of problems ($M = 2.31$) was about five times higher ($t(24) = 4.97$, $p < .001$) than the unreleased group's recall ($M = 0.46$).

Discussion

These results are difficult to reconcile with any disrupted memory acti-

vation or dissociation model. The forbidden material—the water jar solution algorithm—clearly entered the working memory of virtually every hypnotized subject. If it had not been actively retrieved, it could not have been employed to solve the first two test problems. Instead, the short method would have been used, just as in the anagram control group. Furthermore, if it had not been retrieved into working memory, the subject would have searched more readily for other ways to solve the third test problem and a greater proportion should have succeeded than in the released amnesia group or the water jar control group. It is difficult to argue that active retrieval of the solution algorithm is not needed to solve the problems, as with interference effects. If it were not actively retrieved, the algorithm could hardly be employed.

When one considers the recall data in conjunction with the problem solution data, the distracted attention model also does not hold up well. If attention were sufficiently distracted to prevent recall of the problem, why was it not sufficiently distracted to prevent the retrieval and use of the solution algorithm?

The output inhibition model fits the observed data more accurately. According to this model, both the solution algorithm and problems should be retrieved, with some loss, into working memory (attention). The subject blocks the output of the problems because he/she recognizes them as forbidden material. However, the use of the solution algorithm to solve new problems does not require an explicit verbal report of the algorithm. It only requires that the algorithm be retrieved into working memory. Therefore, as was observed, the retrieved material is denied verbal output but is actively employed in problem solving.

One other alternative explanation must be at least briefly considered. It is possible that in the standard posthypnotic recall or recognition paradigms, subjects simply lie about retrieveal. In other words, they consciously and deliberately suppress verbalization of the retrieval information in order to fulfill the role expected of a hypnotic subject. Such a model would explain the data from the water jar experiment. Of course, the possibility that hypnotic subjects are faking their responses has been raised to explain hypnotic phenomena ever since they were first observed. Over the past 20 years, investigators have developed theories and conducted research designed to determine whether hypnotic subjects' performance is "real" (i.e., attributable to some psychological process unique to hypnosis) or artifactual.

Orne (1959) compared the responses to suggestions of hypnotized subjects and nonhypnotically susceptible control subjects who were induced to simulate being hypnotized (i.e., to fake their responses to suggestions). If the hypnotized subjects had been faking, they should have been indistinguishable from the simulators, but they were not. Orne explained the differences (which occurred in response to some, but not to all, sugges-

tions) by describing the hypnotized subjects as experiencing "trance logic." Sarbin and Coe (1972; Coe, 1978) developed a model of the hypnotic role and Barber (1969; Barber & Calverly, 1962) developed a task motivation model. Neither of these models asserts that hypnotized subjects are faking; nor do they assert that the behavior is attributable to the hypnotic trance. Rather, each explains hypnotic behavior as determined by social psychological variables that also explain other categories of behavior.

There is much empirical evidence that supports each of the above models, but each has been the target of trenchant criticism, as well. The current state of knowledge, therefore, does not allow us to rule out conclusively that hypnotic behavior can be explained by subjects' faking, but the weight of the evidence points to other more complex mechanisms and leads us to judge faking an implausible one.

Although Experiment 1 seems to provide compelling evidence that posthypnotic deficits in recall and recognition are not memory retrieval failures but rather output failures, it remains to be explained exactly how verbal output of forbidden material is suppressed. Somehow the to-be-forgotten items must be marked as "forbidden" after the amnesia suggestion is given, and this "forbidden tag" must be processed in working memory when retrieval is requested and attempted.

One mechanism by which this may occur is that a forbidden tag can be explicitly associated with every to-be-forgotten item. This mechanism seems implausible, however, because it is unduly cumbersome and would require substantial processing time following the amnesia suggestion. The same result can be achieved more efficiently by an alternative mechanism. The subject marks larger semantic structures in episodic memory as forbidden, denoting that all the items or substructures within those structures are "to-be-forgotten." However, within this mechanism at least two different models for utilizing the tags at retrieval time are plausible.

In one model, any tags encountered during the memory search process are attached to all subsequently retrieved substructures further along the same branch in episodic memory. When retrieving the item into working memory, the tag is detected and output is inhibited. In the other model, tags are not attached to substructures during search. Instead, when an item is retrieved into working memory, its representations in episodic memory are "reactivated." This reactivation spreads in the memory network and, if a forbidden tag is reactivated in the process, then output of the item is suppressed.

The available data do not distinguish well between these models. Kihlstrom's (1980) experiments are most relevant. He found that subjects who did not recall to-be-forgotten words nevertheless gave them as re-

sponses in free-association and category-instance tests. These results make the "reactivation" model less plausible because, according to this model, the forbidden tag would be reactivated when a response is to be made, even in a free-association context. That is, according to the reactivation model, the forbidden tag should be reactivated regardless of how the to-be-forgotten word is accessed; according to the tag model, on the other hand, the tag should be reactivated only when the to-be-forgotten word is accessed via a search through the branches of episodic memory.

It should also be noted that there may in fact have been an amnesia effect that was not detected in Kihlstrom's study. Some to-be-forgotten words may indeed have been suppressed as responses in the free-association and category-instance tests, but this suppression would have been detected only if performances had been compared before and after the amnesia release signal, a test that was not reported. In other words, emission of to-be-forgotten words in response to a priming cue might have been even greater if the amnesia suggestion had not been given. If such an amnesia effect did indeed occur, the reactivation model would remain viable.

Furthermore, in Kihlstrom's (1980) study the to-be-forgotten words were not presented originally in any controlled semantic context, so the semantic structure in episodic memory elicited during the free-association test could have differed from the one in which the tag was encoded. If this were the case, it could help to explain why subjects were unable to recall the to-be-forgotten words but were able to report them on the free-association test. One implication, of course, is that the semantic contexts for learning and memory tests should be controlled. Another implication concerns the nature of evidence that would disconfirm the reactivation model.

Suppose hypnotized subjects hear a set of semantically ambiguous words in a story guaranteed to bias in favor of one particular meaning. The subjects are then told to forget the story and everything about it. Later the semantically ambiguous words are presented and the subjects are asked to give an association to each. If the tag model is correct, subjects should be able to give associations that reflect the meaning of words in the context of the story. This would indicate that the story had been reactivated even though it was not recalled. On the other hand, if the reactivation model is correct, subjects should not be able to give associations that reflect the meaning of the words in the story.

EXPERIMENT 2

This experiment tested whether subjects who were instructed to forget a particular semantic structure posthypnotically would suppress verbal reports that activated, and were activated by, the semantic structure. In

particular, each subject was asked to listen to a story containing several homographs whose meanings were biased by the story. After being given a suggestion for posthypnotic amnesia for the story, the subject was then asked to generate close associates of the homographs. The words reported were scored to see if they indicated activation of the forbidden semantic context.

Method

Subjects. As before, the subjects were introductory psychology students who scored 6 or higher on the Harvard Group Scale of Hypnotic Susceptibility (Shor & Orne, 1962). The 50 subjects were randomly assigned to five groups–three amnesia groups and two amnesia release groups.

Materials. Two stories of approximately 300 words each were written. Each contained the same 10 high-frequency homographs. One story concerned a visit to a baseball game, and the other concerned the exploration of a cave. The homographs were clearly biased toward one specific meaning by the stories. For example, "diamond" and "bat" were two of the homographs. A third story, (the "neutral" story), written as a control, did not contain any of the homographs.

Procedure. The subjects were again run in groups of four to six in a small quiet room. After a brief introduction, all subjects were hypnotized by the same 27-min procedure used in Experiment 1. Once hypnotized, the subjects were told to listen carefully to a tape-recorded story. The story lasted about 2 min. The "cave" and "baseball" stories were heard by both the amnesia group and an amnesia release control group. The neutral story was heard only by an amnesia group, yielding a total of five different groups of 10 subjects each. Next, every group received the instruction for posthypnotic forgetting. These were very similar to those used in Experiment 1 and included the direction to "forget the story you have heard and everything about it." These taped instructions required about 1 min and were followed by a 2-min passage to terminate hypnosis.

After a 3-min rest, during which response booklets were distributed, subjects performed the word-association task. Their instructions were to generate three close associates of each word they would hear on the tape. The 10 homographs were then presented at 30-s intervals. Immediately before the tape was turned on, however, the experimenter gave the releaser signal for the "cave" and "baseball" amnesia release groups. After the response booklets were collected, the releaser signal was given for the remaining subjects, and all subjects were debriefed.

Results

Each word generated by a subject was classified as derived from the "baseball" meaning of the stimulus homograph, from the "cave" meaning, or from neither. The scoring was done by a rater blind to the subjects' experimental condition, who examined all of a subject's responses simultaneously. If the rater was uncertain about a response, it was placed in a "neither" category.

The mean percentages of associations falling in the "baseball" and "cave" categories for each group are shown in Table 4. The percentage of "cave" and "baseball" associations varied significantly as predicted, depending on the priming story used. However, whether or not the sub-

TABLE 4
Mean Percentage of Homograph Associations

	Group				
	Cave story		Baseball story		
Type of association	Hypnotic amnesia	Hypnotic release	Hypnotic amnesia	Hypnotic release	Neutral story
Cave meaning	55.7[a]	50.2[a,c]	25.7[b,d]	17.5[d]	36.2[b,c]
Baseball meaning	17.9[p]	11.3[p]	49.9[q]	55.8[q]	22.9[q]

Note. Within each meaning, means having no common superscript are significantly different at less than the .01 level. $n = 10$ for each group.

ject was released from amnesia before giving his/her associations had no effect on the percentage of associations of each type. In fact, the percentages were almost identical for the released and unreleased conditions.

Discussion

Under instructions for posthypnotic forgetting of a semantic structure, subjects reported words whose meanings were associated with the forbidden structure as adequately as when the instructions were lifted. The words reported were demonstrably activated by the forbidden structure and must also have activated it. Yet the subjects experienced no difficulty in reporting them.

Such an outcome suggests that the verbal inhibition of forbidden material is accomplished by a mechanism similar to "tagging" rather than a check for activation of a forbidden structure. Upon receipt of the instructions for posthypnotic forgetting, the subject may tag what he/she perceived to be forbidden. The tag need not be applied individually to all items in a set but could be attached to an attribute defining a set in episodic memory. Upon activation and retrieval of material into working memory, but before output, a check must then be made to see if a "forbidden" tag is attached to the material. When the releaser signal is given, the tag may remain, but the check need no longer be made.

GENERAL DISCUSSION

The model for the effects of posthypnotic amnesia on memory that has emerged from these experiments operates at the level of working memory and attention. Our analysis of previous research coupled with the results of the two experiments suggests that retrieval from long-term memory is

not directly affected by hypnotic instructions to forget. Deficits in long-term memory search may be produced indirectly by the subject's failure to input the appropriate retrieval cues. Even when appropriate cues are forced upon the subject (McConkey & Sheehan, 1981), however, the deficits in verbal report remain; so the lack of cues is not a sufficient explanation. More importantly, as Experiment 1 demonstrated, hypnotically forbidden material that is not reported as recalled can be retrieved into working memory and actively utilized. The deficit occurs only in explicit output of the material. Experiment 2 suggested that this inhibition of output derived from a tag applied specifically to the semantic structure representing the forbidden material and did not extend to acoustically or semantically similar material even if it reactivated the to-be-forgotten material. We propose that when a highly hypnotically susceptible subject is given a posthypnotic suggestion to forget certain material, the subject attempts to associate "forbidden" tags with the material in memory. Such tags may be associated with individual items in episodic memory or with sets of items connected in lists or semantic structures. However, tagging will be imperfect both because of imperfect interpretation of the hypnotists' instructions and difficulties in inserting the tags. When memory access is attempted during the posthypnotic period, activation of memory, search, and retrieval into working memory proceeds unhampered. Therefore, the forbidden material may be employed actively by the information-processing system, may influence new learning, and may reveal itself indirectly through its effects on behavior. However, forbidden material cannot be explicitly reported, because it is tagged as forbidden and the output routines check for such tags. Unless the tag was not inserted or is not detected or obeyed at output time, the forbidden material will not be reported.

The Output Inhibition Model

An essential element of this theory is that the "to-be-forgotten" material must be retrieved and tagged as forbidden in order to be "forgotten," i.e., not reported as recalled. Therefore, posthypnotic amnesia requires active processing after the forgetting instruction is given and again when recall or recognition is attempted. The tag indicating forbidden may be attached to an individual item or an entire semantic structure in episodic memory. However, for amnesia to occur, the forbidden tag must be encountered at retrieval time and carried into working memory with the item. Being "connected" by some path to a forbidden tag is not by itself a sufficient condition for an item to have its output inhibited, however. Consider the case of an experiment in which subjects learn a list to a criterion that is less than perfect recall and then are instructed to forget it with a hypnotic suggestion. For an individual item to be "forgotten,"

several things must happen. First, a subject must interpret the forgetting suggestion as requiring forgetting of the item in question. Second, the subject must access that item's representation in memory and tag it as "forbidden." Third, the tag must be retained until retrieval time. Finally, the tag must be encountered at retrieval time, carried into working memory with the item, and obeyed.

We propose that the hypnotized subject responds to instructions to forget a list by attempting to retrieve the list in order to tag it as forbidden. Some words (the better connected ones, the ones more closely related to active cues, the more meaningful words, those at the beginning or end of the list) will be retrieved, but some will not. Words that are not accessed or are not part of an accessed structure will not be tagged to-be-forgotten.

What happens later when the subject, still under the influence of the forgetting suggestion, is asked to recall the list? Again, semantic, temporal, and other cues activate the memory structures representing the list of words. Under our output inhibition model, forbidden tags encountered during memory search do not block the search but are attached to the words retrieved by the process. The retrieved words are transferred to working memory where they are checked for a forbidden tag. If a word has such a tag, its output is inhibited. Of course, other words that are difficult to recall may be neither retrieved nor output (as would be true with unhypnotized subjects).

A difficult issue to address with this theory is whether the subjects are "aware" of their output inhibition. Usually, a person's working memory is assumed to be the focus of his/her attention. Yet it is well established that certain automatic processes can operate on material passing through working memory without the subject's awareness (Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977). The empirical evidence with regard to posthypnotic amnesia and awareness is confused. For some material some subjects report they recall the material but could not report it. For other material the subjects may deny any knowledge of the material. Other subjects may deny knowledge of all material (Coe, 1978; Kihlstrom et al., 1980; Spanos, Radtke-Bodorik, & Stam, 1980). One possibility suggested by the current model is that the items which a subject is aware of inhibiting are those that were not output because of forbidden tags, while the items which the subject is unaware of inhibiting are those that were not retrieved and tagged. Another possibility is that the forgetting instructions and therefore the forbidden tag are interpreted differently by different subjects. To some, detecting the tag may signal the necessity of inhibiting both output of the item and output of knowledge of the item (awareness). To others the tag may only signal inhibiting output of the item.

There are several interesting predictions of the output inhibition model that were not tested in these experiments. One of these stems from the fact that under the model an item must be retrieved at tagging time in order to be "forgotten" at recall time as a result of the amnesia suggestion. It follows, for example, that the list items for which the probability of recall should change the most between the amnesia and release conditions should be the items normally easiest to recall. Their not being recalled under amnesia must be due to inhibition of output which requires prior recall. On the other hand, the items that would be most likely to be recognized but not recalled in the amnesia condition should be the items normally hardest to recall since their not being recalled must be a true retrieval failure. This principle should hold regardless of whether "easy" and "hard" are defined in terms of serial position, meaningfulness, or any other known characteristic that affects encoding ease.

We are unaware of published evidence on item difficulty and retrieval failure in posthypnotic amnesia. However, the recall and recognition data are consistent with the above model in that recognition deficits are not nearly as severe as recall deficits and recognition deficits remain about the same relative to recall deficits across susceptibility conditions.

More clearly consistent with existing data are the predictions of the model about subjective and objective organization in recalled material. Again, because an item must be retrieved in order to be marked forbidden, the items that are output under an amnesia suggestion should have less organization than normal output. The well-organized clusters of items will have been recalled and tagged as forbidden. Tagging failure is most likely to occur for items that are not well integrated with the other items on the list. Of course, many of these will also not be retrieved at recall time. However, among the items that are retrieved, one should expect less organization than among items retrieved by comparable control groups. As discussed in the introduction, the evidence on organization of recalled material under amnesia instructions is not clear cut. Nevertheless, on the whole, the data suggest decreased organization among the material recalled under amnesia instructions. Such a finding is consistent with the proposed output inhibition model.

Alternative Models

Although the outcome of Experiment 1 could not have been explained in the context of a "distracted attention" model, "distracted attention" cannot be ruled out as playing a role in hypnotic memory phenomena and other hypnotic phenomena. In many respects the "output inhibition" model and "distracted attention" model are consonant. Under both, the locus of the hypnotically induced deficit is at the level of working memory and attention. Long-term memory activation, search, and re-

trieval processes are only influenced indirectly through what is input to the processes and through what happens to the output from the processes. It is possible that distracted attention could be a first defense whose failure necessitates output inhibition. However, there are several unresolved problems with the concept of *selective* distracted attention. For example, until the material enters attention, how can the information-processing system determine whether or not attention should be distracted? Similarly, cues to forbidden material must be recognized as such before attention can be distracted from this material selectively. Nevertheless, the ability of hypnotically susceptible subjects to focus their attention away from certain stimuli on demand (e.g., pain) is well documented (Hilgard, Morgan, & Macdonald, 1975; Karlin et al., 1980). It may be that distracted attention provides a generalized lowering of memory processing while output inhibition provides the selectivity.

Perhaps the most plausible alternatives to the output inhibition model are those models that postulate separate retrieval systems for episodic memory and for semantic or procedural memory. The experiments reported in this article reveal that hypnotic suggestions for amnesia eliminate verbal reports of episodes of learning but do not eliminate activation and utilization of the procedural and semantic information learned. Recent studies of patients displaying amnesia due to physiological factors (e.g., Korsakoff's syndrome patients) have revealed some remarkably analogous results.

Korsakoff's syndrome patients display much poorer recall and recognition than normals on almost any standard verbal learning task. However, it has been shown that they can learn and retain skills such as "inverted mirror reading' (Cohen & Squire, 1980) and solution algorithms for problems such as the Tower of Hanoi problem (Cohen & Corkin, 1981). Furthermore, they retain such algorithms even though they report no memory of having solved such problems. Korsakoff's syndrome subjects also perform as well as controls on word completion tasks that only require access to semantic memory, but they show a marked deficit on cued recall tasks requiring access to episodic information (Graf, Squire, & Mandler, 1984). The conclusion that most researchers have drawn from these studies is that episodic memory employs encoding and/or retrieval systems that are distinct from those used in semantic or procedural memory.

The possible implication is clear. Amnesia instructions delivered to susceptible subjects under hypnosis, like the neurological deficit in Korsakoff's psychosis, might block retrieval in episodic memory but not in semantic or procedural memory. Such a model could explain most of the results of the current experiments and deserves further consideration. However, the model is not without its problems. First, the subjects in the

current study were asked to report any *procedure* for solving the problems that they could recall, and they could recall none. Thus, one needs an explanation of why information in procedural memory can be utilized but not reported. Second, any deficit in memory during posthypnotic amnesia must have its locus in the retrieval process. However, there is evidence from the studies with Korsakoff's syndrome patients (Graf et al., 1984) that their memory deficits are largest when the task requires elaboration rehearsal, i.e., an encoding process. Thus, the analogy may not hold. Finally, while all episodes are unretrievable to the Korsakoff's patient, only those that the hypnotist instructs the subject to forget are unretrievable to the hypnotized subject. A mechanism is still needed to explain such selective retrieval, and the output inhibition model provides an explanation.

SUMMARY

The results of the two experiments reported in this paper in conjunction with the analysis of other research on posthypnotic amnesia imply that hypnotic suggestions do not produce retrieval deficits but only inhibit output. According to this theory, hypnotically supressed material is tagged as forbidden either directly or through its associated context. Upon activation it is retrieved into attention and short-term memory (though not necessarily awareness). At this point, however, the information-processing system blocks the verbal report (and perhaps awareness) of the forbidden information. As a result the forbidden information can be actively employed and may interfere with other processes but cannot be reported. While for many applications the practical consequences of the difference between retrieval without verbal report and no retrieval may be small, from a theoretical perspective they are important. Under the proposed theory hypnotism is exerting its effect only at a relatively peripheral processing level and requires processing effort. Thus, subjects who are most responsive to suggestions and most in control of their information processing display the greatest deficits in report. While the discussion in this article did not deal with hypermnesia or hypnotic age regression, the theory for posthypnotic amnesia that emerged suggests that one should look at the peripheral effects of hypnosis for either reestablishing an encoding context or eliminating verbal inhibitions.

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