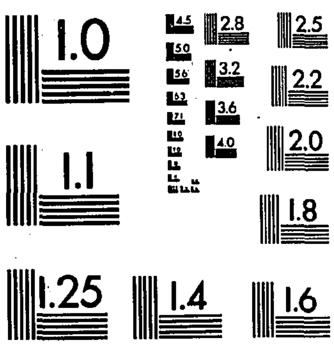
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AN INVESTIGATION OF THE FACTORS GOVERNING EXPERIMENTALLY INDUCED HYPERMNESIA

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AN INVESTIGATION OF THE FACTORS GOVERNING EXPERIMENTALLY INDUCED HYPERMNESIA

by

Gary W. Cantor

A dissertation submitted to the Graduate Faculty in Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

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Abstract

AN INVESTIGATION OF THE FACTORS GOVERNING
EXPERIMENTALLY INDUCED HYPERMNESIA

by

Gary W. Cantor

Advisor: Professor Arthur S. Reber

The roles of visual imagery, depth of processing, and other factors affecting hypermnesia (increasing memory recall over successive trials) were examined in a number of experiments.

Several pieces of evidence were presented that indicate that visual imagery processes do not in themselves explain the occurrence of hypermnesia. These include the finding of hypermnesia for low imagery words and for items in long-term memory that are not apt to be imaged. In addition in one experiment indicators of visual imagery did not correlate significantly with subjects' individual levels of hypermnesia.

As other recent studies have suggested, semantic elaboration was shown to facilitate hypermnesic recall. However, in the final analysis it was concluded that the occurrence of hypermnesia cannot be described as being a depth of processing phenomenon any more than it can be

described as being a visual imagery phenomenon.

As a possible alternative to visual imagery and depth of processing explanations of hypermnesia, levels of hypermnesia may be said to be determined by levels of memorial availability. As support for this position, it was found that recognition memory levels correlated significantly with levels of hypermnesia for items in long-term memory. An availability explanation of hypermnesia is parsimonious because it can account for the effects of visual imagery, depth of processing, and category size.

The role of recall time was examined by varying the amount of time subjects were allowed on a repeated recall task. It was found that level of hypermnesia was unaffected by the length of recall periods.

Finally, it was found that the amount of psychological time subjects are given between recall periods is an important determinant of level of hypermnesia, whereas the mere passage of (real) time is not.

ACKNOWLEDGEMENTS

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INTRODUCTION

The foundation for much of the memory research that has ensued in the last century was laid down by Ebbinghaus' (1885) classical work. Using his savings method, Ebbinghaus was able to plot the rate at which items (nonsense syllables) were forgotten. Although his methods were crude, this work can surely be appreciated on historical grounds, because it entailed the first attempt to utilize the scientific method in studying memory.

In addition to its methodological importance, this work was influential in its characterization of human memory. In essence, the results of this effort - the 'forgetting' curve - established in the minds of experimental psychologists the 'fact' that memory decreases at a specific rate over time (see Erdelyi and Kleinbard, 1978). As such, due to the general acceptance of forgetting that followed this work, the bulk of memory research that has ensued since the time of Ebbinghaus has dealt with the reasons for memory loss (i.e., trace decay, interference, repression), leaving the premise of forgetting over time relatively unchallenged.

However, the notion of decreasing memory over time is not one which has been totally accepted, especially when non-experimental traditions are concerned. For example, as Erdelyi and Kleinbard (1978) pointed out, the notion that memory may actually increase with time can be found in Freud's writing, particularly in relation to his belief that dreams are a conduit by which otherwise inaccessible memories may be experienced (Freud, 1900). In a totally different way, the work of Penfield (1959) further advanced the notion that inaccessible memories may be experienced. Penfield reported that (during surgery), by applying electrical stimulation to the cortex of certain patients, they would experience quite vivid images. These images were assumed to be a reliving of the past, and as such their existence could be seen to be supportive of the notion that all of our past experiences are accessible under the proper conditions. Penfield's work, as it relates to memorial accessibility has been roundly criticized, and rightly so. As Neisser (1967) pointed out, the fact that patients relate quite detailed and vivid memories in no way means that they are actually remembering events as they happened. It is just as likely that they were creating or synthesizing a sequence of events that never really occurred as such in their lives. Nonetheless, regardless of the inadequacies of Penfield's work from an experimental point of view, this work is interesting for two reasons. First, like the work of Freud, it suggests that otherwise inaccessible memories may be accessible under certain circumstances. Second, and also in agreement with Freud's observations, Penfield's work suggests that the recovery of locked away memories may be related to the evocation of vivid visual images.

In terms of experimental research, some studies that were conducted early in this century did suggest that memorial performance could increase instead of decrease as time passed. For example, Brown (1923) showed that recall for the states of the U.S. as well as for a list of words was greater on a second test than on a first test. Perhaps the most interesting of these early works was that of Ballard (1913). Utilizing large numbers of school children as his subjects, Ballard found that the number of lines recalled from a poem was greater after a few days than it was on a first recall test given immediately after the poem was learned.

Despite these early successes, as time went on interest in the growth of recall over time waned. This lack of interest was due predominantly to a nagging inability to replicate findings, which in itself was at least partly due to the fact that a variety of methodologies was being used rather unsystematically to study the phenomenon (see Buxton (1943) for a review of this early literature).

In the past decade, however, interest in memorial growth over time has been revived. This revival has occurred for the most part because of the reliability of these recent findings, and because of the ensuing controversy centered around explaining these very reliable results. However, before discussing the results of this recent experimental work and the implications that they have for our understanding of human memory processes, it is essential to explain how this phenomenon, which has come to be known as hypermnesia, is studied and to define it precisely.

In a typical experiment on hypermnesia, subjects are shown a set of stimuli, and later given several opportunities to recall the stimulus materials. On each successive recall attempt subjects are asked to try to recall all of the stimulus items - those they have already recalled as well as any new items they have yet to recall. If subjects recall more items - in total - on successive recall attempts, they are said to be hypermnesic. Thus, hypermnesia refers to the growth of net recall over trials. Considering this definition, it is clear that hypermnesia can occur only when (1) subjects recover new items from memory on successive recall attempts, and (2) this recovery of new items exceeds intertrial forgetting.

As Erdelyi (in preparation) has pointed out, it is very important to distinguish between hypermnesia and what is known as reminiscence. Although the latter term was operationalized quite succinctly by Ballard (1913), it has been used to refer to different phenomena by different authors. According to Ballard (1913) reminiscence refers only to increases in cumulative recall over trials. For a subject to be reminiscent, he (she) must recall items from memory that were not recalled on previous recall trials. However, net recall need not increase over trials. As such, by definition, the occurrence of reminiscence is dependent on one of the features that is necessary for hypermnesia - the recovery of new items from memory - without regard to intertrial forgetting. Thus, it can be seen that whereas the occurrence of hypermnesia necessitates reminiscence, reminiscence can and does occur in the absence of hypermnesia. For example, if a subject recalls 10 words from a list on a first recall attempt and 10 words on a second recall attempt, there is by definition no evidence of hypermnesia - since net recall has not increased. However, if any of the words recalled on Trial 2 were different from those recalled on Trial 1, there is evidence of reminiscence. In fact, as Ballard (1913) showed, whereas reminiscence varies in relation to a number of variables (i.e., type of material used, age of subjects, etc.), its very occurrence is ubiquitous. On the other hand, he found that hypermnesia, as it has been defined here, is unusual and for this reason it is an interesting phenomenon to study. With these definitions in mind, it is now appropriate to discuss recent findings of hypermnesia and their implications.

Most of the recent interest in hypermnesia has centered around evidence linking this phenomenon to visual imagery processes. In fact, many studies seemed to indicate that hypermnesia was dependent upon visual imagery processes. In a study by Erdelyi and Becker (1974) hypermnesia was found when pictorial stimuli were presented to subjects but not when words were utilized. Similar findings were reported by others as well (e.g., Yarmey, 1976; Madigan, 1976; Shapiro and Erdelyi, 1974). In a study by Erdelyi, Finkelstein, Herrell, Miller, and Thomas (1976) evidence for the linkage between hypermnesia and visual imagery processes was presented in a different but perhaps more powerful way. In this study subjects who were presented with verbal stimuli displayed hypermnesic recall, but only when they were asked to image the words upon presentation. The implication of this study was that hypermnesia is not dependent upon the utilization of any particular type of stimuli (such as pictures), but rather that it is dependent upon internal imagistic processing. As such, this study provided converging evidence for the visual imagery hypothesis of hypermnesia.

These recent laboratory results linking hypermnesia to visual imagery processes are conceptually interesting for three reasons. First, the results reported run counter to what one would expect if Ebbinghaus' (1885) forgetting curves were indeed the rule. Second, the linkage of hypermnesia to visual imagery processes seems to tie together quite nicely with the ideas of Freud as well as with Penfield's work in regard to the recovery of lost memories. Finally, these results may be important in explaining why it is that hypermnesic recall has not been observed reliably in earlier studies throughout this century. As Erdelyi and Kleinbard (1978) point out,

> Replication failures were due less to the unreliability of the phenomenon and more to the unwitting adoption of ineffective stimuli by subsequent researchers. The almost universal - but unquestioned - shift from methodologically unwieldy poetry, Ballard's usual stimulus, to the more controllable 'scientific' stimulus of Ebbinghaus, the nonsense syllable, may have erroneously undermined a seminal discovery in memory. More recent research on multitrial recall for unconnected strings of words (e.g., Donaldson, 1971; Hogan & Kintsch, 1971; Rosner, 1970; Tulving, 1971) has similarly yielded flat or amnesic memory functions, despite recoveries of individual items from trial to trial. Our hunch is therefore, that when the stimulus materials are imagistic, as when they are pictures, poems, or even unconnected strings of words that are individually imaged (cf. Erdelyi et.al., 1976), recall may be hypermnesic. (p. 276).

More recently, the necessary role of imagery in hypermnesia has been questioned due to findings of hypermnesia for nonpictorial materials in situations that do not lend themselves easily to visual imagery interpretations. Most of these studies suggest that hypermnesia is related to the depth of processing (Craik and Lockhart, 1972) given to stimuli. For example, Erdelyi, Buschke, and Finkelstein (1977) presented subjects with riddles, the answers to which comprised the word list that subjects were later to recall. Hypermnesia in this condition was greater than hypermnesia for pictures; words that were presented without specific processing instructions showed no increase in recall. Erdelyi et al. made the not unreasonable suggestion that the common finding of hypermnesia for pictures but not words may be due to a tendency to accord pictorial stimuli greater depths of cognitive processing.

Additional support for the depth of processing interpretation comes from Belmore (1981), who found hypermnesia for words, but only when they were semantically elaborated during encoding, and from Roediger and Thorpe (1978), who found hypermnesia for high as well as low imagery words when subjects were given semantic elaboration instructions during encoding. This latter finding of hypermnesia for low imagery words presents perhaps the most convincing evidence to date against the simple imagery hypothesis. However, the impact of this finding has been less than catastrophic for the imagery position because of (1) a failure to replicate (Belmore, 1981), and (2) the fact that the absolute level of hypermnesia found by Roediger and Thorpe (1978) was quite small (less than a 2 word increase over trials).

Recently, Roediger, Payne, Gillespie, and Lean (1982) have put forth the rather simple hypothesis that hypermnesia is determined by level of recall. More specifically, their argument is that the level of hypermnesia attained by subjects is determined by the level of subjects' cumulative recall. Their argument is made empirically as well as on theoretical grounds, and they present several studies that support their hypothesis. This 'level of recall' hypothesis is an interesting departure from the imagery and depth of processing positions, because, whereas the latter two hypotheses relate hypermnesia to specific types of cognitive processing, this hypothesis links hypermnesia to a measure of performance. In essence, Roediger et als.' claim is that whatever processes are responsible for increasing levels of cumulative recall will lead to greater levels of hypermnesia. The importance of this type of hypothesis is that it can, in essence, be seen to encompass both the imagery position and the depth of processing position, since both imagery and depth of processing lead to greater levels of recall.

Unfortunately, as appealing as this hypothesis is, it does not seem to offer a satisfactory explanation of the hypermnesia phenomenon. One problem with this hypothesis is that it cannot account for some of the existing data on hypermnesia, as even Roediger et al. (1982) acknowledge. In several studies (e.g., Yarmey, 1976; Erdelyi et al., 1977; Madigan and Lawrence, 1980) level of hypermnesia has not been related to level of recall. In addition, a critique of this hypothesis can be made in regard to the theoretical arguments that are made in suppport of it. Roediger (1982) explains that the level of recall hypothesis is based on the following logic:

> (a) Hypermnesia - increased recall across repeated tests - is equivalent in terms of total number of items recalled to performance during a single long test of the same duration. (b) Since hypermnesia is equivalent to cumulative recall, properties of cumulative recall curves are critical for understanding the phenomenon. (c) These cumulative recall curves typically exhibit the property of a negative correlation between the asymptote, n (∞) and the rate of approaching that asymptote, ∞ . (d) Since the rate of approaching the asymptote is greater with lower levels of asymptotic recall, if recall is stopped after a fixed period of time performance will be nearer the asymptote in cases of lower rather than higher recall. Thus, potential gains in recall (hypermnesia) will be greater in cases of higher asymptotic recall. (p. 683).

Although the logic of this argument seems appealing, upon close inspection it can be seen to be flawed. The cornerstone of this argument is the contention that hypermnesia is equivalent to cumulative recall. The basis for this argument is to be found in studies (i.e., Roediger and Thorpe, 1978) that show that the total number of words recalled from a list is equivalent regardless of whether subjects are given one long recall session or three shorter (but equivalent in terms of total time) recall sessions. The problem is that this type of study does not in any way equate hypermnesia with cumulative recall. It simply makes the point that cumulative recall is equivalent when total time is equivalent. Since hypermnesia refers to increases in net recall, such an experiment does not and cannot compare hypermnesia and cumulative recall. As such, their argument, which is based on the equivalence of hypermnesia and cumulative recall is without foundation.

To summarize, hypermnesic recall, which is contrary to the type of retention curve that is predicted by Ebbinghaus, has been observed reliably in the laboratory in recent years. At this point three different hypotheses have been formulated to explain the observation of hypermnesic recall. The first hypothesis - the imagery position - links hypermnesia to visual imagery processes. The strength of this hypothesis is its ability to account for the very reliable finding of hypermnesia for pictures (but not words) under neutral processing conditions, and for words when they are imaged. Its weakness is its inability to account easily for the occurrence of hypermnesia under non-imagistic conditions. The second hypothesis - depth of processing - relates hypermnesia to processing materials at meaningful levels. The strength of this hypothesis is to be found in its ability to explain hypermnesia in conditions that do not involve imagery - as well as under 'imagery' conditions. However, as Erdelyi (1982) has aptly pointed out, because this position must rely on an explanation based on internal cognitive processing, it may not be possible to separate it completely from the imagery position. In essence, one could argue that in many semantic elaboration conditions, imagery is actually taking place. Finally, the level of recall position marks a departure from the other two hypotheses, in that it attempts to explain hypermnesia on the basis of a performance measure - rather than on the basis of cognitive processing. However, this hypothesis suffers from both (1) its inability to account for some existing data and (2) problems that relate to its theoretical evolution.

The experiments that follow are intended to further our understanding of the hypermnesia phenomenon. The major goal of this research is to provide new data that can be used to assesss the above mentioned hypotheses, as well as to generate new ideas that will help explain the occurrence of hypermnesia. In addition to this, a number of other issues in regard to hypermnesia will be examined, including the importance of intratrial and intertrial time, and the relationship between hypermnesia and other measures of performance - such as short-term memory and recognition memory.

EXPERIMENT 1

As was discussed above, one of the key findings that has been used to dispute the visual imagery hypothesis of hypermnesia was the finding of hypermnesia for low as well as high imagery words (Roediger and Thorpe, 1978). In Experiment 1 the primary goal was to replicate this finding. In addition, an attempt was made to determine whether or not the finding of hypermnesia for such low imagery words is dependent upon having subjects utilize deep (meaningful) processing of these stimuli.

In order to accomplish both of these goals in this experiment, two groups of subjects were asked to recall repeatedly low imagery words. The groups differed only in terms of the instructions they were to follow during encoding. One group of subjects (the "Depth of Processing" group) was given encoding instructions that would encourage the use of deep cognitive processing, while the other group (the Control group) was given neutral instructions.

Method

Subjects

The subjects were 30 Brooklyn College undergraduates. All of these subjects participated in order to fulfill an introductory psychology course requirement.

Design

Subjects were assigned to one of two groups (n = 15 per group). The groups differed only in terms of their encoding instructions. Following the presentation of stimuli both groups were given three recall trials. Thus, this study utilized a 2 (Groups) x 3 (Recall Trials) factorial design where Recall Trials was a repeated measure.

Materials

Sixty printed words were photographed and placed onto slides. The 60 words that were used were taken from the list of nouns compiled by Paivio, Yuille, and Madigan (1968). All of these words had imagery ratings below the median level for the 925 words on their list. These words are listed alphabetically in Appendix A.

Procedure

Subjects were run in small groups of 4 or fewer. Subjects in both groups received booklets at the beginning of the session. They were told that they would be seeing slides of words that they would later be asked to remember. During presentation, the words were shown for 10 seconds each. Subjects in the Control group were instructed simply to attend to each word as it was presented, and then when the experimenter said "OK" (after 10 seconds) to copy it down quickly in their booklet and look up in anticipation of the next word. Subjects in the "Depth of Processing" group were also instructed to write down each word when the experimenter said "OK." However, after copying each word, they were also supposed to enter a pleasantness rating for the word next to it. The pleasantness ratings could range from 1 to 10, with 10 representing a word that meant something to them that was very pleasant, and 1 meaning something that was very unpleasant.

After the presentation period, subjects in the two groups were treated identically. They were given three 7-minute periods to recall (in any order) the words that were presented. In betweeen the first and the second, and the second and the third recall trials they were given 3-minute "think" periods during which they were asked to sit back quietly and think about the words they were shown.

In this experiment (as in the next three) a forced recall procedure was used. On all three recall trials, subjects were compelled to write down exactly 40 responses (each page of their answer booklet was pre-numbered from 1 to 40), regardless of whether or not they thought they could remember this many words. As such, they were urged to guess in order to make sure they wrote down 40 words on each recall trial. During each recall trial, the experimenter told the subjects as each minute passed, and subjects were instructed to underline the last word written prior to each announcement. In addition, in order to aid subjects in completing their forced recall, special warnings were given for each of the final two minutes before each recall session expired. Finally, before the second and third recall trials, subjects were told to attempt to recall both the words they had already recalled (on earlier trials) as well as any words they had not written on earlier recall trials.

Some rationale should be given for several aspects of this procedure. First, as was stated above, subjects in both groups were asked to write down the words as they were presented. This procedure was intended to ensure that subjects in both groups attended to the stimuli. Second, forced recall was used, as it has been in many studies on hypermnesia, as a control to ensure that increases in recall did not result solely from the loosening of response criteria from one trial to the next. Although it is now questionable whether or not forced recall is a necesssary control for criterion shifts (see Experiment 5 below), forced recall was utilized in this study because (1) it was relatively easy to utilize, and (2) its utilization would add credibility to Roediger and Thorpe's (1978) finding, since these authors used free recall sessions. In connection with the utilization of forced recall in this study, the warnings that were given 2 and 1 min. before the end of each recall session were deemed to be necessary as a result of work with pilot subjects that suggested that these warnings aided subjects in finishing their forced recall.

Results

The key data to assess in studies of hypermnesia are net recall levels. As such, these data will be presented here as well as for all of the experiments reported. In this experiment, however, cumulative recall levels will be reported as well. This will be done here simply to demonstrate the difference between assessing hypermnesia (via net recall levels) and reminiscence (via cumulative recall levels) and to see whether reminiscence occurred in either group in the absence of hypermnesia (a phenomenon noted quite often by Ballard, 1913).

Net Recall

Table 1 gives the mean levels of recall for both groups of subjects on the three recall trials. An overall analysis of variance reveals that the "Depth of Processing" group recalled a significantly greater number of words across all tests than did the Control group ($F(1,28)=6.47$, $p<.05$). In addition, recall did increase reliably across tests ($F(2,56)=13.89$, $p<.01$), demonstrating overall hypermnesic recall for these low imagery words. Finally, the interaction between groups (Control vs. "Depth of Processing") and recall trials was significant ($F(2,56)=5.89$, $p<.01$), indicating that the increase in recall across tests was greater for the "Depth of Processing" group than for the Control Group.

In order to examine whether or not both groups exhibited

Table 1

Mean Levels of Net Recall In Experiment 1

Group	Recall Trial Trial 1	Trial 2	Trial 3	Net Increase (T3 - T1)
Control	18.93	19.40	20.07	1.14
Depth of Processing	22.80	26.27	27.73	4.93

hypermnesia, or whether the significant increase in recall across trials was limited to the "Depth of Processing" group, an analysis of simple main effects was conducted. This analysis revealed that the increase in recall across trials was significant for the "Depth of Processing" group ($F(2,56)=18.82$, $p<.01$), but was not significant for the Control group ($F(2,56)=.95$, $p>.05$). Thus, whereas the "Depth of Processing" group was hypermnesic, the Control group was not.

Cumulative Recall

Table 2 gives the mean levels of cumulative recall for both groups of subjects on the three recall trials. An analysis of the difference in cumulative recall from Trial 1 to Trial 3 revealed that subsequent to Trial 1 more new items were recalled for the "Depth of Processing" group than for the Control Group ($t(28)=2.97$, $p<.01$). However, when analyzed separately, an increase was found in cumulative recall for the Control group ($t(14)=6.73$, $p<.01$) as well as for the "Depth of Processing" group ($t(14)=8.75$, $p<.01$). This finding of a significant recovery of new items subsequent to Trial 1 for the Control group means that the lack of true hypermnesia for this group was not due to an inability to come up with new words after Trial 1, but rather was due to the fact that intertrial forgetting offset the recovery of new words. As such, the results of the Control group reveal what Ballard (1913) noted long ago - that reminiscence is generally found, even when net recall does not increase over trials.

Discussion

In terms of the objectives that were stated at the outset of this study, the conclusions to be drawn from these data seem quite clear. First, the findings of an overall increase in net recall across trials

Table 2

Mean Levels of Cumulative Recall in Experiment 1

Group	Recall Trial Trial 1	Trial 2	Trial 3	Cumulative Increase (T3 - T1)
Control	18.93	22.13	24.00	5.07
Depth of Processing	22.80	28.87	31.60	8.80

serves as a replication of Roediger and Thorpe's (1978) finding of hypermnesia for low imagery words. As such, these results seem to contradict the notion that hypermnesia is an effect that is limited to specific stimuli (e.g., pictures or highly imageable verbal stimuli). In addition, since visual encoding instructions were not used, the results can be seen as being damaging to the visual imagery hypothesis.

The fact that hypermnesia was found only for the "Depth of Processing" group implies that semantic elaboration is an effective way of inducing hypermnesic recall. As such, these results tend to support Belmore's (1981) suggestion that hypermnesic recall is the result of semantic elaboration.

However, some caution should be used in considering these results. Although the results of this experiment suggest that semantic elaboration is a key in hypermnesic recall, one aspect of the design in Experiment 1 weakens this assertion. Whereas members of the "Depth of Processing" group were given an orienting task that involved semantic elaboration, the Control group was not given an orienting task at all. They were simply asked to copy the words as they were displayed (as an attentional control). As such, one might say that Experiment 1 did not demonstrate the importance of semantic processing, but rather only the importance of any type of processing.

In order to answer such a critique, and to further investigate the role that depth of processing plays in hypermnesia, the next experiment will involve groups of subjects that are given encoding instructions that are either 'deep' or 'shallow.' If depth of processing is of prime importance to hypermnesia, then only subjects that are involved in deep encoding should demonstrate hypermnesic recall.

EXPERIMENT 2

This experiment has two goals. The first is to replicate the first experiment's finding of hypermnesia for low imagery words. The second is to demonstrate properly the role that depth of processing plays in hypermnesia. In this experiment a direct comparison was made between groups of subjects that were each processing the same stimuli - only at different 'depths'.

To accomplish both of these goals in this experiment, subjects in three groups were asked to recall repeatedly low imagery words. In one group (the "Meaning" group) a deep encoding task was utilized, whereas in the other two groups (called the "Sound" and the "Syllables" groups) encoding tasks were aimed at shallow levels of processing. According to the depth of processing interpretation of hypermnesia, only subjects in the "Meaning" group should show hypermnesic recall.

Method

Subjects

The subjects were 45 Brooklyn College undergraduates. All of these subjects participated in order to fulfill an introductory psychology course requirement.

Design

Subjects were assigned to one of three groups ($\underline{n}$ = 15 per group). The groups differed only in terms of the encoding instructions they were given. Following the stimulus presentation subjects in all groups were given three recall trials. Thus, this study utilized a 3 (Groups) x 3 (Recall Trials) factorial design where Recall Trials was a repeated measure.

Materials

The materials used in this study were the same as those utilized in Experiment 1.

Procedure

The general procedures for stimulus presentation as well as for repeated recall were the same as those used in Experiment 1. The procedural differences between Experiments 1 and 2 were in terms of the encoding instructions given to subjects. As in Experiment 1, subjects in all three groups were asked to copy down each word after the experimenter said "OK" (after the word had been on the screen for 10 seconds). The groups diverged from one another in terms of the additional encoding task they were asked to perform. These tasks were as follows:

Group 1 (the "Meaning" group) - This group was identical to the "Depth of Processing" group in Experiment 1. After copying each word, subjects were supposed to write down a 1 to 10 rating of the pleasantness of the "meaning" of the word, where 10 referred to a word whose meaning was very pleasant and 1 referred to a word whose meaning was very unpleasant.

Group 2 (the "Sound" group) - After copying each word, subjects in this group were suppposed to write down a 1 to 10 rating of the pleasantness of the "sound" of each word, where 10 referred to a very pleasant sounding word, and 1 referred to a word that had a very unpleasant sound.

Group 3 (the "Syllables" group) - After copying each word, subjects in this group were supposed to write down the number of syllables in the word.

As is evident from the above description, whereas subjects in the "Meaning" group were given a deep encoding task, subjects in both the "Sound" and the "Syllables" groups were given encoding tasks that stressed only the surface (shallow) features of the words.

Results

Table 3 gives the net recall data for the three groups in this study. An analysis of variance reveals that overall recall level did vary reliably across groups ($F(2,42)=6.42$, $p<.01$). In addition, the overall Recall Trials effect was significant ($F(2,84)=3.57$, $p<.05$), indicating that recall levels varied across trials. Finally, the interaction betwen Groups and Recall trials was significant ($F(4,84)=7.60$, $p<.01$). This interaction indicates that the change in recall across tests varied for the three groups.

In order to follow upon the finding of the significant Group X Recall Trials interaction, two partial interaction effects were calculated. The first of these compared the variation in recall across tests for the "Meaning" group versus the "Syllables" and "Sound" groups in combination. This interaction proved to be significant ($F(2,84)=12.70$, $p<.01$), and thus demonstrates that the growth in recall for the "Meaning" group was superior relative to the other two groups. The second partial interaction examined the rate of recall change over trials for the "Sound" group versus the "Syllables" group, and revealed no significant difference ($F(2,84)=2.49$, $p>.05$).

Finally, in order to assess the significance of the change in recall for each group separately, an analysis of simple main effects was conducted. This analysis revealed that the increase in recall across

Table 3

Mean Levels of Net Recall in Experiment 2

Group	Recall Trial			Net Increase
	Trial 1	Trial 2	Trial 3	(T3- T1)
Meaning	21.20	23.13	25.93	4.73
Sound	18.40	18.47	19.13	0.73
Syllables	16.27	14.40	14.33	-1.94

trials was significant for the "Meaning" group ($F(2,84)=15.11$, $p<.01$). Thus, this group can be classified as being hypermnesic. A similar analysis for the "Syllable" group revealed that the decrease in recall for this group was significant ($F(2,84)=3.21$, $p<.05$). As such, recall for this group was amnesic. Finally, recall did not vary signficantly across trials for the "Sound" group ($F(2,84)=0.44$, $p>.05$).

Discussion

As in Experiment 1, the results of this experiment can be seen as both damaging to the imagery hypothesis of hypermnesia and as providing support for the notion that depth of processing is an important factor in hypermnesic recall.

In regard to the imagery hypothesis, as in Experiment 1, hypermnesia was found (in the "Meaning" group) for stimuli that are not likely to be imaged - namely low imagery words. Although it is still possible to argue that imagery played a role in the hypermnesic recall found for the "Meaning" group, such an explanation is made unlikely when one takes into account not only the stimulus materials that were utilized but also the encoding instructions, which did not include any mention of visual imagery. As such the results of this experiment seem to weaken once again the proposition that hypermnesia is linked to visual imagery processes.

The fact that hypermnesic recall occurred only for the group of subjects who were instructed to utilize a deep encoding strategy (the "Meaning" group) suggests once again that depth of processing is a determinant of hypermnesic recall. In connection with this, the non-hypermnesic recall patterns of the "Sound" and "Syllable" groups fit in nicely with most results that have been observed in studies of hypermnesia. That is, in general repeated recall of words has yielded either flat or even amnesic recall curves (see Tulving, 1967; Donaldson, 1971).

As a final note on this experiment, the flat recall function that was found for the "Sound" group may help to explain an anomalous finding in the literature (Belmore, 1981). As was mentioned earlier, she was unable to find hypermnesia for low imagery words, even though deep encoding instructions were utilized in her study. In fact, the encoding task that Belmore utilized was essentially the same one that was utilized by the "Meaning" group in this experiment. In attempting to explain the non-hypermnesic effect in that study, Belmore asserted that perhaps (at least some) subjects were rating the pleasantness of the sounds of words instead of rating their meanings. Since rating the sounds of words would be a rather shallow task, Belmore believed that this could possible explain why hypermnesia was not found. As such, in this experiment, a comparison of the "Sound" group to the "Meaning" group allowed for an evaluation of her hypothesis. Although there are other possible explanation, given the findings here of hypermnesia for the "Meaning" group, but not for the "Sound" group, her explanation may be an accurate account of what occurred in that study.

EXPERIMENT 3

In Experiments 1 and 2 the importance of semantic elaboration in hypermnesic recall was confirmed by showing that increasing recall for a set of stimuli (low imagery words) is dependent upon having subjects utilize a deep encoding task. As such, these experiments complement a number of others (e.g., Erdelyi, Finkelstein, Herrell, Miller, and Thomas, 1976; Erdelyi, Buschke, and Finkelstein, 1977; Belmore, 1981) in asserting the importance that encoding strategies play in hypermnesic recall.

In the present experiment, rather than examining the effects of different encoding strategies on hypermnesia, an attempt was made to examine the effects of a property of the input stimuli - specifically level of meaningfulness. The relationship between stimulus meaningfulness and hypermnesia is of interest for a number of reasons. First, it is interesting for historical reasons. As was mentioned earlier, Erdelyi and Kleinbard (1978) have argued that hypermnesic results may have been unreliable for many years because relatively non-meaningful stimuli were utilized in many studies involving multitrial recall. Second, a finding of a direct relationship between meaningfulnes and hypermnesia may explain the common finding of hypermnesia for pictures but not words. That is, it is possible that pictures are simply more meaningful to people than words. Finally, a positive relationship between meaningfulness and hypermnesia may explain why "deep" processing leads to increasing levels of hypermnesia. Although it is only speculation, it is possible that processsing stimuli deeply results in an increasing number of associations and that it is the number of stimulus associations (which in itself is generally the operational measure of meaningfulness) that is the underlying predictor of level of hypermnesia.

Method

Subjects

The subjects were 15 Brooklyn College undergraduates. These subjects were enrolled in two psychology learning laboratory classes. The two classes (*n*=8 and 7) participated separately as part of their class lesson. After their participation as subjects they were debriefed, and they aided in the statistical analysis and interpretation of the results.

Design

A totally within group (one group) design was utilized. All subjects were shown 60 words that were to be recalled. Half of the words were highly meaningful (see below) and half were low in meaningfulness. Following the presentation of stimuli subjects were given three recall trials.

Materials

The 60 words that served as the stimuli in this study were taken from the list compiled by Paivio et. al. (1968). Of these 60 words, 30 were above the median (of all words on that list) in terms of meaningfulness, and 30 were below the median level of meaningfulness. All of the high as well as low meaningful words were below the median in terms of imageability. Finally, in order to ensure rough comparability of word frequency between the high and low meaningful words, an equal number of words for each set were high frequency words (A or AA in the Thorndike and Lorge (1944) word counts). All of the words utilized are listed in Appendix B.

The words were printed and placed onto slides. The slides were placed into a slide carousel in a random order except for the restriction that 15 out of the first (and second) 30 words shown had to be of each level of meaningfulness (high or low).

Procedure

The procedures for both stimulus presentation as well as repeated recall were exactly the same as those utilized for the "Depth of Processing" group in Experiment 1 and for the "Meaning" group in Experiment 2.

Results and Discussion

Table 4 gives the mean levels of recall across the three recall trials separately for the high and low meaningful words as well as for all of the words combined. An analysis of variance reveals that the overall increase in recall across trials was significant ($F(2,28)=14.97$, $p<.01$). This result in itself is important because, as in Experiments 1 and 2, it serves as a replication of Roediger and Thorpe's (1978) finding of hypermnesia for low imagery words. In fact, because the mean imagery ratings for the 60 words used here was lower than for the list utilized in Experiments 1 and 2 (3.97 versus 4.46 on a 1 to 7 scale) an even stronger case can now be made against the notion that hypermnesia is linked to visual imagery processes.

In terms of comparing performance for the high and low meaningful words, as one would expect, recall was significantly greater across all trials for the highly meaningful words ($F(1,14)=27.32$, $p<.01$). However, of most interest in terms of the two sets of stimuli utilized, the interaction between Level of Meaningfulness and Recall Trials was not

Table 4

Mean Levels of Net Recall in Experiment 3

Stimuli	Recall Trial			Net Increase
	Trial 1	Trial 2	Trial 3	(T3 -T1)
High m Words	11.53	12.47	13.87	2.34
Low m Words	7.27	7.80	9.27	2.00
All Words	18.80	20.27	23.13	4.33

significant ($\underline{F}(2,28)=0.81$, $\underline{p}>.05$). Thus, the variation in recall over trials was not reliably different for the low and high meaningful words.

The fact that the increase in recall over trials was not related to level of stimulus meaningfulness is surprising, especially in light of Erdelyi and Kleinbard's (1978) rather convincing argument that lack of stimulus meaningfulness may have been a key reason why hypermnesic recall was not reliably found in studies performed earlier in this century. However, there is some precedence for such a finding. In his pioneering work in this area, Ballard (1913) expresssed his doubts that meaningfulness was an important factor in determining the rate at which recall changes over repeated trials. Ballard compared the repeated recall of meaningful ballad poetry to nonsense verses and found that although the overall level of recall was greater for the meaningful poetry, the curves reflecting the change in recall over trials were nearly identical. An additional reason to doubt the importance of meaningfulness in determining levels of hypermnesia was a recent finding of hypermnesia for nonsense syllables (Roediger, Payne, Gillespie, and Lean, 1982).

In any case, the lack of a relationship between meaningfulness and level of hypermnesia implies that meaningfulness probably is not the factor that is responsible for such phenomena as (1) the typical finding of hypermnesia for pictures but not words, and (2) the relationship between hypermnesia and depth of processing. As such, other factors must surface to explain these phenomena.

Before concluding the discussion on this experiment, it should be noted that due to one aspect of the methodology used, the results should be interpreted with a bit of caution. Because the subjects were utilizing deep encoding instructions, it is possible to argue that the differences in stimulus meaningfulness that existed prior to encoding could have been narrowed in a psychological sense, as low meaningful words might have gained relatively in meaningfulness as a result of the encoding. Such an argument would be difficult to evaluate. However, it exists as a possibility, and as such an attempt to replicate utilizing different (or no) encoding instructions would be interesting.

EXPERIMENT 4

In Experiment 4 an attempt was made to examine comprehensively the roles that real time, psychological time, and repeated recall play in determining level of hypermnesia. The importance of this study lies in the fact that no previous study has examined all of these factors concurrently.

The results of several studies have led some to the conclusion that allowing subjects greater amounts of psychological time - time spent trying to remember or otherwise processing to-be-remembered items - leads to an increase in level of hypermnesia. For example, Erdelyi and Becker (1974) found that the increase in recall across trials was greater for subjects who were given "think" periods between recall trials than for subjects who were simply given consecutive recall trials. In addition, Shapiro and Erdelyi (1974) found that subjects' recall of pictures (though not words) on a single recall test was enhanced when they were given additional time to think about the stimuli between presentation and recall. In sum, these studies suggest that hypermnesia increases with additional psychological time. They also lead to two further questions that are worth exploring. These questions are: (1) Is it really necesssary for subjects to "think" about stimulus items in order for hypermnesia to be enhanced, or is the mere passage of time sufficient?, and (2) Does allowing subjects to "think" about stimuli have the same effect as giving them additional recall trials?

The results of a recent study by Roediger and Payne (1982) suggest that the answer to the first of these questions is "no." In that study, they presented pictures to three groups of subjects. All three groups were later given three attempts to recall the names of the pictures. The first recall attempt was delayed for various amounts of time for the three groups. These delays were filled by having subjects read a passage. The authors found hypermnesia in all three conditions, but, more to the point, found recall on Trial 1 was equivalent across groups. This result is potentially important because it argues against time per se as the important variable in determining level of hypermnesia. Unfortunately, because the intervening task was reading, verbal interference as opposed to simple distraction may have resulted from this delay task. Nonetheless, the present experiment will attempt to answer both of the above questions.

Method

Subjects

The subjects were 45 Brooklyn College undergraduates. All of these subjects participated in order to fulfill an introductory psychology course requirement.

Procedure

Subjects were assigned to one of three groups (n = 15 per group). In all three groups the stimuli presented to subjects as well as the recall testing procedures were identical to those used in Experiments 1 and 2. The encoding instructions given to subjects in all groups were the same as those given to subjects in the "Depth of Processing" and the "Meaning" groups in Experiments 1 and 2 respectively. The groups differed only in terms of (1) the number of recall trials they were given, (2) the amount of time between recall trials, and (3) whether they were able to "think" about the stimuli between recall trials or not.

The three groups can be best described as follows:

Group 1 - Stimulus presentation was followed by three recall trials. Between recall trials they were given 11-minute "think" periods during which they were asked to sit back quietly and think about the words that were presented.

Group 2 - Stimulus presentation was followed by 5 recall trials. Between recall trials were 2-minute "think" periods.

Group 3 - Stimulus presentation was followed by 3 recall trials. Between recall trials subjects were given 11-minute distractor tasks to keep them from thinking about the words that were presented. The distractor tasks that were used were two paper and pencil tests that are used by the Educational Testing Service to assess visual-spatial abilities. Between the first and second recall trials, subjects were given the Form Board Test, in which subjects were asked to determine - for several large geometric figures - which of several small geometric figures can be put together to form a large geometric figure. Between the second and third recall trials, subjects were given the Paper Folding Test, in which they were asked to match folded pieces of paper (with one or two holes in it) to the unfolded versions of the same pieces of paper. These two distractor tasks were chosen because, (1) work with pilot subjects indicated that they would amply fill the 11-minute periods between recall trials, and (2) they are visual-spatial as opposed to verbal, and therefore should minimize verbal interference (which, as suggested above, might have been a problem in Roediger and Payne (1982). Their function was simply to keep subjects from thinking about the stimuli between recall trials.

Figure 1 illustrates the tasks that the three groups were engaged in as a function of time. In this diagram, S stands for stimulus presentation, TH stands for a "think" period, D stands for a distractor task, and R stands for a recall trial.

As is evident from Figure 1, three recall trials coincide exactly in time across groups. These recall trials have been enclosed in rectangles in this figure. Recall from these trials constituted the data analyzed in this study. Recall trials 2 and 4 for Group 2 were not intended to be part of the primary data base. These trials were meant only to provide extra overt practice for subjects in this group.

The design allows for the evaluation of certain comparisons across groups in order to test specific hypotheses. The hypotheses and their tests are as follows: Hypothesis 1 - If level of hypermnesia is determined by passage of real time (the amount of time subsequent to stimulus presentation) then the growth of recall across the above mentioned recall trials should be equal across all groups; Hypothesis 2 - If level of hypermnesia is dependent on psychological time (if "think" time and overt recall have equivalent effects), then the growth of recall across the above mentioned trials should be equal for Groups 1 and 2, and less for Group 3, which is prevented from processing the stimuli between recall trials; Hypothesis 3 - If psychological time and overt recall are both determinants of level of hypermnesia (that is, if the act of recalling has in itself an additional positive effect), then Group 2 should show the greatest amount of hypermnesia, followed by Group 1, and then Group 3.

Results and Discussion

Table 5 gives the mean levels of recall across all recall trials for all groups in this study. An analysis of variance was applied

Figure 1. Tasks for the three groups in Experiment 4 as a function of time.

	Task									
Group 1	S	R_1		TH		R_2		TH		R_3
Group 2	S	R_1	TH	R_2	TH	R_3	TH	R_4	TH	R_5
Group 3	S	R_1		D		R_2		D		R_3

→ Time

S = Stimulus Presentation

R = Recall Trial

TH = Think Period

D = Distractor Task

to the recall data from the three trials that coincided exactly in time. For ease of interpretation, these data have been enclosed in rectangles in Table 5.

The results of this analysis indicate that the overall recall level did not vary significantly across groups ($F(2,42)=0.36$, $p>.05$). However, recall did increase reliably across trials ($F(2,84)=31.63$, $p<.01$). This latter finding reinforces the findings in Experiments 1 though 3 of hypermnesia for low imagery words.

The interaction between groups and recall trials was significant ($F(4,84)=2.49$, $p<.05$), demonstrating that level of hypermnesia varied reilably across groups. Following up on this significant interaction, a partial interaction was calculated in an effort to assess whether time alone determines level of hypermnesia. In this partial interaction the increase in recall for Groups 1 and 2 (combined) was compared to the increase in recall for Group 3, which was the only group that was not allowed intertrial time to process the to-be-remembered words. The results of this partial interaction revealed that hypermnesia was significantly greater for Groups 1 and 2 than for Group 3 ($F(2,84)=4.11$, $p<.05$). This demonstrates that allowing subjects time to process the stimuli is an important factor in determining level of hypermnesia and agrees well with the results of Erdelyi and Becker (1974) and Shapiro and Erdelyi (1974).

An analysis of simple effects revealed that the increase in recall across trials was significant for Group 1 ($F(2,84)=11.75$, $p<.01$), and for Group 2 ($F(2,84)=22.13$, $p<.01$). However, recall across trials for Group 3 did not increase signficantly ($F(2,84)=2.74$, $p>.05$). This indicates that allowing subjects time to process stimuli is not only

Table 5

Mean Levels of Net Recall In Experiment 4

	Recall Trial					Net Increase
	Trial 1	Trial 2	Trial 3/2	Trial 4	Trial 5/3	(T5/3-T1)
Group 1	23.47	NA	26.20	NA	28.47	5.00
Group 2	21.20	23.80	25.47	27.07	28.00	6.80
Group 3	23.07	NA	24.00	NA	25.47	2.40

important, but also is a necessary condition for hypermnesic recall. This result agrees well with Roediger and Payne's (1982) finding that level of recall on a first recall trial did not vary when subjects were given a reading task that filled various amount of time.

A second partial interaction compared the increase in recall for Groups 1 and 2 and revealed no significant difference in rate of increasing recall for these groups ($F(2,84)=0.89$, $p>.05$). Since Group 2 received more overt practice, this indicates that extra overt practice does not offer any significant advantage above and beyond the internal processing of to-be-remembered items.

In summary, the results of this experiment indicate that whereas psychological time (time processing stimulus items) is a contributing and necesssary factor for hypermnesic recall, overt practice is no more effective than internal processing.

EXPERIMENT 5

Experiment 5 had two aims. One was to replicate the common finding of hypermnesia for pictures but not words under neutral encoding conditions. The second, and more important aim, was to test a hypothesis put forth by Roediger and Thorpe (1978). According to those authors, the increase in recall over trials found for any given set of stimuli will depend on the length of each recall trial.

Roediger and Thorpe's belief is that when very long recall trials are employed, very small increases will occur over trials because subjects will approach their recall limit during the first recall trial. On the other hand, when relatively short (though not extremely short) recall periods are employed, increases in recall should be maximized since subjects will not approach their recall limit at the conclusion of the first recall trial. If this hypothesis is correct, the implications it has for the interpretation of hypermnesia are great. First, it would mean that the size of the hypermnesic effect for any given set of stimuli and type of encoding will be subject to wide fluctuations, depending on the recall time allowed during each recall trial. In conjunction with this, it also suggests a rather different interpretation of studies in which hypermnesia was found for pictures but not for words. According to Roediger and Thorpe (1978), "If the first recall test lasts so long that subjects have already reached asymptote, then no increments are to be expected from allowing additional tests. This may be the reason that researchers have not found hypermnesia for words (e.g., Erdelyi and Becker, 1974; Madigan, 1976)." (p. 303). Thus, since picture recall has generally been found to be greater than word recall in these studies, it may be that when long recall trials have been used, recall for words has been nearly asymptotic by the end of the first recall trial, whereas picture recall was not yet near its limit. According to this hypothesis, if shorter intervals were to be used, hypermnesia would be evident for both pictures and words. It also follows that if very long intervals were to be employed, recall for both pictures and words would be very nearly asymptotic after the first recall trial and neither would show hypermnesia.

If shown to be valid, this hypothesis would also explain why hypermnesia has been found for words (e.g., Belmore, 1981; Experiments 1 through 4 above) when these stimuli are deeply processed. It has long been known that depth of processing instructions increase the total number of items that can be recalled from a list (Craik and Lockhart, 1972). As such, it can be argued that even when relatively long recall trials are used, subjects receiving depth of processing instructions do not reach their asymptotic level of recall after their first recall trial. Hence, when given subsequent recall trials, their output has the potential to increase.

As interesting as this recall time hypothesis is, it is still based entirely on a post hoc analysis (to be discussed below). In this experiment this hypothesis was tested directly by examining repeated recall levels when trials of 3, 7, and 15 minutes were utilized. Moreover, both pictorial and verbal stimuli were used to examine further the generality of the findings of greater hypermnesia for pictures than for words.

Method

Subjects

The subjects were 66 Brooklyn College undergraduates. Of this total, 54 participated to fulfill an introductory psychology course requirement; the remaining 12 subjects served for pay.

Design

There were two input conditions (pictures vs. words) and three recall times (3, 7, and 15 minutes per trial) yielding six independent groups of 11 subjects each. Every subject was given three recall trials. Comparisons between these three trials form the critical data.

Materials

Sixty line drawings of easily named objects were photographed and placed onto slides. The word stimuli were simply the names of the 60 pictures printed in capital letters and placed onto slides in the same manner. Appendix C lists all of the stimuli used in this study.

Procedure

Subjects were run in small groups of 4 or fewer. Subjects in all conditions were handed booklets at the beginning of the session. They were told that they would be seeing stimuli (words or pictures) that they would later be asked to remember. During presentation, stimuli were shown for 10 seconds each. As each stimulus item was presented, subjects were supposed to attend closely to it and then when the experimenter said "OK," they were to quickly write down in their booklet what the item was (either the word or the name of the picture) and then look up at the screen for the next item. After all of the stimuli were presented, subjects turned to the next page in their booklets. Subjects were told how long their recall sessions would last and were instructed to recall as many items from the presentation list as they could. During recall sessions the passing of each minute was announced by the experimenter. Subjects were instructed to underline the last word they wrote prior to each announcement. Finally, subjects were told "not to guess wildly, that is try to write down only words (or names of pictures) that were really on the list."

After the first recall trial, subjects were given 3 minutes "to sit back quietly and think" about the items they saw. They were told that after this period they would be given a second chance to recall all the items on the list. The think period was followed by a second recall period, a second think period, and finally a third (and final) recall period. Before the second and third recall periods, subjects were reminded to underline the last word written after each minute and reminded not to guess wildly. They were also told that they could recall words that they had already recalled (on earlier recall trials) as well as any new words remembered.

Before concluding the procedure section, it is necessary to justify one aspect of the procedure utilized in this experiment. As the reader will note, in this study subjects were asked to recall as many items on each trial as they could, and were not forced (as they were in Experiments 1 through 4) to recall a set number of items. Forced recall sessions like those used in the first 4 experiments have been used in many studies of repeated recall (e.g., Erdelyi and Becker 1974; Erdelyi et. al, 1977; Belmore, 1981). This technique has been used in order to make sure that hypermnesia does not result simply from a loosening of subjects' response criteria. In this experiment a forced recall procedure would not be practical. Because different groups of subjects received recall trials of different lengths: (1) forcing subjects in all groups to recall the same number of items would lead to a situation in which more 'pressure' was being applied to subjects receiving short recall trials, and (2) forcing subjects in different recall time conditions to output different numbers of items could arguably result in different levels of interference (from subjects' own output) across groups. In addition to these practical considerations, there is recent evidence that forced recall is not necessary to control response criteria changes. Roediger and Thorpe (1978) found that the number of new intrusions (non-list items) did not increase across trials.

Scoring criteria

Because of potential variation in the names given to pictures, scoring of recall items was based on the names given to items during presentation. In order for a recall item to be considered correct, the item had to be (a) identical to what a subject had written during presentation, (b) a shortened (or lengthened) version of a presentation item, or (c) a synonym of the word written during presentation. Thus, if a subject saw a picture and wrote down "automobile" during presentation, recall of "automobile," "auto," or "car" would be considered correct. The exact same scoring criteria were used for the recall of words as for pictures. These scoring criteria are slightly stricter than those used by Roediger and Thorpe (1978), but they were utilized because they might better allow one to separate correct recall from the recall of items that were simply associates of list items.

Results and Discussion

Net Recall

Table 6 gives the mean levels of recall for all six groups of subjects on the three recall trials. In this table, groups are denoted as follows: The number refers to the length of time (in minutes) during one recall trial, and the letter W or P refers to the type of stimuli that group received. Thus, 3W refers to the group receiving three-minutes trials, using words as the stimuli; 3P refers to the group that received three-minute recall trials, using pictures as the stimuli, etc.

An analysis of variance indicated that pictures were recalled better than words on the three recall trials ($\underline{F}(1,60)=34.74$, $\underline{p}<.01$). In addition, recall was greater for groups receiving more time ($\underline{F}(2,60)=18.58$, $\underline{p}<.01$) and recall improved reliably over trials ($\underline{F}(2,120)=80.32$, $\underline{p}<.01$). The interaction between input modality (pictures vs. words) and recall trials was significant ($\underline{F}(2,120)=7.28$, $\underline{p}<.01$), thus replicating results of studies that have shown hypermnesia to be greater for pictures than for words. Interestingly, though, an analysis of simple effects revealed reliable increases in recall across tests for both pictures ($\underline{F}(2,120)=66.64$, $\underline{p}<.01$) and words ($\underline{F}(2,120)=21.26$, $\underline{p}<.01$). This very reliable increase in word recall across tests is unusual in the literature, although Roediger and Thorpe (1978) also found a reliable increase across tests for both pictures and words. A possible explanation for the hypermnesia found for words here is that during encoding subjects wrote down the words as they were presented. This task, which was intended to force subjects to attend to stimuli, may have led inadvertently to deep processing by some subjects. Alternatively, this task in itself may simply lead to a stronger memory code, and therefore, to a greater level of memorial availablity. Arguments that level of availability affect level

Table 6

Mean Levels of Net Recall in Experiment 5

Group	Recall Trial: Trial 1	Trial 2	Trial 3	Net Increase (T3 - T1)
3W	17.00	18.36	20.82	3.82
3P	20.55	23.64	26.91	6.36
7W	22.09	22.09	25.09	3.00
7P	31.82	35.36	37.91	6.09
15W	25.36	27.45	28.64	3.28
15P	38.55	41.82	44.18	5.63

of hypermnesia are made later (see Experiment 8).

The key finding of this study, however, is the failure to find any evidence that recall time per trial affects level of hypermnesia as Roediger and Thorpe (1978) suggest it should. The critical interaction here is recall time x trials which does not even approach significance ($F(4,120)=0.56$, $p>.05$). Thus, the level of hypermnesia for pictures and words does not seem to depend on the amount of recall time given to subjects. All other interactions including the three-way were not significant.

The failure of the recall time factor could result from either of two processes. First, it could reflect a retrieval-forgetting trade-off in which subjects in short recall trial conditions actually do remember more new items on Trials 2 and 3 than subjects in long recall conditions, but at the same time forget more items that have already been retrieved. On the other hand, it may be that regardless of the length of recall trials, approximately the same number of new items are retrieved on Trials 2 and 3. Which of these alternatives accounts for the results is revealed by an examination of levels of cumulative recall.

Cumulative Recall

Table 7 presents the mean levels of cumulative recall for all groups over all recall trials. Analyses of the increase in cumulative recall from Trial 1 to Trial 3 were performed, and the results indicated that regardless of recall time, there were no significant differences in the number of new items recalled ($p>.05$ for all comparisons).

It is quite possible that this equality in the number of new items retrieved over trials is the simple result of the fact that subjects

Table 7

Mean Levels of Cumulative Recall in Experiment 5

Group	Recall Trial Trial 1	Trial 2	Trial 3	Cum Increase (T3 - T1)
3W	17.00	20.55	23.91	6.91
3P	20.55	27.09	31.64	11.09
7W	22.09	25.36	27.91	5.82
7P	31.82	38.45	41.45	9.63
15W	25.36	29.64	31.09	5.73
15P	38.55	43.82	47.18	8.63

given long recall trials were given much more time to retrieve new items on Trials 2 and 3. A comparison of conditions reveals that subjects receiving 15-minute trials had 30 minutes of recall time beyond Trial 1 to retrieve new items. On the other hand, subjects in the 3-minute groups were allowed only 6 minutes of recall time beyond Trial 1. With the extra recall time on Trials 2 and 3 subjects in long recall trial conditions were able to offset the fact that their high levels of recall on Trial 1 left them with fewer (and perhaps quite difficult) remaining items to retrieve.

Minute-by-minute recall

Roediger and Thorpe (1978) plotted subjects' cumulative minute-by-minute recall for each of three successive 7-minute recall periods. Upon inspecting the difference in recall from Trial 1 to Trial 3 (for minutes 1 through 7), they noted that the differences in recall were greatest between 2 and 4 minutes, and considerably less before and after. They thus assumed that had their subjects been given 2-4 minute recall trials, their levels of hypermnesia would have been greater than they were.

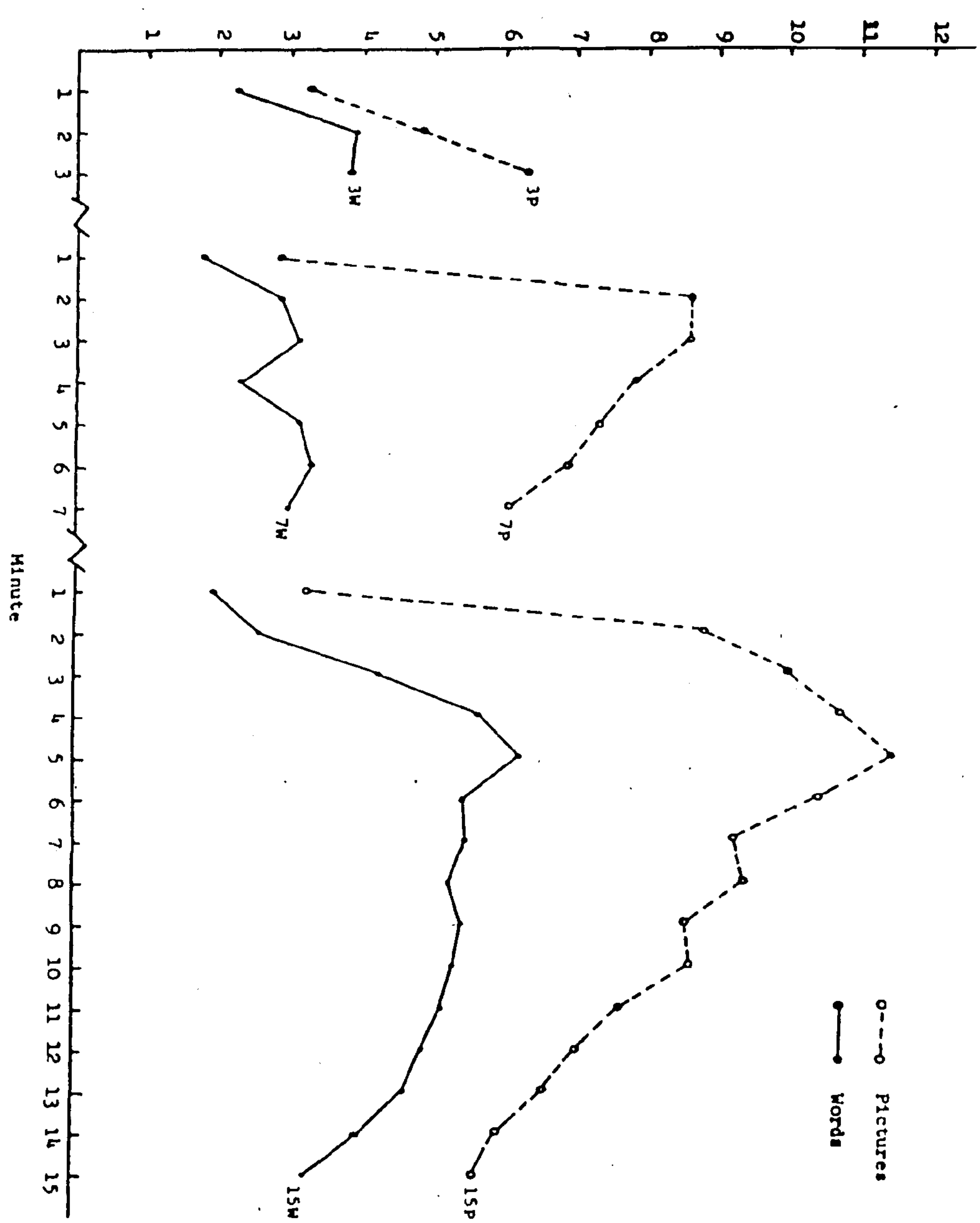
Figure 2 presents the difference in net recall level (that is, hypermnesia) from Trial 1 to Trial 3 for all groups in the present study as a function of time. An inspection of these curves reveals certain trends similar to those found by Roediger and Thorpe (1978). In particular, for groups receiving long recall trials, the greatest differences in recall between Trials 1 and 3 occur at intermediate times. This trend is greater for pictures than for words.

More specifically, if one observes the progress of the two 15-minute recall groups, it is apparent that at 3 minutes and 7 minutes

Figure 2. Magnitude of hypermnesic effect (T3-T1) as a function of time in Experiment 5.

Mean Level of Hypermnesia

(Recall on Trial 3 Minus Recall on Trial 1)



the differences in recall between Trials 1 and 3 are greater than at 15 minutes. Similarly, data from the 7-minute picture group (and to a slight extent the 7-minute word group) reveal greater differences between Trials 1 and 3 at 3 minutes than at 7 minutes.

Since we already know that levels of hypermnesia were not different when subjects were given 3, 7, or 15 minute recall trials, Roediger and Thorpe's (1978) argument that one can extract data from (successive) long recall trials in order to make predictions about (successive) shorter recall trials does not hold up. One possible reason that the extrapolation from long recall conditions to shorter recall conditions did not work here has to do with different recall dynamics that may be operating in long and short recall sessions. It is possible to argue that, since subjects in long recall trial conditions remember more items during their first (and second) recall trials than do subjects in short recall conditions, they begin their second and third recall trials with a greater number of highly accessible memory items than do subjects in short recall trial conditions. Thus, it is expected that they will display greater increases in recall over relatively early portions of subsequent recall trials than will subjects receiving short recall trials.

This is borne out to a large extent in the data from this study, and especially for pictorial input. Table 8 gives the differences (extracted from Figure 2) in recall between Trials 1 and 3 for all groups at times of 3 and 7 minutes.

When comparing groups with the same type of input stimuli, in all cases but one (group 7W) these differences are greater for subjects receiving longer successive recall trials. Thus, it seems quite

Table 8

Mean Differences in Recall Over Trials (T3 - T1)

for All Groups at 3 and 7 Minutes in Experiment 5

Group	Minute 3	Minute 7
3W	3.82	
7W	3.19	3.00
15W	4.54	5.55
3P	6.36	
7P	8.63	6.09
15P	10.10	9.36

perilous to extrapolate from long recall trials to shorter recall trial conditions.

Intrusions

An intrusion was defined as any item written during recall not meeting the criteria for a correct recall. For the most part, these extralist items were minimal in this study. The mean level of intrusions per subject was 1.88 items. As was stated above, Roediger and Thorpe (1978) examined the rate at which new intrusions appeared on successive trials and found no increase in new intrusions over trials. As such, they argued that the hypermnesia found in their study (which, like this study utilized free recall periods) was not the result of a successive loosening in response criteria. A similar analysis was carried out here and showed that new intrusions did not increase over trials in this study either ($F(2,130)=0.47$, $p>.05$). As such, like in Roediger and Thorpe's (1978) study, there is no evidence that the hypermnesia found in this study was due to a loosening of response criteria.

Before leaving this study, one final point should be made. The result of primary importance in this study was the finding that level of hypermnesia was not affected by length of successive recall trials. It may be argued that the reason for the failure to find such a 'recall time effect' was that hypermnesia was not tested under extreme enough recall times (e.g., less than 1 minute or over a period of hours). That levels of hypermnesia may be affected by the use of such extremely long or short recall periods is quite possible. Such conditions were not included in this study because it was felt that in such conditions non-memory factors (writing speed for short trials, and fatigue and ceiling effects for very long trials) may play a role in limiting hypermnesia. Nonetheless, it seems reasonable, as Roediger and Thorpe (1978) argue, that extremely short recall periods used in some studies (e.g., Donaldson, 1971) may have posed some problems for finding hypermnesia for words. However, the finding in this study of hypermnesia with very long recall trials does not support their contention that (other) previous failures to find hypermnesia for words was due to the utilization of long recall trials.

EXPERIMENT 6a

In reviewing the "hypermnesia" literature that has emerged over the past decade one would conclude that increasing levels of recall over trials is strictly related to the utilization of specific types of stimuli (pictures) and/or specific types of stimulus encoding (imaginal or depth of processing). It is interesting to note, however, that there is some evidence to suggest that when items are recalled repeatedly from long-term memory (with no stimulus presentation) recall increases over trials (Brown, 1923; Lazar and Buschke, 1972). The results of these studies are interesting if only because they imply that hypermnesic recall may be a more general result than the recent literature suggests. In both of these studies, however, subjects were recalling items that were apt to be imaged easily. Brown (1923) found increasing recall for the states of the U.S., while Lazar and Buschke (1972) found increasing recall for the following categories: sports, animals, birds, and trees. Because all of these categories are made up of concrete items that people are exposed to frequently, one could argue that the hypermnesia found in these studies was due to the evocation of visual images and, as such, provide additional support for the notion that hypermnesia is related to visual imagery processes.

In this experiment subjects were asked to recall repeatedly items from long-term memory that are not apt to be imaged easily - namely the presidents of the United States. This category was chosen after work with pilot subjects (Brooklyn College undergraduates) which suggested that clear visual images are generally available only for a few of the recent and/or more famous presidents. As such, a finding of hypermnesia for the presidents would (1) challenge the notion that hypermnesia is intimately linked to visual imagery processes, and (2) provide additional evidence that hypermnesia is a general effect and not necessarily tied to specific types of stimuli and/or processing.

Method

Subjects

The subjects were 32 Brooklyn College undergraduates. They were run during one of their class sessions in an exercise meant to illustrate to them the necessity of having experimental control.

Design

There were two groups (control verus "telepathy"). Subjects in each group received three 3-minute recall trials, hence yielding two independent groups of 16 subjects each.

Procedure

The two groups of subjects were run separately, with the control group being run first while the experimental group waited outside the classroom until it was their turn to participate. For both groups, subjects were given booklets at the beginning of the session. They were asked to turn to the first page, and then told that they would be given three minutes during which they must write down the names of all of the presidents of the United States that they could think of in any order. As in the previous experiments, the experimenter announced the passing of each minute at which times subjects were to underline the last word written.

After this first trial, subjects in both groups were asked to turn their booklets to the next page, and then sit back and "just think quietly to themselves for two minutes," after which they would be given a second 3-minute period to write down the names of the U.S. presidents. It was on this second and the subsequent third recall trial that the two groups differed. For the control group's second and third recall trials the instructions were the same as in the first recall trial. But for the "telepathic" group's second recall trial, subjects were told that they would be joined by their course instructor, who would stand in front of the room holding a list of the presidents' names. He would attempt to telepathically transmit to them the names of the presidents, and it was hoped that the subjects would receive these messages which would help them in recalling them during the second recall trial. In the third recall trial, the first "sender" (the course instructor) was joined by another "sender" (a graduate student serving as an accomplice), who also had a list of the presidents. For the third trial both messengers would attempt to "transmit" the presidents' names to the subjects.

For both control and "telepathic" groups, Trials 2 and 3 were separated by a 2-minute think period similar to the one between Trials 1 and 2. All subjects were told that they were not required to list the presidents in chronological order but in the order in which they could think of them. Also, they were told that the last names of the presidents were sufficient, except when two presidents shared the same last name, in which case they had to provide first names or initials. Finally, on the second and third recall trials, they should write any names that they remembered from the preceding trial(s), in addition to writing any new names that they could think of.

It should be noted that the "telepathic" group was not utilized in this study because of any belief that it would differ from the control group. This group was utilized to demonstrate to the class (a class in parapsychology) how easily people can be fooled by so-called psychic phenomena. As such, by utilizing both a "telepathic" and a control group the class would see that if hypermnesia was found for the "telepathic" group, this could only be indicative of telepathy if an equal effect was not shown to occur in the control group.

Results and Discussion

Recall

Table 9 gives the mean levels of recall for both groups of subjects on all three recall trials. An analysis of variance indicated that the two groups did not differ in the total number of names they recalled ($F(1,30)=0.31$, $p>.05$). In addition, recall did increase reliably over trials ($F(2,60)=34.66$, $p<.01$). Finally, the interaction between groups (control versus "telepathic") and recall trials was nonsignificant ($F(2,60)=0.99$, $p>.05$).

The very reliable increase in recall over trials was, of course, the interesting finding in this study. This finding of hypermnesia for the presidents' names is important for three reasons. First, it illustrates the generality of the hypermnesia phenomenon. Second, it seems unlikely that visual imagery was an important factor in the recovery of new names (although this possiblity will be examined in more detail in Experiment 8). In this regard the results here complement the finding of hypermnesia for low imagery words (shown in Experiments 1 through 4) in arguing against the notion that visual imagery plays a crucial role in hypermnesia. Finally, the fact that the increase in recall was very similar for both of the groups utilized indicates that this effect is robust and not subject to large variations due to

Table 9

Mean Levels of Net Recall in Experiment 6a

Group	Recall Trial: Trial 1	Trial 2	Trial 3	Net Increase (T3 - T1)
Control	13.13	15.06	15.69	2.56
"Telepathic"	14.25	15.38	16.56	2.31

differences in experimental procedure.

Intrusions

An intrusion was defined as any name written during recall that was not the name of a U.S. president. The mean number of intrusions per subject was 2.00. As in Experiment 5, because a free recall procedure was utilized here, an analysis of variance was performed to examine whether or not new intrusions increased over trials. The results of this analysis indicated that new intrusions did not significantly increase across trials ($F(2,62)=1.10$, $p>.05$). Hence, there is no evidence that the hypermnesia found in this study was produced by a shift in response criteria.

EXPERIMENT 6b

In order to solidify the finding of hypermnesia for items in long-term memory, in Experiment 6b an attempt was made to replicate the results of Experiment 6a utilizing forced recall as opposed to free recall. Although this may not be a necessary exercise, in lieu of the finding that new intrusions did not increase across trials in the last experiment, a finding of hypermnesia under forced recall conditions would eliminate any doubt that the hypermnesia found for the presidents' names was due to a loosening of response criteria.

Method

Subjects

The subjects were 22 Brooklyn College undergraduates. They were run in two class sessions. All of the students participated in order to fulfill an introductory psychology course requirement.

Design

All subjects were run as part of a single group, with each subject receiving three chances to recall the names of the U.S. presidents. As such, the study entailed a one-way design with three levels of recall trials.

Procedure

The procedure utilized in this study was nearly the same as that used for the control group in Experiment 6a. As in that condition, subjects were given three 3-minute trials on which to write down the names of all of the U.S. presidents. Between recall trials they were given 2-minute "think" periods. The only difference in the procedure used here was that in this study subjects were required to write down exactly 25 names on each trial. As such three aspects of the procedure were new here. First, the recall booklets that the subjects were given at the beginning of the session were numbered on each page from 1 to 25. Second, at the beginning of the first recall trial subjects were told that they must write down exactly 25 names, whether or not they thought they knew that many presidents. They were reminded of this requirement prior to the second and third recall trials. Finally, subjects were given a special warning when only 30 seconds remained in each recall session to make sure that they finished the forced recall.

The decision to use 25 names as the requirement in this forced recall procedure was made after several pilot subjects were run with forced recall sessions of 40 and then 30 names. It was found that when subjects were forced to recall 40 names (and to a lesser extent with 30 names), there was a tendency among some subjects to leave lines blank, even though they were told to write down something for every numbered line in their booklet. With 25 names to write subjects were better able to follow through with forced recall. Of course, a potential problem with the 25 name forced recall session was the possibility that some subjects would know more than 25 presidents, and as such it was possible that hypermnesia could be limited due to the ceiling put on recall.

Results and Discussion

The mean number of presidents recalled for the three recall trials were 14.45, 16.09, and 16.59 for Trials 1, 2, and 3 respectively. As such, the mean increase in net recall from Trial 1 to 3 was 2.14. An analysis of variance revealed that the increase in recall across trials was significant ($F(2,42)=14.00$, $p<.01$). Thus, a true hypermnesic effect for the recall of the presidents' names occurred under forced recall conditions. The importance of this finding is that it clears any doubt that the hypermnesia found in Experiment 6a was due to loosening of response criteria.

Interestingly, in a very recent study Roediger and Payne (1985) found roughly equivalent levels of hypermnesia for subjects who utilized free recall, forced recall, and uninhibited (free association) recall. That result indicates that the concern over the type of recall procedure utilized in hypermnesia experiments is probably unwarranted.

As a secondary point of interest, it should be noted that none of the subjects in this study recalled as many as 25 presidents' names on any recall trial. As such, the fear that hypermnesia might be reduced due to the ceiling put on recall was not realized.

EXPERIMENT 7

Experiment 7 was designed to carry out two functions. The first was to replicate the finding of hypermnesia for the presidents' names. The second was to serve as an additional test of Roediger and Thorpe's (1978) hypothesis that level of hypermnesia is related to recall time.

In this experiment, subjects were again given three opportunities to recall the names of as many presidents as they could remember. In order to test Roediger and Thorpe's hypothesis, the length of recall trials was varied. Subjects either received successive 3-minute or 15-minute recall trials. If Roediger and Thorpe's analysis of recall trial length is correct, then subjects receiving 15-minute recall trials would be expected to show reliably smaller increases in recall than subjects given the relatively short 3-minute recall trials because in the 15-minute recall condition subjects would be near their asymptotic recall level after the first trial.

Method

Subjects

The subjects were 40 Brooklyn College undergraduates. They participated in order to fulfill an introductory psychology course requirement.

Design

Twenty subjects received three 3-minute recall trials, while the other 20 received three 15-minute recall trials.

Procedure

The procedure here was the same as it was for the control group in Experiment 6a, with the same scoring criteria applying here as well.

Subjects were run in groups of four or fewer, with the groups being differentiated only by the length of recall trials (3 minutes or 15 minutes) they received.

Results and Discussion

Net Recall

Table 10 gives the mean levels of recall for both groups of subjects on all of the three recall trials. An analysis of variance revealed that the differences in recall between groups was not significant ($F(1,38)=.09$, $p>.05$). This finding was not anticipated, since it was expected that the subjects given more time would recover more items overall. In fact, in Experiment 5 it was found that subjects given more time recalled more. This unusual finding is probably due to an unfortuitous sampling in that two subjects in the 3-minute recall condition knew the names of the presidents quite well (attaining 31 and 34 names on recall Trial 1).

As in Experiments 6a and 6b a strong hypermnesic effect was observed; recall reliably increased over trials ($F(2,76)=42.75$, $p<.01$). The important finding of this study though, was that the length of each recall trial did not reliably affect levels of hypermnesia. Although the increase in recall over trials was numerically greater for subjects receiving 3-minute recall trials, the group x trials interaction was not significant ($F(2,76)=2.63$, $p>.05$). Thus, the increase in recall over trials was not significantly affected by the length of recall trials. As such, as in Experiment 5, the predicted interrelationship between recall time and hypermnesia that Roediger and Thorpe (1978) referred to failed to appear.

The failure to find a reliable difference in level of hypermnesia

Table 10

Mean Levels of Net Recall in Experiment 7

Group	Recall Trial Trial 1	Trial 2	Trial 3	Net Increase (T3 - T1)
3-Minute Recall Trials	16.40	17.85	18.85	2.45
15-Minute Recall Trials	17.45	18.50	18.95	1.50

between groups could result from one of two processes. First, it could result from a retrievel-forgetting trade-off. That is, perhaps subjects in the 3-minute recall condition actually do retrieve more new names on Trials 2 and 3 than subjects in the 15-minute recall condition, but at the same time forget more items that have already been retrieved. On the other hand, it may be that regardless of the length of recall trials, subjects recover approximately the same number of new names on Trials 2 and 3. In order to investigate which of these two processes account for the data in this study, levels of cumulative recall were examined.

<u>Cumulative Recall</u>

Table 11 presents the mean levels of cumulative recall for both groups over all recall trials. An inspection of this table reveals that subjects receiving relatively short recall trials recovered more new items subsequent to Trial 1 than did subjects receiving long recall trials. The increase in cumulative recall from Trial 1 to Trial 3 was significantly greater for subjects receiving 3-minute recall trials ($t(38)=2.47$, $p<.05$). As such, the failure to find a significant group x trials interaction when examining net recall data indicates that subjects receiving short recall trials forgot more items that were already retrieved than did subjects receiving long recall trials.

The failure to find a group x recall trials interaction when net recall is the dependent variable is in agreement with Experiment 5, and once again contradicts predictions made by Roediger and Thorpe (1978). On the other hand, the fact that cumulative increases in recall were greater for the group receiving relatively short recall trials implies that recall length does have some effect on repeated recall. The fact

Table 11

Mean Levels of Cumulative Recall in Experiment 7

Group	Recall Trial: Trial 1	Trial 2	Trial 3	Cum Increase (T3 - T1)
3-Minute Recall Trials	16.40	19.00	20.20	3.80
15-Minute Recall Trials	17.45	18.85	19.60	2.15

that this occurred in the present experiment but not in Experiment 5 is probably due to the difference in the materials that subjects were recalling. In Experiment 5 subjects were asked to recall 60 pictures or words corresponding to concrete nouns. The potential for recall in those conditions is probably greater than it is for the relatively small pool of U.S. presidents (of which there have been only 39). As such, it is quite possible that in this study some subjects in the 15-minute recall condition were actually close to asymptotic recall after the first recall trial, whereas this was not the case in the long recall conditions of Experiment 5.

EXPERIMENT 8

In this experiment an attempt was made to discover which variables, if any, are predictive of levels of hypermnesia. This was accomplished by ascertaining subjects' levels of hypermnesia for the presidents' names and then examining how effective a number of factors were in predicting level of hypermnesia. Of the various factors that could be related to levels of hypermnesia, the following four were examined: visual imagery, level of recall, memorial availability, and short-term memory. Each needs some justification:

1. Visual imagery: As has been mentioned several times above, several researchers have taken the postion that hypermnesia is related to visual imagery (e.g., Erdelyi and Becker, 1974). If this factor is reliably correlated with increasing levels of recall, it should be manifested in one or both of two ways. First, individual differences in the ability to evoke clear images ought to correlate with levels of hypermnesia, all other things held constant. Second, if imagery is reliably associated with "real world" stimuli, as Kosslyn and his co-workers have strongly suggested (see Kosslyn, 1981), then one would expect to find correlations between levels of hypermnesia and scores on a picture recognition task. The argument here is simple; if subjects are hypermnesic because images of the presidents as derived from real life experiences were coming to mind, then levels of hypermnesia should be correlated with recognition levels.

2. Level of recall: It may be that hypermnesia is determined by level of stimulus recall. If level of recall is a determinant of hypermnesia for the presidents' names, then the increase in subjects'

recall of names over trials should be related to their level of recall on the first recall trial.

3. Memorial availability: As Tulving and Pearlstone (1966) pointed out, subjects often have many more items in memory than they are able to recall at a given time. The distinction here is between material which is accessible and can be recalled at a given time and material which cannot be recalled at a given time but is still "available." The former variable is, of course, going to be reflected by level of recall; the latter can be better represented by a measure of recognition.

4. Short term memory: The role of this variable has generally been ignored in research on hypermnesia. However, there are reasons to believe that it could be of importance. In particular, when subjects are asked to recall items repeatedly, the ability to hold onto large numbers of items and unload them quickly at the beginning of subsequent recall trials could serve to enhance levels of hypermnesia.

In the following section the method by which each of these factors was assessed and the manner in which its role in predicting level of hypermnesia was ascertained is outlined.

Method

Subjects

The subjects were 40 Brooklyn College undergraduates. All participated in order to fulfill an introductory psychology course requirement.

Procedure

In this study all subjects were run individually. The first task that subjects performed was the repeated recall of the presidents' names. The procedure for this task was the same as that utilized for the control group in Experiment 6a and for the 3-minute recall trial group in Experiment 7. Following this, all subjects were given the following four tasks in the order presented here.

1) Presidential Name Recognition: Subjects were given a list of 100 names arranged in random order. Thirty-nine were the names of the presidents, while the remaining 61 names were of people who, while never president, were nonetheless prominent figures in American history (e.g., George Wallace, George Patton, Henry Clay, Alexander Hamilton, etc.). This list of 100 names is shown in Appendix D. Subjects were given 15 minutes in which they were supposed to circle the names of the 39 people who they believed to be the U.S. presidents. They were told that exactly 39 names had to be circled. This task was utilized as an indicator of the number of presidents' names that subjects actually knew. As such, it was assumed that performance on this task served as a measure of the availability (see above) of the presidents' names. If memorial availability is a crucial determinant of hypermnesia, then performance on this task should correlate with levels of hypermnesia.

2) Presidential Picture Recognition: Subjects were given a list of the presidents' names, arranged in chronological order. They were also given a complete set of color portraits of the presidents, all painted by a prominent historical artist and appearing in the publication, The Presidents (1981). The portraits were randomly arranged, and each portrait had a number, from 1 to 39, printed in the bottom right-hand corner. Subjects were given 15 minutes to match each picture with the name of that president by writing the number of the portrait next to the corresponding president's name on the list.

Subjects were told that they could sort through the pictures in any order they wished. This task was used to examine subjects' pictorial knowledge of the presidents. If subjects were hypermnesic because images of the presidents were coming to mind, subjects with high levels of hypermnesia should do well on this task. In addition, performance on this task would allow the experimenter to discern whether or not subjects even knew what the presidents they were hypermnesic for looked like.

3) Vividness of Visual Imagery Questionnaire (VVIQ): In order to examine further whether visual imagery is an important determinant of hypermnesia for the presidents' names, Marks' (1973) Vividness of Visual Imagery Questionnaire was administered. This questionnaire was designed to measure subjects' general ability to form clear visual images. In this task the experimenter described aloud to each subject four different settings, e.g., "Think of a country scene which involves trees, mountains, and a lake....." For each setting, the subject was then asked to try to form mental images of four successive aspects of that setting, hence requiring the subject to make a total of 16 mental images. For each image formed, the subject rated its clarity on a scale of 1 to 5, where 1 reflects extreme clarity, that is, as vivid as normal vision, and 5 represents a complete lack of a visual image. Intermediate ratings referred to intermediate levels of imaginal clarity. The subject always had the rating scale before him for reference. The subject's score on the VVIQ was his mean rating for the 16 items.

4) Digit Span Task: Subjects were given both the forward and backward versions of the digit span subtest of the Wechsler Adult

Intelligence Scale (WAIS). Subjects were read successive strings of digits, every new string increasing by one digit, with every digit being pronounced at the rate of one per second. After a string was read, the subject had to repeat it either forwards or backwards. All "forward" trials were run first, followed by the sequence of "backward" trials. The directions given to subjects, as well as the scoring procedure were identical to those used in an actual WAIS administration. A subject's measure of digit span was defined as the sum of his forward and backward spans. Performance on this task was used as a measure of subjects' short-term retention.

As indicated above, the role of level of recall as a determiniant of hypermnesia was also examined. In this experiment, subjects' recall level on Trial 1 is representative of this factor.

Results and Discussion

Recall

Subjects' mean levels of recall were 13.83, 14.88 and 15.78 names on Recall Trials 1, 2, and 3 respectively. As in Experiments 6a, 6b, and 7 the increase in the number of presidents' names recalled over trials was significant ($F(2,78)=27.40$, $p<.01$).

The major aim of this study, however, was to investigate the role of several potentially important variables in determining levels of hypermnesia. To this end, a regression analysis was performed in order to examine whether or not performance on any of the posttests administered, as well as initital level of recall are related to the levels of hypermensia attained.

Regression Analysis

In this analysis, the dependent measure was always the subject's level of hypermnesia, defined as the change in recall from Trial 1 to Trial 3. The independent variables were (a) number of correct responses on Trial 1, (b) score on the digit span task, (c) name recognition performance, (d) picture recognition performance, and (e) score on the VVIQ.

Tables 12 presents the intercorrelation matrix for these measures. Of particular interest are the correlations between all of the independent variables and level of hypermnesia. As Table 12 shows, in general these correlations are not strong, although name recognition correlates to the greatest extent with level of hypermnesia. In fact, it was the only variable whose correlation with level of hypermnesia was significant ($p<.05$).

In order to examine further the effects of these five different independent variables on levels of hypermnesia, each was entered individually into a regression equation in the following order: (1) name recognition, (2) initial level of recall, (3) visual imagery questionnaire (VVIQ), (4) picture recognition, (5) digit span. Name recognition was entered first in order to account for variance due to levels of availability; initial levels of recall were then entered to ascertain whether performance on Recall Trial 1 adds to the ability to predict levels of hypermnesia once availability is accounted for; performance on the VVIQ was inserted next to examine the contribution of differences in ability to form clear visual images; picture recognition data were added next to examine the effects of specific pictorial knowledge of the presidents; and finally, digit span was entered to examine the effects of short-term memory (and perhaps attentiveness).

Table 13 presents the results of this analysis. The first

Table 12

Intercorrelation Matrix of Factors in Experiment 8

	Hypermnesia	Initial Recall	VVIQ	Name Recog.	Picture Recog.	Digit Span
Hypermnesia	1.00					
Initial Recall	.16	1.00				
VVIQ	.07	-.14	1.00			
Name Recog.	.38*	.81**	-.27	1.00		
Picture Recog.	.23	.47**	.06	.51**	1.00	
Digit Span	.15	.27	-.04	.37*	.36*	1.00

* $p < .05$
** $p < .01$

column of this table indicates which variables have been entered into the equation at any given stage of analysis. The second column indicates the value of the multiple correlation coefficent (R). This is a measure of the correlation between all independent variables in the equation and the dependent variable (levels of hypermnesia). The third column indicates the F value associated with the increment in our ability to predict levels of hypermnesia due to the addition of each newly added independent variable.

The results of this analysis are quite clear. The measure of availability (name recognition) was the only significant predictor of levels of hypermnesia. After this variable was inserted into the regression equation, no other performance measure added significantly to the ability to predict levels of hypermnesia. In fact, it is interesting that inclusion of all the other variables only increased the multiple correlation coefficient by .12.

Several of the findings of this study are of importance in our understanding of the hypermnesia effect for material in long-term memory. First, there is no evidence that visual imagery was a determininant in this hypermnesia. Performance on the posttests used to access the possible influence of imagery did not correlate significantly with levels of hypermnesia. In addition, when an examination was made of the actual names that subjects retrieved after Recall Trial 1, it was found that in over two-thirds of these cases subjects did not recognize the picture of the president whose name they retrieved. Second, the results do not lend support to the notion of Roediger et al. (1982) that recall levels are an important determinant of levels of hypermnesia. It should be noted however, that this study did not test their hypothesis directly, as those authors claim that it is the asymptotic level of cumulative level that best predicts hypermnesia. Finally, the results suggest that level of memorial availability (as indicated by recognition memory) is an important determinant of levels of hypermnesia.

Table 13

Summary of Regression Analysis in Experiment 8

Variable added to Equation	Value of Multiple R	F value associated with the increment in explained variance
Name Recognition	.38	6.33*
Initial Recall	.45	2.74
VVIQ	.50	2.02
Picture Recognition	.50	.04
Digit Span	.50	.02

* $p < .05$

SUMMARY AND CONCLUSIONS

The results of the experiments reported here add to our understanding of the factors involved in hypermnesic recall. In particular the results help to clarify the roles of the following factors: visual imagery, depth of processing, and memorial availability. What is known about these factors can be summarized best as follows:

The Role of Visual Imagery

It seems clear that visual imagery processes do not in themselves explain the occurrence of hypermnesia. The best evidence reported here in support of this assessment is the finding of hypermnesia for low imagery words under conditions that did not prompt subjects to utilize visual imagery processes (Experiments 1-4). In addition, the finding of hypermnesia for the presidents' names in Experiments 6a - 8 argues against there being any vital link between hypermnesia and visual imagery processes for two reasons. First, this is not a category that is filled with highly imageable entries. Second, the results reported in Experiment 8 demonstrate the lack of correlation between level of hypermnesia and indicators of visual imagery.

This rebuttal of the role of visual imagery processes is not surprising. As was mentioned earlier, the position that hypermnesia is linked to visual imagery processes has been weakened by a number of other studies (e.g., Erdelyi, Buschke, and Finkelstein, 1977; Roediger and Thorpe, 1978; Belmore, 1981). The data reported here simply add in discounting the crucial role of visual imagery processes.

However, it should be duly noted that the data reported in Experiment 5 do show what earlier studies of hypermnesia demonstrated -

specifically the superiority of pictorial hypermnesia. In fact, the demonstration of Experiment 5 showing the superiority of pictorial over word hypermnesia at three different recall times actually adds to the generalizability of the picture-word distinction. The problem with the visual imagery position was not that it was illogical but simply that it suffered from being an early theory of hypermnesia - being based on early data.

The Role of Depth of Processing

The results of Experiments 1 through 4 demonstrate that giving subjects instructions to encode stimuli deeply can result in hypermnesic recall. These data could be used to support the notion that hypermnesia is a 'depth of processing' phenomenon by tying them in with picture-word differences in the following way: if one assumes that pictures are more deeply encoded than words, then the picture-word difference simply reflects a difference in the depth of processing given to these stimuli.

However, the depth of processing hypothesis has a problem in that it attempts to explain hypermnesia on the basis of stimulus encoding alone. There are some instances in which encoding does not seem to be a factor. In Experiments 6a through 8 hypermnesia was found for items in long-term memory. In these experimenents, subjects were never given any encoding instructions let alone depth of processing instructions, yet they were nonetheless hypermnesic. Of course, one could get around this by asserting that the presidents' names were encoded deeply 'at some time', though this would only be conjecture.

On the other hand, one could attempt to preserve the depth of processing position by asserting that hypermnesia is not necessarily caused by depth of processing but that differences in levels of hypermnesia are determined by differential depth of processing. However, even this modified position is not viable in light of some recent data on hypermnesia. In one experiment, Roediger et al. (1982, conducted at approximately the same time as Experiments 6a through 8 here) found hypermnesia for items in long-term meory. The categories used in that study were sports, birds, and the presidents. Furthermore, they found that level of recall and hypermnesia were both greater for larger categories. This relationship between hypermnesia and category size cannot be reasonably explained on the basis of differences in depth of processing between the categories. As such, the depth of processing position is limited in its explanatory power.

Of course, this is not to say that level of hypermnesia is not related to depth of processing. With all other factors being held constant, it is quite reasonable to assume that hypermnesia will vary due to varying levels of cognitive processing. However, this in itself does not give the depth of processing position the power to encompass the range of hypermnesic phenomena that would make it a valuable hypothetical position.

The Role of Availability

The results of Experiment 8 suggest that level of memorial availability (as indicated by level of recognition memory) is an important determinant of levels of hypermnesic recall. In fact, for a variety of reasons it seems at this point that this position does the best job in handling the hypermnesia data that have been generated to date.

Firstly, the notion that level of hypermensia is determined by level of memorial availability allows for a parsimonious explanation of the outcomes of previous studies. In particular the picture-word hypermnesia differences that have been found as well as the effect of depth of processing can be encompassed by the rather simple suggestion that whatever stimuli or experimental procedures lead to greater levels of memorial availability enhance the probability of finding (or increasing levels of) hypermnesia. Thus, in regard to earlier studies, it can be argued that the use of pictorial stimuli, as well as the utilization of semantic elaboration instructions at input are simply different methods by which levels of memorial availability can be increased. Evidence for this statement can be found in the many studies that have revealed greater levels of recognition memory for pictures than for words (e.g., Shepard, 1967; Paivio and Csapo, 1969) as well as studies reporting incremental levels of recognition memory following the semantic elaboration of words (Eagle and Leiter, 1964; Craik and Tulving, 1975).

In addition, the level of availablity hypothesis can account nicely for the category set size effect that was found by Roediger et al. (1982). As was mentioned above, in that study hypermnesia was greater for items recalled from larger long-term memory categories. This result is complimentary to the results found in Experiment 8 here, in which subjects' performance on a recognition test of the presidents' names was predictive of their level of hypermnesia for these names. If performance on the name recognition test in Experiment 8 is indicative of the size of a subjects' presidents category, then both findings reveal that the larger the psychological category subjects are recalling from the greater the level of hypermnesia.

In addition to accounting well for so much of the existing data, the availability position is appealing because it accounts for hypermnesia on a more general theoretical level than do the visual imagery and the depth of processing positions. Whereas both of the latter positions attempt to account for hypermnesic recall on the basis of type of cognitive processing, this hypothesis is neutral in respect to cognitive processing. It simply stipulates that whatever processes increase memorial availability will lead to increasing hypermnesia.

The availability hypothesis may actually be nearly identical in its implications to Roediger et al.'s (1982) level of recall hypothesis. The indicator that they believe is the best for predicting level of hypermnesia is asymptotic cumulative recall. It seems quite reasonable to assume that asympototic cumulative recall levels are, like recognition memory, indicative of levels of memorial availability. However, a problem that their hypothesis suffers from is that by definition subjects' level of cumulative recall will place restrictions on level of attainable hypermnesia. For example, if a person has an asymptotic cumulative recall level of 5 items, it is <u>known</u> that their upper limit for hypermnesic recall on a repeated recall task is 5 items. As such, the fact that hypermnesia is often predicted by cumulative recall levels is not surprising. In fact, there is an element of tautology in their account.

However, none of this is to say that the availability hypothesis accounts for hypermnesia perfectly. One problem with this formulation is that there are bound to be ceiling effects that limit this formulation. In this regard, it seems reasonable to assume that as memorial availability becomes very great, levels of hypermnesia will most likely begin to decline since subjects will recall at a rate near their upper limit on a first recall attempt.

An additional problem with this formulation is that availability is a theoretical notion and cannot ever be tested for in a foolproof fashion. In Experiment 8 it was assumed that performance on a recognition memory task is indicative of the number of items available to subjects. Although recognition memory is most likely the best indicator of memorial availability that can be used, it is still only an estimate. It is undoubtedly true that performance on a recognition memory task is determined not only by memorial availability, but also by the choice of distractor items and the complex decision strategies employed by subjects.

Nevertheless, one element of human memory seems to come through all this empirical work: hypermnesia occurs under a wide range of conditions. We have observed hypermnesia for pictures, words, and items in long-term memory. In addition, Roediger et al. (1982) have even found hypermnesia for nonsense syllables. Thus, as Erdelyi and Kleinbard (1978) have argued, the classic Ebbinghaus position - that memory for material diminishes over time - is probably wrong. However, this is not meant to slight Ebbinghaus. By using the savings method of measuring retention, he was bound to show that forgetting was the norm. Had he utilized a methodology similar to that used by those who presently study repeated recall he probably would have found flat or hypermnesic memory functions.

Appendix A

Low Imagery Words

Used in Experiments 1, 2, and 4

Abode
Affection
Afterlife
Air
Belfry
Blessing
Bravery
Centennial
Charm
Chasm
Code
Comedy
Contract
Crime
Death
Direction
Disaster
Disease
Drama
Dynasty
Emergency
Errand
Exertion
Exhaustion
Fortune
Gravity
Grief
Health
Heaven
History
Homicide
Hope
Infection
Justice
Life
Lord
Mathematics
Mileage
Molecule
Multiplication
Oxygen
Pep
Poetry
Pollution
Present
Prosecutor
Research
Retailer
Rheumatism
Robbery
Science
Season
Settlement
Shock
Theologian
Time
Truce
Victory
Vision
Volume

Appendix B

Low Imagery Words

Used in Experiment 3

High Meaningfulness		Low Meaningfulness	
Affection	Heaven	Advantage	Impotency
Afterlife	Homicide	Array	Interest
Air	Justice	Atrocity	Moment
Answer	Life	Blunderbuss	Month
Blessing	Lord	Buffoon	Opinion
Crime	Mathematics	Confidence	Opportunity
Death	Moral	Copybook	Pacifism
Direction	Multiplication	Derelict	Pride
Disease	Pollution	Distraction	Quantity
Drama	Position	Excuse	Residue
Dynasty	Research	Fate	Sonata
Emergency	Season	Fatigue	Spirit
Gravity	Time	Form	Strength
Grief	Truce	Henchman	Truth
Health	Vision	Ignorance	Victim

Appendix C

Stimuli Used in Experiment 5

Airplane
Alligator
Anchor
Apple
Arm
Bicycle
Bird
Book
Bottle
Butterfly
Cabin
Candle
Cane
Car
Cat
Chair
Church
Clock
Coin
Compass
Cow
Door
Drum
Eyeglasses
Fireplace
Fish
Fork
Frog
Guitar
Hammer
Horse
Key
King
Kite
Knife
Lamp
Leaf
Pencil
Plant
Priest
Refrigerator
Revolver
Saw
Scissors
Shirt
Yacht
Shoes
Shovel
Skull
Snake
Stagecoach
Sun
Table
Telephone
Television
Toast
Tree
Turtle
Umbrella
Whale

Appendix D

Names Used in Presidential Name Recognition Task

Aaron Burr	Dwight Eisenhower	Herbert Hoover
George Marshall	James Buchanan	George Romney
Millard Fillmore	Martin Van Buren	Joseph McCarthy
Rutherford Hayes	Lyndon Johnson	Edwin Stanton
Samuel Chase	William Bryan	Henry Beecher
Thomas Paine	John Brown	William McKinley
Benjamin Franklin	John Lewis	Abraham Lincoln
William Hearst	Andrew Jackson	Louis Brandeis
Hugo Black	Henry Brown	Calvin Coolidge
Thomas Moore	John Calhoun	Fiorello LaGuardia
Andrew Johnson	George Wallace	Ronald Reagan
Horace Greeley	Robert Taft	William Seward
John Pershing	Cordell Hull	Robert LaFollette
John Jay	John Adams	Douglas MacArthur
Jefferson Davis	Henry Clay	Grover Cleveland
James Monroe	Franklin Pierce	William Harrison
John Q. Adams	Matthew Perry	Woodrow Wilson
William Sherman	Barry Goldwater	Ullyses Grant
John Hancock	John Astor	Alger Hiss
Huey Long	John Kennedy	Benjamin Harrison
Pat Paulsen	Earl Warren	James Madison
James Garfield	John Rockefeller	John Tyler
Bernard Baruch	Henry Lodge	Pierce Butler

Appendix D (cont'd)

Names Used in Presidential

Name Recognition Task

William Vanderbilt	Chester Arthur	John Conally
Daniel Webster	Spiro Agnew	Gerald Ford
Adlai Stevenson	Alfred Smith	Zachary Taylor
Warren Harding	Stephen Douglas	Thomas Dewey
Harry Truman	James Polk	Alexander Hamilton
George Washington	Franklin Roosevelt	Charles Coughlin
Hubert Humphrey	Thomas Pinckney	DeWitt Clinton
Robert Lee	James Carter	John Mitchell
Richard Nixon	Wendell Wilkie	Thomas Jefferson
Carl Weiss	John Booth	Theodore Roosevelt
James Walker		

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