

INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.



University Microfilms International
A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
313/761-4700 800/521-0600

Order Number 9325108

Hypermnnesia for subliminal stimuli

Ionescu, Marcos Drago, Ph.D.

City University of New York, 1993

U·M·I

**300 N. Zeeb Rd.
Ann Arbor, MI 48106**

A

HYPERMNESIA FOR SUBLIMINAL STIMULI

by

MARCOS D. IONESCU

**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.**

1993

This manuscript has been read and accepted for the Graduate Faculty in Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

4/28/93

Date

[Signature]

Chair of Examining Committee

April 29, 1993

Date

Herbert A. Seltzstein

Executive Officer

Doratheia Halpert

Neil Macmillan

Arthur Reber

Supervisory Committee

THE CITY UNIVERSITY OF NEW YORK

Abstract

HYPERMNESIA FOR SUBLIMINAL STIMULI

by

Marcos D. Ionescu

Advisor: Professor Matthew H. Erdelyi

The phenomenon of hypermnesia (net increase in memory with repeated testing) was investigated in a series of experiments. Experiment 1 examined memory for a single pictorial stimulus shown for one of three exposure durations (500 msec, 50 msec, and 5 msec). The stimulus consisted of 12 simple objects arranged in three rows of 4 figures each. No increase in memory over three trials was found for any of the exposure durations. Experiments 2-4 assayed hypermnesia for a list of stimuli (40 pictures, 40 words) presented for a wide variety of exposures, ranging from 5 sec to 5 msec. Hypermnesia was found at all exposure durations with the possible exception of the 5 msec duration (a trend in Experiment 2 and a significant effect in Experiment 3). When exposure durations were made "absolutely subliminal" (chance level performance on the first recall attempt) through the use of a graded series of neutral density filters at the 5 msec exposure duration, no hypermnesia was found in any of the groups (Experiment 5). Control groups (subjects shown sham flashes) were employed in all the experiments to evaluate guessing performance.

Reminiscence, which measures the number of correct new items recovered beyond the initial recall trial, regardless of whether earlier recalled items are recalled again or forgotten on later trials, was also examined in Experiments 2-5. It was found that the reminiscence functions were virtually identical for control and experimental groups in these studies, regardless of stimulus exposure durations. This insensitivity of reminiscence to exposure conditions, and even to the presence or absence of stimuli (sham flashes), raises questions about the appropriateness of reminiscence as a measure of stimulus recovery. The basic conclusions to be derived from these studies are: (1) A single complex stimulus does not yield hypermnesia (Experiment 1); (2) When stimuli exposures are supraliminal, hypermnesia tends to occur for serially presented lists of pictorial stimuli, even at very short exposure durations (50 msec and, in Experiment 3, 5 msec); (3) When lists of stimuli are degraded enough so that they are absolutely subliminal, recall hypermnesia fails to occur (Experiment 5); (4) Reminiscence failed to reflect exposure duration, raising questions about its adequacy as a sensitive indicator of recall level or recall improvement.

Acknowledgements

I would like to thank the members of my committee, Professors Arthur Reber, Neil Macmillan, Dorathea Halpert, and David O'Brien for their support, encouragement, and advice in the preparation of this dissertation. A special thanks goes to my friend, mentor, and advisor, Professor Matthew Hugh Erdelyi, for his insights concerning the design of the experiments, his encouragement, and his numerous revisions of this manuscript.

Table of Contents

Title Page.....	i
Approval Page.....	ii
Abstract.....	iii
Acknowledgements.....	v
Table of Contents.....	vi
List of Tables.....	viii
List of Figures.....	xiii
General Introduction.....	1
Experiment 1.....	31
Method.....	34
Results and Discussion.....	40
Experiment 2.....	56
Method.....	60
Results and Discussion.....	68
Experiment 3.....	95
Method.....	98
Results and Discussion.....	101
Experiment 4.....	117
Method.....	118
Results and Discussion.....	118
Experiment 5.....	135
Method.....	139
Results and Discussion.....	141
General Discussion.....	170

Appendix 1A.....	187
Appendix 1B.....	188
Appendix 1C.....	195
Appendix 1D.....	214
Appendix 1E.....	220
Appendix 2A.....	222
Appendix 2B.....	226
Appendix 2C.....	229
Appendix 2D.....	236
Appendix 2E.....	242
Appendix 3A.....	248
Appendix 3B.....	251
Appendix 3D.....	254
Appendix 4A.....	260
Appendix 4B.....	264
Appendix 5A.....	268
Appendix 5B.....	277
Appendix 5C.....	286
References.....	289

List of Tables

Table 0.1.	Experimental, Dart, and Yoked Group's Average R1 and R2 Free-Recall and R2 Forced-Recall (R*2) Scores.....	11
Table 0.2.	Free Association, Think, and No Interval Group's Average R1, R2, and R3 Scores For Pictures and Words.....	18
Table 1.1.	Free- and Forced-Recall Over Three Trials for Experimental and Control Groups for the 500 msec Exposure.....	42
Table 1.2.	Free- and Forced-Recall Over Three Trials for Experimental and Control Groups for the 50 msec Exposure.....	43
Table 1.3.	Free- and Forced-Recall Over Three Trials for Experimental and Control Groups for the 5 msec Exposure.....	44
Table 1F.1.	Summary of Analysis of Variance of the Combined (Structural + Semantic) Free-Recall Scores Over Three Trials (R1, R2, R3) for the Experimental and Control Groups.....	46
Table 1F.2.	Summary of Analysis of Variance of the Combined (Structural + Semantic) Scores Over Two Trials: R1 (Initial Free-Recall) and R*3 (Final Forced-Recall), for the Experimental and Control Groups.....	49

Table 1F.3.	Summary of Analysis of Variance of the Combined (Structural + Semantic) Forced-Recall Scores Over Three Trials (R*1, R*2, R*3) for the Experimental and Control Groups.....	51
Table 1.4.	Average Correct Free-Associations After Three Trials for Experimental and Control Groups.....	53
Table 1F.4.	Summary of Analysis of Variance of the Free-Association Scores After Three Trials (R*1, R*2, R*3) for the Experimental and Control Groups.....	54
Table 2.1.	Average Forced-Recall Over Three Trials for the Experimental and Control Groups.....	69
Table 2G.1.	Summary of Analysis of Variance of the Correct Forced-Recall Scores Over Three Trials for the Experimental Groups.....	75
Table 2G.2.	Summary of Analysis of Variance of the Correct Forced-Recall Scores Over Three Trials for the 5 msec and 0-Exposure Control Groups.....	78
Table 2.2.	Average Cumulative Recall Over Three Trials for the Experimental and Control Groups....	83
Table 2G.3.	Summary of Analysis of Variance of the Cumulative Recall Scores Over Three Trials for the Experimental Groups.....	89

Table 3.1.	Average Forced-Recall Over Three Trials for the Experimental and Control Groups.....	101
Table 3C.1.	Summary of Analysis of Variance of the Correct Forced-Recall Scores Over Three Trials for the Experimental and Control Groups.....	106
Table 3C.2.	Summary of Analysis of Variance of the Correct Forced-Recall Scores Over Three Trials for the 5 msec Experimental and 0-Exposure Control Groups.....	108
Table 3.2.	Average Cumulative Recall Over Three Trials for the Experimental and Control Groups...	110
Table 3C.3.	Summary of Analysis of Variance of the Cumulative Recall Scores Over Three Trials for the Experimental and Control Groups...	114
Table 4.1.	Average Forced-Recall Over Three Trials for the Different Exposure-Duration Groups.....	119
Table 4C.1.	Summary of Analysis of Variance of the Correct Forced-Recall Scores Over Three Trials for the Different Exposure-Duration Conditions.....	125
Table 4.2.	Average Cumulative Recall Over Three Trials for the Different Exposure-Duration Groups.....	127

Table 4C.2.	Summary of Analysis of Variance of the Cumulative Recall Scores Over Three Trials for the Different Exposure-Duration Conditions.....	133
Table 5.1.	Average Forced-Recall Over Three Trials for the Different Filter-Combination Groups.....	142
Table 5C.1.	Summary of Analysis of Variance of the Correct Forced-Recall Scores Over Three Trials for the Different Filter-Combination Experimental Conditions.....	148
Table 5C.2.	Summary of Analysis of Variance of the Correct Forced-Recall Scores Over Three Trials for Seven Experimental Filter-Combination Conditions: 0.70, 0.80, 0.90, 1.00, 1.10, 1.20, and 1.40.....	150
Table 5C.3.	Summary of Analysis of Variance of the Correct Forced-Recall Scores Over Three Trials for the 0.70, 0.80, 0.90, 1.00, 1.10, 1.20, and 1.40 Filter-Combination and the 1.00 Filter Control Conditions.....	152
Table 5.2.	Average Cumulative Recall Over Three Trials for the Different Filter-Combination Groups.....	155

Table 5.3.	Reminiscence (cum R3 - R1) increase for Pictures and Words for all Experimental Groups.....	160
Table 5C.4.	Summary of Analysis of Variance of the Cumulative Recall Scores Over Three Trials for Eight Filter-Combination Experimental Conditions.....	162
Table 5C.5.	Summary of Analysis of Variance of the Cumulative Recall Scores Over Three Trials for Seven Experimental Filter-Combination Conditions: 0.70, 0.80, 0.90, 1.00, 1.10, 1.20, and 1.40.....	164
Table 5C.6.	Summary of Analysis of Variance of the Cumulative Recall Scores Over Three Trials for the 0.70, 0.80, 0.90, 1.00, 1.10, 1.20, and 1.40 Filter-Combination and the 1.00 Filter Control Conditions.....	166
Table 6.1.	First Recall Trial (R1), Third Recall Trial (R3), and Hypermnnesia Levels (R3 - R1) for the Different Exposure Groups in Experiments 2 Through 4.....	173
Table 6.2.	First Recall Trial (R1), Cumulative Recall (cum Rn), and Reminiscence (cum Rn - R1) for the Different Exposure Groups in Experiments 2 Through 4.....	175

List of Figures

Figure 0.1.	Hypermnnesia for Pictures Over a Period of Seven Days in the Experiment of Erdelyi and Kleinbard (1978). Adapted from Erdelyi and Kleinbard (1978).....	21
Figure 0.2.	Hypermnnesia for Pictures and Words Over a Period of Seven Days in Erdelyi and Kleinbard (1978, Study 2). Adapted from Erdelyi and Kleinbard (1978, Study 2).....	22
Figure 0.3.	Reminiscence Functions for the Subjects in Erdelyi and Kleinbard (1978, Study 2). Adapted from Erdelyi and Kleinbard (1978, Study 2)...	24
Figure 2.1.	Combined (Pictures + Words) Average Recall Over Three Trials for all Groups in Experiment 2.....	71
Figure 2.2.	Average Recall for Pictures Over Three Trials for the Experimental Groups in Experiment 2.....	72
Figure 2.3.	Average Recall for Words Over Three Trials for the Experimental Groups in Experiment 2.....	73
Figure 2.4.	Average Combined (Pictures + Words) Cumulative Recall Over Three Trials for all Groups in Experiment 2.....	85
Figure 2.5.	Cumulative Recall for Pictures Over Three Trials for the Experimental Groups in	

	Experiment 2.....	86
Figure 2.6.	Cumulative Recall for Words Over Three Trials for the Experimental Groups in Experiment 2.....	87
Figure 3.1.	Average Combined (Pictures + Words) Recall Over Three Trials for the Groups in Experiment 3.....	103
Figure 3.2.	Pictures and Words Recall Over Three Trials for the 5 msec Group in Experiment 3.....	104
Figure 3.3.	Combined (Pictures + Words) Cumulative Recall Over Three Trials for the Groups in Experiment 3.....	112
Figure 3.4.	Pictures and Words Cumulative Recall Over Three Trials for the 5 msec Group in Experiment 3.....	113
Figure 4.1.	Combined (Pictures + Words) Recall Over Three Trials for the Groups in Experiment 4.....	121
Figure 4.2.	Recall for Pictures Over Three Trials for the Groups in Experiment 4.....	122
Figure 4.3.	Recall for Words Over Three Trials for the Groups in Experiment 4.....	123
Figure 4.4.	Combined (Pictures + Words) Cumulative Recall Over Three Trials for the Groups in Experiment 4.....	129
Figure 4.5.	Cumulative Recall for Pictures Over Three	

	Trials for the Groups in Experiment 4.....	130
Figure 4.6.	Cumulative Recall for Words Over Three Trials for the Groups in Experiment 4.....	131
Figure 5.1.	Combined (Pictures + Words) Recall Over Three Trials for the Groups in Experiment 5.....	144
Figure 5.2.	Recall for Pictures Over Three Trials for the Experimental Groups in Experiment 5.....	145
Figure 5.3.	Recall for Words Over Three Trials for the Experimental Groups in Experiment 5.....	146
Figure 5.4.	Combined (Pictures + Words) Cumulative Recall Over Three Trials for the Groups in Experiment 5.....	157
Figure 5.5.	Cumulative Recall for Pictures for the Experimental Groups in Experiment 5.....	158
Figure 5.6.	Cumulative Recall for Words for the Experimental Groups in Experiment 5.....	159

General Introduction

The primary purpose of the research described in this dissertation was to extend the hypermnnesia findings (net increase in memory over time) of Erdelyi and associates (Erdelyi, 1984; Erdelyi & Becker, 1974; Erdelyi & Kleinbard, 1978) in the supraliminal stimulus exposure range (5 sec - 1 sec) to very short and absolute subliminal exposures.

Several investigators (Fisher, 1954, 1956; Haber & Erdelyi, 1967; Hilgard, 1962; Poetzl, 1917) have reported evidence suggesting the accessibility in memory of initially unreported elements of briefly presented stimuli. These elements tended to emerge subsequently in fantasy productions of subjects (e.g. doodles, free-associations, dreams). The notion that subliminal stimuli can exert influence on the unaware observer, although still controversial (e.g., Holender, 1986), is rapidly becoming the consensus view in experimental psychology (e.g., Bargh, 1984; Bornstein, Leone, & Galley, 1987; Dixon, 1981; Kihlstrom, 1987; Marcel, 1983a; 1983b; Reingold, 1990; Schachter, 1987; Weiskrantz, 1986).

It has often been assumed (e.g., Poetzl, 1917; Fisher, 1956; 1960a; 1960b; 1988; Shevrin & Dickman, 1980) that such "subception" effects imply that the stimuli are registered and stored unconsciously.

The Poetzl/Emergence Effect

The reference study is one carried out by Otto Poetzl, a professor of psychiatry and neurology at the University of Vienna, in 1917. Poetzl tested a dozen subjects in an experiment involving the following steps: (1) A complex pictorial stimulus (a landscape scene, etc.) was exposed for 10 msec by means of a tachistoscope; (2) the subject was required to produce an exhaustive reproduction, in the form of a drawing, of what he had seen--which was generally little; and (3) the subject was told to have a dream that night and to return the next day to report the dream and draw elements of it.

Poetzl's finding was that initially inaccessible stimulus elements emerged in the content of the subjects' dreams.

Poetzl's work was largely ignored for the next several decades, giving rise to only a few follow-up studies (Allers & Teler, 1924; Malamud & Linder, 1931; Malamud, 1934).

Although much neglected, Allers and Teler's (1924) work made important contributions, at both the conceptual and procedural levels. They argued that Poetzl's results did not need to be connected to dreams as such. Opting for an early dual-code approach (cf. Paivio, 1971), they contended that perceptual

input was coded in two formats: word-near (verbal), and word-distant (imagistic). Both formats were assumed to encode some non-overlapping input information.

Intentional recall made contact mainly with information in the verbal system, missing some of the non-overlapping information in the imagistic system. The Poetzl effect, according to Allers and Teler, was due to the accessing of residual input information through imagery production which, in Allers and Teler's view, could include, but was not restricted to, dreams.

Allers and Teler showed experimentally that subjects could recover stimulus elements not present in intentional recall in free-associative imagery. These "belatedly emerging elements" (p. 141) were recovered, according to Allers and Teler, because of the tapping, through free-associative imagery, of information not accessible in intentional recall.

Not only dreams, but also the tachistoscope was soon shown to be unnecessary for obtaining Poetzl-type effects. Malamud and Linder (1931) demonstrated, with psychotherapy patients as subjects, that unreported elements of a complex stimulus (e.g., a picture of the Madonna and Child), presented for 30 seconds, emerged in the content of dreams. These recoveries often involved omitted elements associated with the patients' psychological conflicts which, Malamud and Linder

assumed, had been repressed in the immediate recall. Malamud (1934) extended the procedure to connected verbal materials, showing that omissions or distortions in recall of a passage containing sexual symbolism tended to emerge in dreams.

The Zeitgeist did not smile upon these early efforts, and the area drifted into obscurity for two decades, until its revival by Charles Fisher (Fisher, 1954; 1956; 1960a; 1960b; Fisher & Paul, 1959). Fisher was able to replicate Poetzl's effect with dreams and also to show, after Allers and Teler, similar effects with free-associations and imagery.

Although Fisher produced some dramatic effects and introduced important methodological refinements into the area, several crucial methodological issues remained. Most serious, perhaps, was the failure to develop a scheme for quantifying the amount of stimulus material recovered in dreams and fantasy imagery. The empirical studies, therefore, did not constitute experiments in the true sense: base-rates or control group performance could not be formally (i.e., statistically) evaluated against that of experimental groups and so positive results--impressive examples of stimulus recoveries in dreams and fantasy--could be artifacts of chance or of biased selection by the experimenter of positive outcomes from a pool of

indifferent outcomes.

Shevrin and Luborsky (1958) filled this methodological breach by developing an objective scoring scheme that allowed statistical comparison of the performance of experimental and control groups. They showed that Poetzl-type effects were true recoveries of previously unreported stimulus content. Using different scoring techniques, Giddan (1967) and Haber and Erdelyi (1967) further corroborated the Poetzl (or Allers & Teler) findings.

There remained additional methodological issues, however. One pervasive problem, to be taken up in greater detail below, is the possibility that differential reporting criteria (cf. Green & Swets, 1966; Swets, 1964; Swets et al., 1961) might account for Poetzl-type effects: Subjects may adopt a laxer response criterion when generating free-associative imagery and dream reports than when producing an intentional recall. Thus, the stimulus recoveries in dreams or fantasy drawings may reflect not the recovery of unconscious materials but only the recovery of unreported materials. Also, response number and chance base-rates may differ for intentional reports and fantasy. Chance effects might thus be taken for recoveries. Moreover, contextual elaboration in fantasy of part-cues (fragmentary recollections in

intentional reports) may yield compelling "recoveries" of stimulus content in fantasy (cf. Erdelyi, 1970; 1972; 1985; Eriksen, 1960; Hilgard, 1962; Johnson & Eriksen, 1961). Although these various methodological nuances complicate the interpretation of Poetzl effects, standard control procedures are available to deal with them.

A fundamental problem remains, however, that may prove methodologically refractory. It arises from the fact that Poetzl-type effects are based on the contrast of two different indicators of memory: intentional recall versus some fantasy indicator (cf. Erdelyi, 1985; 1986; Eriksen, 1958; Goldiamond, 1958).

Indicators of memory must be relied upon because there is no direct way of assessing what is perceived, consciously or unconsciously. Although it is not typically spelled out, the implicit assumption underlying these types of studies is that one indicator (e.g., intentional recall) indexes conscious perception whereas the other indicator (e.g., fantasy) reflects unconscious (or conscious plus unconscious) perception. When the indicator of conscious perception, let us designate it R, shows less information than the other, more inclusive indicator of availability, F (for fantasy), the researcher infers the existence of available information that is not accessible to

awareness, hence unconscious perception. Thus, the discrepancy or dissociation between the output of the two indicators ($F > R$) is taken to imply a corresponding dissociation between the psychological subsystems indicated, i.e., the conscious and unconscious subsystems. For this reason, the general class of designs based on the contrast of two different indicators, F and R , is termed the dissociation paradigm of the unconscious (Erdelyi, 1985; 1986; Holender, 1986; Reingold, 1990; Reingold & Merikle, 1988).

To recapitulate: In Poetzl-type experiments, a stimulus, S , is presented (usually tachistoscopically), followed by an intentional free-recall, R (e.g., a drawing of the stimulus), which is then followed by some kind of fantasy report, F (free associations, drawings of dream contents, etc.). Thus: $S - R - F$. The Poetzl ("emergence") effect consists in the inter-indicator discrepancy, $F > R$, the interpretation of which is problematic because F and R are different indicators.

The Recovery Effect (Hypermnesia and Reminiscence)

In an attempt to by-pass the problems involved in interpreting differences in stimulus accessibility produced by two different memory indicators, Haber and Erdelyi (1967) introduced a methodological modification

in the standard Poetzl-type experiment: They added an extra step to the Poetzl design, namely, a second, post-fantasy, intentional recall, R2. Thus:

S - R1 - F - R2. They reasoned that if fantasy production makes contact with unconscious stimulus elements, it is possible that these elements might be carried over into a post-fantasy intentional recall (R2), which would, therefore, reflect more stimulus content than a pre-fantasy recall (R1).

Whereas the traditional Poetzl phenomenon rested on the dissociation paradigm, the between-indicator discrepancy, $F > R$, the new design type, termed the recovery or hypermnnesia paradigm (Erdelyi, 1985; 1986), involved the within-indicator inequality, $R2 > R1$. Note that the same indicator, free-recall in the form of drawings, is assessed twice, before and after fantasy (in this case, a free-association task). This new design was seen by Haber and Erdelyi as a test of the psychoanalytic claim that free-associations help in the recovery of unconscious memory contents. Their results indicated that experimental subjects, who engaged in free-association production during an interpolated task between the two intentional reports were able to "recover" significantly more stimulus elements of a briefly (500 msec) presented complex pictorial scene during their second intentional recall

effort (R2) than control subjects who did not engage in free-association production during their interpolated task.

It could not be determined, however, whether free-associating actually increased the accessibility in memory of previously unreported stimulus elements, or whether it increased the willingness of the subjects to report more elements. In terms of signal detection theory (Green & Swets, 1966), it remained unclear whether the interpolated task affected the "sensitivity" of the subjects or their "report criterion." This is a problem endemic to any output task (i.e. recall, fantasy) where the subject is free to report as much as he/she judges appropriate.

To clarify whether the Haber and Erdelyi (1967) results constituted an accessibility increment or merely a response increment (or, possibly, both), Erdelyi (1970) conducted an experiment which introduced a methodological control over shifts in the subjects' post-fantasy response rates. After the second intentional free-recall trial (R2) by the subjects, a forced-recall trial (R*2) was elicited, in which the subjects guessed additional stimulus items, until a preset number of responses were produced. Thus, if the stimulus consisted of 12 elements and a subject produced, say, 4 elements in his/her second intentional

report (R2), then an additional 8 guesses were required of that subject, so that the total number of responses equalled 12.

Erdelyi (1970) used three groups of subjects, one experimental and two control groups. The experimental group was briefly shown (for 500 msec) a slide of a 3 x 4 pictorial stimulus grid which consisted of 12 simple drawings and, immediately following exposure to the stimulus, these subjects were asked for an intentional free-recall (R1). After an interpolated free-association task, which lasted approximately 30 minutes, subjects in this group were asked for a second intentional free-recall (R2). Up to this point, the design was similar to that of the Haber and Erdelyi (1967) study. The subjects' responses during this second free-recall trial were, however, automatically duplicated onto a second response sheet by means of carbon paper. After their completion of R2, the subjects were handed this carbon copy and asked to fill out all of the remaining boxes on the 3 x 4 sheet, guessing if necessary. This trial, R*2, constituted the forced-recall part of the design.

One control group, the "dart" group, was treated identically to the experimental group, except for the interpolated task between R1 and R2. Instead of free-associating, subjects in this group threw darts for a

comparable amount of time. A second control group, the "yoked" group, never saw the stimulus. Subjects in this group were presented with a sham (10 msec) flash, and told that the stimulus would be "deeply subliminal." After the flash, they were shown the first recall protocol (R1) of an experimental subject. (A different experimental subject's protocol was used for each yoked subject.) They were asked to copy this protocol on their own recall sheet, and then to try to improve upon the performance of the experimental subject, if they could. This group was thereafter treated like the experimental group, with minor changes in their instructions to reflect the initial difference between them and the experimental subjects.

Table 0.1 presents the Erdelyi (1970) results.

Table 0.1

Experimental, Dart, and Yoked Group's Average R1 and R2
Free-Recall and R2 Forced-Recall (R*2) Scores.

(Adapted from Erdelyi, 1970, p. 104.)

	R1	R2	R*2	R2 - R1	R*2 - R1
<u>Group</u>					
<u>Experimental</u>	3.43	4.48	7.45	1.05	4.02
<u>Dart</u>	3.82	4.16	8.19	0.34	4.37
<u>Yoked</u>	3.38	3.80	5.92	0.42	2.54

Of main interest was whether the Haber and Erdelyi (1967) findings that fantasy increases free recall

would be replicated. Table 0.1 shows that this is so: Experimental (free-association) subjects, unlike their dart control and yoked-control subjects, evidenced a significant recall increment from R1 to R2. Now, this increase could have resulted from either a bona fide memory enhancement by free association or from greater response productivity as a function of the free association task. If the increase was due to true memory enhancement, then control over response productivity in R*2 (the forced-recall trial) should not have undermined the differential recall increments among the three groups. As Table 0.1 shows, however, the effect collapsed with control over response bias: R*2 - R1 increments were similar for experimental and dart control subjects.

It should also be mentioned that the R*2 - R1 recall increments obtained by the two groups that were actually exposed to the stimulus (free-association and dart control) were greater than that of the yoked-control subjects, who never saw the stimulus. The 2.54 recall increase (R1 to R*2) of the yoked subjects reflects the chance guessing rate, given R1 (the R1 these subjects copied from an experimental counterpart). The (significantly) greater improvement of the subjects exposed to the stimulus (4.02 and 4.37, for the free-association and dart control groups,

respectively), indicates that these subjects had more information accessible than they were willing to report on R1; for this reason, it seems, they produced, under a laxer criterion, greater recall increments than those associated with chance.

Since both the experimental and dart control groups evidenced similar difference scores ($R^*2 - R1$) after their forced-recall trial, Erdelyi (1970) concluded that free-associations affected the subjects' "productivity" or willingness to respond, rather than their memory. In short, the outcome was a B (response criterion), rather than a d' (sensitivity) effect. Since, as we have seen, the experimental (free-association) subjects showed no evidence of a "recovery effect" relative to the dart control subjects, Erdelyi concluded that the interpolated free-association task acted on response productivity, not on sensitivity, and that, therefore, an increase in memory for briefly presented stimuli had not been demonstrated. By extension, Erdelyi (1970) concluded that the Haber and Erdelyi (1967) results were not true "recovery effects," but response bias effects.

A different reading of the results is possible, however. Although it is apparent from Erdelyi's (1970) experiment that free-associating, relative to dart-throwing, does not enhance memory, it does not follow

that memory enhancement did not occur in both groups. Erdelyi assumed that free-association was necessary for recovery, and since free-association proved ineffective relative to the dart-throwing task, that no recovery had occurred. It is possible, however, that a range of interpolated activities could produce memory recoveries.

Erdelyi's assumption was buttressed by another experiment (1970, Experiment 2) he reported, in which he compared recognition memory before and after the same interpolated tasks (free-associating and dart-throwing). Using signal detection tests, he found no increments in d' from first to second recognition tests. He assumed that recall memory paralleled recognition memory, and since, clearly, recognition memory, in terms of d' , failed to increase in either experimental or dart control group, that the recall results also showed no increment. Subsequent research (Erdelyi and Becker, 1984; Erdelyi, 1988; Payne and Rodiger, 1987) however, has shown that it may not be appropriate to extrapolate from multi-trial recognition test outcomes to multi-trial recall (see also Erdelyi, 1988). Consequently, it may still be possible that recall memory improves from first to second trial, even though free-associating does not enhance such improvement.

In effect, a weakness of the Erdelyi (1970) design was not to include a forced-recall test prior to the interpolated task. The critical difference score should not be $R^*2 - R1$, but $R^*2 - R^*1$. To assess recall increments with response productivity controlled, it is, therefore, necessary to use forced-recall in both the first and second recall trials, not just on the second trial, as Erdelyi (1970) did.

At this point (1970), since fantasy, free associative or imagistic was not, after all, hypermnesic, Erdelyi was almost ready to abandon this line of research. Fortunately, he carried out what, in his mind, was to be a "last" experiment, since his expectation was that this study, too, would prove negative.

The new study (Erdelyi & Becker, 1974) introduced two major methodological modifications over the previous studies. First, since the studies heretofore discussed all involved semiliminal (500 msec) exposures in which the stimulus was flashed for only a fraction of a second, Erdelyi thought it possible that not enough information was registered with these short exposure durations for recovery to take place, and that it might be possible to obtain hypermnesia with longer (not subliminal or semiliminal) exposures. Thus, Erdelyi and Becker (1974) shifted away from

tachistoscopic flashes to a straightforward memory procedure. In effect, this change in strategy transformed the study from one of subliminal perception to one of subliminal (initially inaccessible) memory. Erdelyi also introduced, with this study, forced-recall trials throughout, a method he has utilized in subsequent experiments. The main question Erdelyi and Becker (1974) undertook to answer was whether inaccessible but once-conscious (registered) input was subject to recovery.

Subjects in this study were shown a supraliminal memory list consisting of 80 slides, 40 words and 40 drawings (e.g., TELEVISION, DOG, HAMMER, GUITAR) randomly mixed. Each slide was shown for 5 seconds. After the presentation of the 80 items, the subjects were given a forced-recall trial, R1, in which they were required to produce, in writing, 60 nonrepeating responses (not drawings, only words and the labels of the pictures) guessing if necessary. After this first forced recall, R1, subjects in the fantasy group were required to generate free-associative doodles and some writing (automatic writing/drawing) for a duration of 7 minutes. Upon the completion of this task, they were given a second forced-recall test, R2 (also requiring 60 responses), which was followed by a second interval of fantasy production. Finally, they were given a last

forced-recall test, R3. (Notice that since all memory tests are forced-recall tests, no asterisk is needed to differentiate the trials.) The basic design, then, may be schematized as follows:

[S: 40P, 40W] - R1 - F1 - R2 - F2 - R3.

Because of the disappointing results obtained with fantasy/free association in the previous two studies (Haber & Erdelyi, 1967; Erdelyi, 1970), a "concentration," or "think" group (patterned after Breuer and Freud, 1895) was also tested. The between-trials interpolated task for these subjects consisted in thinking (with their eyes closed) of the stimulus list they had been shown, for a duration of 7 minutes.

A third group, the no-interval control group, was also tested. This group generated three consecutive forced-recall tests with no interpolated activity between trials.

Table 0.2 presents the three groups' recall of pictures and words across the three forced-recall trials.

Table 0.2

Free Association, Think, and No Interval Group's
Average R1, R2, and R3 Scores For Pictures and Words.
(Adapted from Erdelyi & Becker, 1974, p. 105.)

	Pictures			Words		
	R1	R2	R3	R1	R2	R3
<u>Group</u>						

<u>Free association</u>	16.65	18.30	18.59	14.00	14.17	14.23
<u>Think</u>	15.76	17.76	18.94	16.35	16.82	17.00
<u>No Interval</u>	15.82	17.11	18.05	13.41	12.47	13.00
<u>Mean (all groups)</u>	16.08	17.72	18.53	14.59	14.49	14.74

The most striking result is the differential fate of picture versus word recall: Regardless of the nature of the interpolated activity (free-association, thinking), or its absence (no-interval), picture recall increased reliably with repeated recall trials. On the other hand, recall of words, regardless of treatment, remained constant over trials. The hypermnesia (net increase over trials) effects obtained with picture stimuli could not now be attributed to response criterion shifts, since the forced-recall procedure across trials held subjects to a constant number of

responses. Thus, any increase in correct recalls was necessarily accompanied by a decrease in incorrect recalls. It appeared, then, that bona fide recovery effects (hypermnnesia) could be obtained, at least with picture lists, and within the time parameters of the experiment.

It is also noteworthy that the free-associative fantasy group, although producing significant increases in picture recall over trials, failed to generate more picture hypermnnesia than the "think" or the no-interval subjects. In fact, the free-association group produced the numerically lowest picture hypermnnesia effect of the three groups, although this difference was not statistically significant: There was not even a hint that free-associative fantasy contributed to the hypermnnesia effect.

Erdelyi and Becker (1974) demonstrated that picture hypermnnesia is obtainable in the laboratory within a relatively short time frame, a period of about one hour. What might be expected from repeated recall effort spanning days, weeks, months, even years? That is: How much can recall improve with time and effort?

Erdelyi and Kleinbard (1978) took a preliminary step in the investigation of this issue by looking at the course of recall over a period of approximately one week. A single subject (the second author, J.K)

attempted to recall 40 pictures several times a day for 7 days, beyond five initial forced-recalls in a single laboratory period with no interpolated activity between tests. After the initial laboratory trials, the subject was given three dozen envelopes, each containing a recall protocol. He was instructed to fill out at least three recall protocols a day for the next 7 days, taking 7 minutes per trial, and producing 40 nonrepeating responses, guessing if necessary. After the completion of each trial, the subject was to seal the envelope (to ward off the temptation of consulting a prior recall test). The subject was encouraged to spend as much time as possible during the week thinking about and trying to retrieve the stimulus items. Therefore, the formal recall tests reflect considerably more retrieval time and effort than the 7 minutes spent taking each test.

Figure 0.1 presents the results of the Erdelyi and Kleinbard (1978) experiment.

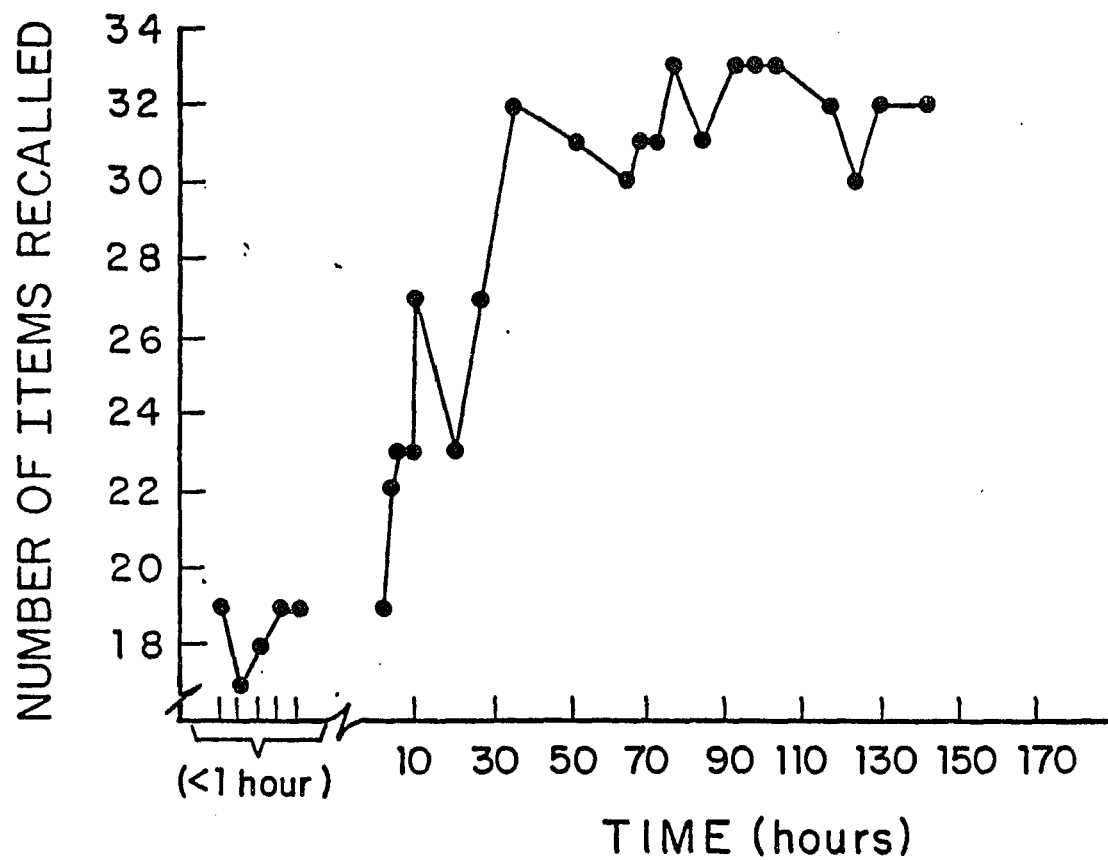


Figure 0.1. Hypermnesia for pictures over a period of seven days in the Erdelyi and Kleinbard (1978) experiment. Adapted from Erdelyi and Kleinbard (1978).

It can readily be seen that the subject's recall of pictures increased steadily with time and retrieval effort.

Since this study was based on the performance of a single subject, Erdelyi and Kleinbard (1978, Study 2) extended their investigation to a larger sample of six subjects. Three of the subjects were to repeatedly attempt to recall 60 pictures; the other three the labels corresponding to the picture items.

Figure 0.2 summarizes these results.

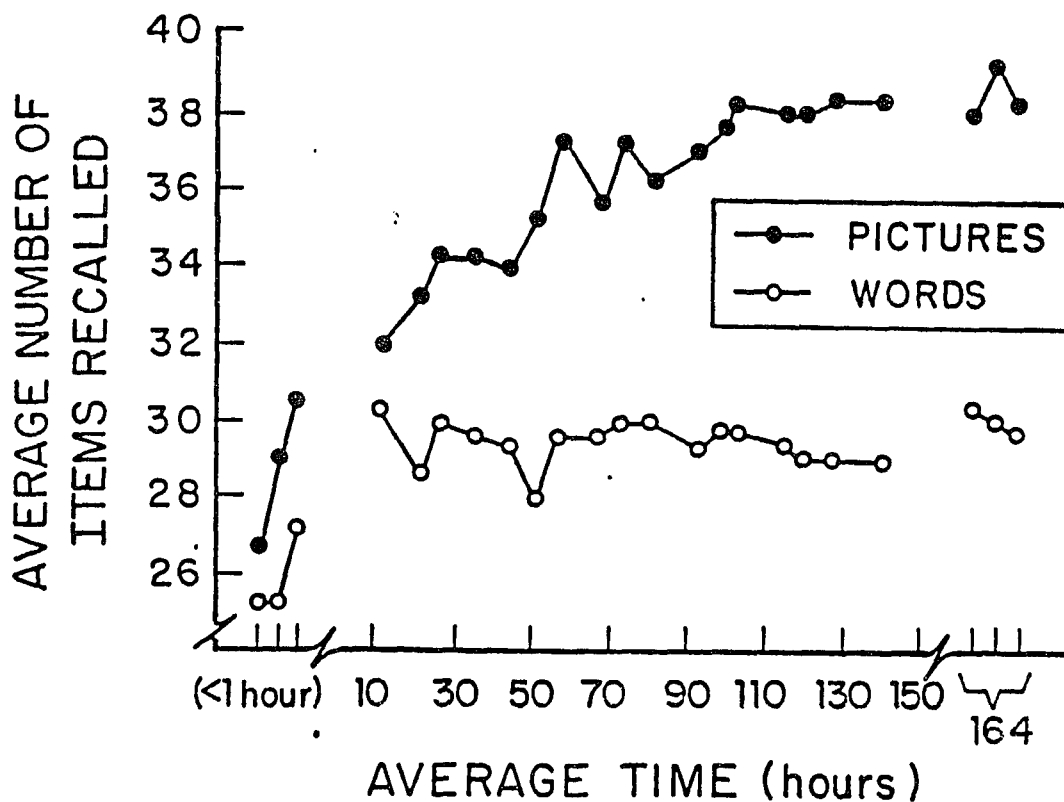


Figure 0.2. Hypermnnesia for pictures and words over a period of seven days in Erdelyi and Kleinbard (1978, Study 2). Adapted from Erdelyi and Kleinbard (1978).

As in the first study, picture recall reliably increased for several days, whereas word recall remained constant.

Notice that both Figures 0.1 and 0.2 represent recall levels across successive trials. Such recall functions usually underestimate the number of memory recoveries achieved throughout testing, since recall level on any one trial reflects both recoveries and losses of memory over time. The appropriate measure of total item recovery is provided by cumulative recall across trials. Cumulative recall measures the total number of items correctly recalled up to a particular trial, irrespective of forgetting of previously recalled items. Increases in net recall define hypermnesia; increases in cumulative recall beyond R_1 define reminiscence (Erdelyi, 1984; also, see below, p. 25). Figure 0.1 provides J.K.'s hypermnesia function for pictures, Figure 0.2 represents hypermnesia functions for both pictures and words for the subjects in Erdelyi and Kleinbard's Study 2 (1978). Figure 0.3 presents the corresponding reminiscence functions for the subjects in Erdelyi and Kleinbard's Study 2 (1978).

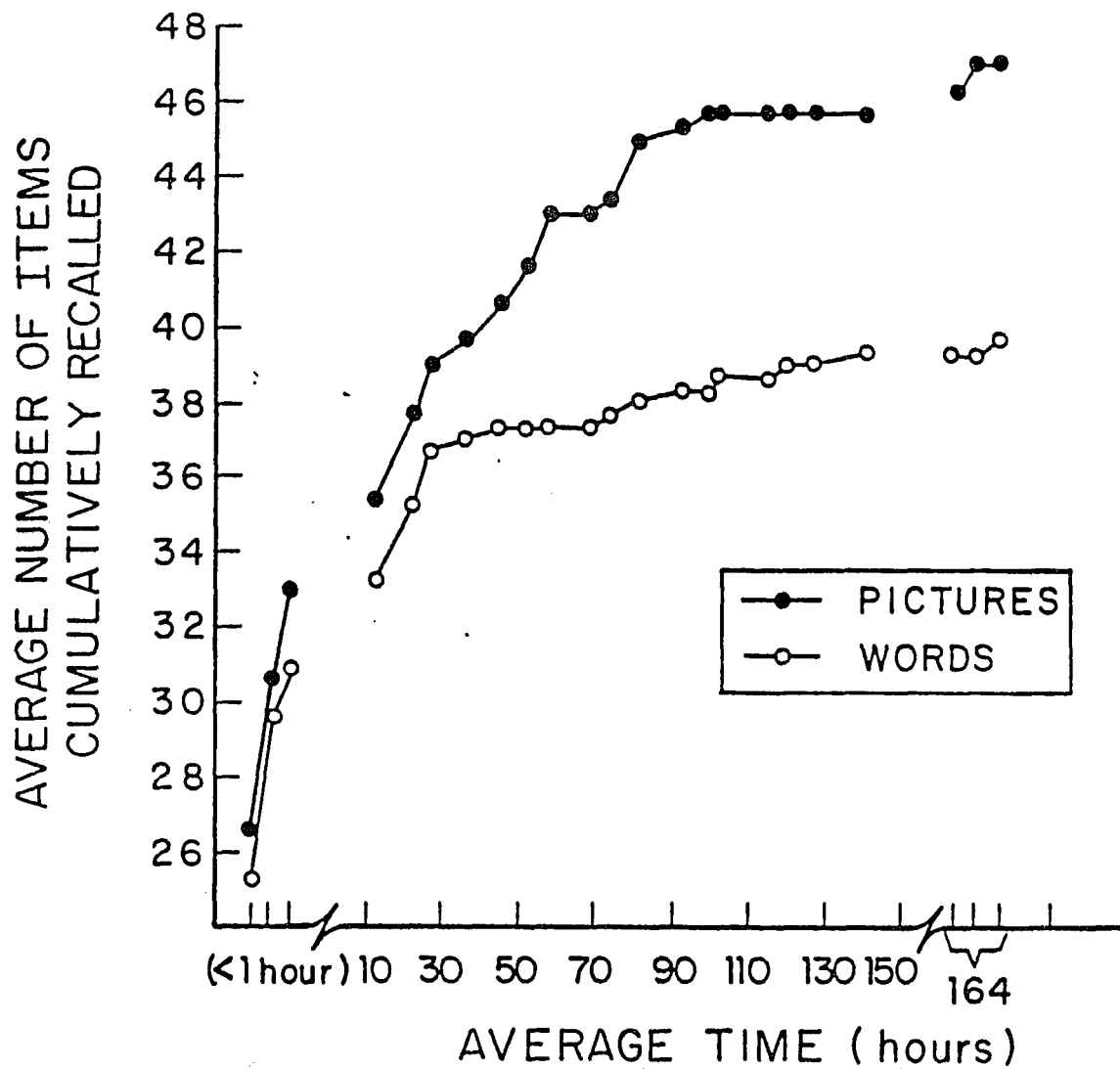


Figure 0.3. Reminiscence functions for the subjects in Erdelyi and Kleinbard (1978, Study 2). Adapted from Erdelyi and Kleinbard (1978).

It should be clear that the six subjects produced reminiscence for both pictures and words, even though net recall (hypermnnesia) increases only for pictures (Figures 0.1 and 0.2).

Experiment 1

As we have seen, Erdelyi (1970) concluded that, since free-associations affected response criterion, rather than true recoveries of briefly presented stimulus flashes, that true recovery of those items was not obtainable. We have already mentioned (p. 12) that a weakness in the Erdelyi (1970) design was the lack of forced-recall trials throughout and that, therefore, his conclusion at the time was not warranted. It is possible that both the free-association and dart control subjects showed bona fide increments from R1 to R*2, but, due to the lack of an initial forced-recall trial, it was impossible to verify this possibility.

This experiment was carried out specifically to introduce the aforementioned modification, namely, the use of forced-recall trials throughout. The purpose remained the same: To determine whether multiple recall trials separated by an interpolated activity could result in memory increase for a tachistoscopically flashed complex pictorial stimulus. Since thinking periods (thinking about the stimulus) as an interpolated activity, and three rather than two

forced-recall trials were shown in subsequent research by Erdelyi and associates (Erdelyi & Becker, 1974; Erdelyi & Kleinbard, 1978) to be effective in facilitating hypermnesia for supraliminally presented memory lists, both of these modifications were incorporated in this study. The design may be schematized as follows:

{Stimulus} - R1 - X - R2 - X - R3,

where R1, R2, and R3 are successive forced-recall trials, and X stands for the interpolated activity: thinking, free-associating, or a combination of both. (The asterisks designating forced-recall are omitted, since all recalls henceforth are of the forced type.)

Recent developments in the subliminal literature suggest that subliminal effects might be restricted to only very brief stimulus exposures (Bonnano & Stilling, 1986; Kunst-Wilson & Zajonc, 1980; Seamon et al., 1984, 1983a, 1983b). Thus, the stimulus used by Erdelyi (1970), a 3 x 4 pictorial grid, was exposed at three different durations: 500 msec (Erdelyi's, 1970, exposure duration), 50 msec, and 5 msec. Yoked-Control subjects (exposed to an experimental counterpart's R1, but not to the stimulus) were asked to generate "R2" and "R3" like the experimental subjects. These control groups were used to evaluate possible increases in "hits" resulting from practice (e.g., smarter guesses).

Experiments 2 Through 5

This set of experiments probed the hypermnnesia findings of Erdelyi and associates for supraliminally presented memory lists to short durations as well as truly subliminal exposures. As we have seen (pp. 13-18), Erdelyi and associates have repeatedly demonstrated hypermnnesia for serially presented stimuli (memory lists) consisting of pictures at exposure durations from 1 to 5 seconds per item. Hypermnnesia for picture lists, as opposed to a single flash of a stimulus set, has been shown to be a robust phenomenon, easily obtained at these supraliminal exposures. Hypermnnesia for words, on the other hand, is less reliable (see Payne, 1987, for review), although, if subjects are asked to encode the words as picture images during the presentation of the words, hypermnnesia for words is easily obtained (see Erdelyi et al., 1976).

The basic paradigm employed by Erdelyi, also used in these studies, involved the presentation, at 5 sec intervals, of 80 black-and-white 35 mm slides (40 pictures, 40 words, randomly mixed) at either 5 sec, 2 sec, or 1 sec exposure duration per item. The design is essentially as in Experiment 1, except that the stimulus is presented serially rather than in a single flash. After presentation of the stimulus list,

subjects were asked for three forced-recall trials of about 7 minutes each, during which they had to recall/guess a preset number of items (60). The three forced-recall trials were separated by two intervals of about 7 1/2 minutes each, during which subjects engaged, as before, in an interpolated task.

These experiments (2 through 5) involved the systematic shortening of stimulus exposures from 5 sec to 5 msec via a two-channel constant illumination projection tachistoscope. According to Erdelyi's (1986) proposal, the strictest sense of "subliminal" is chance level performance. In signal detection theory terms, it would not be $d' = 1$, a frequent convention (cf. Macmillan, 1986), but $d' = 0$. Since d' cannot be calculated for recall data, the counterpart notion is initial forced-recall level (R1) being equivalent to chance performance, as indexed by control subjects exposed to blank flashes. Control (sham flashes) groups are needed both to assess guessing base-rates across trials and initial recall levels in experimental subjects. Since, as pilot studies suggested, some detection occurs at the 5 msec/item exposure duration (the limit of the tachistoscope), neutral density filters of differing strengths were used to further degrade the stimuli and to depress the initial recall level of experimental subjects to chance level

performance.

Cumulative recall (cum Rn) was also measured in these studies. Cumulative recall refers to the total number of stimulus items recalled throughout the recall trials, regardless of whether earlier recalled items are recalled again or forgotten on later trials. For example: suppose a subject recalls 23 of the items in the stimulus list on the first recall attempt (R1) and 5 new items (items not recalled on R1) on the second recall trial (R2). The cumulative recall score through Trial 2 (cum R2) for this subject is 28 ($23 + 5 = 28$), regardless of whether any of the initially recalled items were preserved on R2). If this same subject recalls, during R3, 2 items not recalled on either R1 or R2, the cumulative recall score through Trial 3, cum R3, increases to 30 ($28 + 2 = 30$).

Because forgetting of previously remembered items across trials does not detract from the cumulative recall score, reminiscence functions are not equivalent to those of hypermnesia, which take inter-trial forgetting into account. For example, assume that the subject who recalled 23 items on R1 and then 5 additional new items on R2 also forgot, on R2, 8 items s/he had included on R1. The cumulative recall score is still 28, since only correct new items are cumulated, regardless of losses. However, the

hypermnnesia score at $R_2 = -3$, since net recall goes from $R_1 = 23$ to $R_2 = 20$ (i.e., $23 + 5 - 8$).

Formally, for n trials,

$$\text{Hypermnnesia} = R_n - R_1,$$

that is, the extent to which subjects recall more items on R_n than on the initial recall trial, R_1 . On the other hand,

$$\text{Reminiscence} = \text{cum } R_n - R_1.$$

Reminiscence simply measures the number of correct new items recovered beyond the initial recall trial, R_1 . It should be apparent, therefore, that there cannot be hypermnnesia without reminiscence, but that there can be reminiscence without hypermnnesia. Cumulative recall almost always increases over successive recall trials, thus producing reminiscence. This is not necessarily the case for net recall increments (hypermnnesia), since change in net recall involves the balance between loss (oblivescence) and gain (reminiscence) across trials (see Ballard, 1913; Erdelyi, 1991). The interest in reminiscence is motivated by the suspicion that reminiscence might be a more sensitive indicator of memory recovery than hypermnnesia, in which recoveries are potentially obscured by forgetting.

Experiments 1 through 5 will now be described in detail.

Experiment 1

The Recovery of Subliminal Stimuli:

Modified Replication of Erdelyi (1970)

Although it is apparent from Erdelyi's (1970) experiment (see pp. 7-13 in General Introduction) that free-associating, relative to dart-throwing, does not enhance memory, it does not follow that memory enhancement did not occur in both groups. Erdelyi assumed that free-association was necessary for recovery, and since free-association proved ineffective relative to the dart-throwing task, that no recovery had occurred. It is possible, however, that a range of interpolated activities could produce memory recoveries. Consequently, it may still be possible that recall memory improves from first to second trial, even though free-associating does not enhance such improvement. In effect, a weakness of the Erdelyi (1970) design was not to include a forced-recall test prior to the interpolated task. The critical difference score should not be $R^*2 - R1$, but $R^*2 - R^*1$. To assess recall increments with response productivity controlled, it is, therefore, necessary to use forced-recall in both the first and second recall trials, not just on the second trial, as Erdelyi (1970) did.

The present experiment was conducted specifically

to introduce this modification, namely, the use of forced-recall trials throughout. The purpose remained the same: to determine whether multiple recalls with an interpolated activity could result in an increase in memory for a tachistoscopically flashed pictorial stimulus. Essentially, then, the present study was patterned after Erdelyi's (1970) recall study (1970, Experiment 1), except that a forced-recall procedure was used in all recall trials.

Some additional modifications were also introduced in this study. Since thinking periods (thinking about the stimuli) were shown in subsequent research (Erdelyi & Becker, 1974; Erdelyi & Kleinbard, 1978) to have an enhancing effect on memory in the supraliminal literature when used as interpolated tasks, it was of interest to see whether thinking periods would also have an effect on stimuli presented at very short durations. It bears mentioning that the studies just referred to were clearly "supraliminal" (i.e. the stimuli were presented at durations well above the limen), whereas the present study involved a short stimulus flash. The modification of the interpolated task, a combination of thinking and free-associating was, therefore, arrived at with the knowledge that think periods had proven helpful in the normal, or supraliminal literature. Also, since three recall

trials with normal, as opposed to tachistoscopic, memory lists (Erdelyi & Becker, 1974) suggested that increments might be obtained beyond the second recall trial, the present study incorporated a third forced-recall trial (R*3).

In this study, the same 3 x 4 pictorial grid used by Erdelyi (1970) was exposed at three different durations: 500 msec, 50 msec, and 5 msec. The first duration was that used by Erdelyi (1970); the other two were considered to be more "subliminal." This factor was made potentially relevant by some of the more modern literature on subliminal perception (Seamon et al., 1984; Kunst-Wilson & Zajonc, 1980; Silverman, 1983) suggesting that subliminal effects may be restricted to a narrow range of very short stimulus exposures. It was expected that any memory improvements across recall trials would be the result of an enhanced sensitivity for traces of the stimulus, facilitated by the thinking/free-associating interpolated task, rather than the product of spurious guessing, as a comparison between experimental (exposed to the stimulus) and yoked control (not exposed to the stimulus) subjects was expected to reveal.

Method

Subjects

Thirty-six Brooklyn College undergraduate students served as subjects. They were randomly assigned to six groups as follows: 21 students served as experimental subjects in one of three different stimulus exposure duration groups of 7 subjects each; 15 students served as control subjects, 5 being yoked to 5 randomly selected experimental subjects within each experimental group. (It was not possible to recruit 21 control subjects, since the academic semester was nearing its end.) All subjects were volunteers from the introductory Psychology course at Brooklyn College.

Apparatus and Materials

The stimulus consisted of a 35 mm black-and-white slide of twelve hand-drawn objects arranged in three rows of four each: television, broom, table, lamp, cup, clock, armchair, cat, baby, telephone, pitcher, and toaster. The stimulus was projected on a standard screen via a Lafayette two-channel constant illumination projection tachistoscope, Model 42011-A, with two alligned Kodak Ektagraphic III E projectors, each equipped with a standard 127 mm lens. This particular tachistoscope was designed to eliminate sudden changes in intensity, found with most single projection type tachistoscopes, when the stimulus is

presented. By using two projectors with shutters set exactly 180 degrees out of phase, the screen is equally illuminated before, during, and after stimulus presentation. This reduces variance error due to differential adaptation times of different subjects' retinas. The two alligned projectors work in tandem: when the shutter of the top projector opens to expose a slide, the bottom projector's shutter closes; after stimulus exposure is terminated, the shutter of the bottom projector opens up again, to provide the constant background illumination.

The recall sheets for all subjects consisted of 12 boxes arranged in three rows of four boxes each, thus reproducing the "shape" of the stimulus slide. Erdelyi's (1970) carbon copy procedure was dropped from this study. Instead, a simpler procedure, implemented by utilizing different colored pens, was used: a black pen was used for the free-recall portion of the recall trial, and a green pen for the forced-recall portion of the recall trial.

Procedure

The stimulus was flashed on the screen approximately 7 feet away from the subject for a duration of either 500 msec, 50 msec, or 5 msec. The shutters of both projectors were set at maximum illumination. The screen was constantly illuminated by

the bottom projector's exposure of a blank slide. Thus, both before and after stimulus projection, an illuminated rectangle of the same size as the stimulus was present on the screen. The size of the stimulus on the screen was 27 x 18 inches, subtending a horizontal visual angle of 17.75 degrees. During stimulus exposure the experimental room was uniformly illuminated by a 25 watt bulb. The luminance of the stimulus slide was 252 nits (or 252 candles/m²; or 0.21 microwatts). The illumination in the experimental room during stimulus presentation was 0.1 foot/candles. All subjects were tested individually.

After an initial adaptation of approximately two minutes to the dimly illuminated experimental room, the experimental subject was seated at a table facing the screen and was informed that a stimulus consisting of 12 hand-drawn objects, arranged in three rows of four objects each, would be briefly flashed on the screen. The subject was asked to look at the center of the illuminated rectangle on the screen, since the stimulus would be flashed exactly on that location of the screen. After the subject indicated that he/she was looking at the center of the illuminated rectangle, and was ready to receive exposure to the stimulus, the experimenter showed the stimulus for the prescribed stimulus exposure duration. Both projectors were then

shut off and the main room lights were turned on. The experimenter then placed a recall sheet and a black pen in front of the subject, and asked him/her to draw and label everything he/she remembered seeing in the boxes on the sheet, short of outright guessing. This constituted the free-recall portion of the first recall trial (R1). When the subject stopped drawing and labeling, there was more prodding from the experimenter to ensure that he/she had, in fact, drawn and labeled everything he/she remembered having seen. When the subject indicated that he/she could not remember any more, the experimenter substituted a green pen for the subject's black pen, and instructed him/her to fill in the remaining boxes on the recall sheet with best guesses of the remaining stimulus items. This constituted the forced-recall portion of the first recall trial, hereafter designated R*1. If, during the process of guessing, the subject remembered more items of the original stimulus, he/she was instructed to fill in those items with the black pen.

The interpolated task to be described next followed each recall trial. After each recall trial, the main lights in the room were switched off, the illumination being provided by the 25 watt bulb. The subject was seated on a comfortable chair, instructed to relax, and asked to think about the stimulus for a

few minutes. He/she was instructed to look at the portion of the screen where the stimulus had been projected, to concentrate on the stimulus, and to try to visualize it. The subject was told that every once in a while, he/she would be asked to say aloud the names of things that came to his/her mind while he/she was thinking about the stimulus, without censorship. During this interpolated thinking/concentration interval, the experimenter interrupted the subject's silent thinking three times, and each time he asked the subject to say aloud whatever things or objects came into his/her mind. After garnering 12 such names of objects each time, the experimenter instructed the subject to continue thinking silently about the stimulus that had been flashed on the screen. Each interpolated task thus consisted of three "think" intervals of 90 sec duration and three "free-association" periods lasting approximately 60 sec each, during which the experimenter recorded the 12 words called out by the subject. The duration of each interpolated interval was, thus, approximately seven and one-half minutes.

At the end of the third free-association sequence, the experimenter switched on the main room lights and handed out to the subject a recall sheet and a black pen, in preparation for the second recall attempt (R2).

The second and third recall trials were conducted in the same manner as the first recall. The interpolated task between the second and third recalls was identical to that between the first and second recalls. After the third recall trial was completed by the subject, another Think/FA series followed, with the exception that, after the last 90 sec "think" interval, the subject was not asked to produce any more free-associations. At this point, the subject was thanked for his/her participation in the experiment and was dismissed. The whole session lasted approximately one hour. Control (yoked) subjects were treated, in all respects but one, identically to the experimental subjects. Since they were not exposed to the stimulus, but to a 5 msec sham flash, their recall instructions were modified. Their task was to reproduce, as faithfully as possible on their first recall sheet, the R1 (black pen) recall protocol of one of the experimental subjects. After that, their instructions were slightly modified to take into account their not having been presented with the stimulus originally. A reproduction of the stimulus is to be found in Appendix 1A. Verbatim instructions to experimental and control subjects are to be found in Appendix 1B.

Results and Discussion

Scoring of Drawings

The recall protocols of all experimental and yoked-control subjects were randomly mixed, with the name, recall trial, and group identification removed and substituted by a code. Two methods for scoring recall were employed, both designed to yield measures of "hits," i.e. correspondences between drawn items and the 12 stimulus items. Structural scoring was based on the physical or structural correspondence or similarity between drawn items and stimulus items, regardless of the conceptual relation between them or the labels attached to the drawn items by the subjects. Semantic scoring, on the other hand, disregarded physical similarities between drawn items and stimulus items, and concentrated exclusively on the extent to which the drawn items approached semantically, conceptually, or associatively, the stimulus items. Both scoring procedures allowed for partial credit for "partial hits:" imperfect, but nonetheless noticeable, correspondences between recalled and stimulus items. Both scoring approaches, therefore, necessarily involved subjective judgments about structural and semantic correspondences.

A detailed manual for scoring drawn recalls is provided in Appendix 1C. This manual is similar to the

one employed by Erdelyi (1968). It includes specific examples of both structural and semantic scoring drawn from actual recall protocols of subjects in the experiment. Since the experimenter, and not an outside judge, scored all the recall protocols, a check was needed to determine whether the experimenter carried out the scoring procedures reliably. Twelve protocols, 6 belonging to experimental and 6 belonging to yoked-control subjects, were randomly chosen from the 108 protocols (36 subjects x 3 recall trials each = 108 recall protocols), and scored independently by the experimenter and an experienced (but blind) judge, Dr. Matthew H. Erdelyi. Inter-judge reliability was high. Product-moment correlations for both structural and semantic scoring varied from 0.89 to 0.97, with the average being 0.95. All statistical data analyses reported in this section were based on the recall scores assigned by the experimenter. Individual recall and free-association data for all subjects are to be found in Appendices 1D (Tables 1D.1 through 1D.6) and 1E (Tables 1E.1, 1E.2).

Tables 1.1, 1.2, and 1.3 present the results for the 500 msec, 50 msec, and 5 msec conditions, respectively.

Table 1.1

Free- and Forced-Recall Over Three Trials for
Experimental and Control Groups for the 500 msec
Exposure

<u>Recall Trial</u>		<u>Recall Type</u>		
Trial 1		R1 (Bk)	(Gn)	R*1 (Tot)
<u>Group</u>	Free-Recall		Guessing	Forced-Recall
E500	Structural	1.24	1.61	2.86
	Semantic	2.00	1.47	3.47
	Combined	<u>3.24</u>	<u>3.08</u>	<u>6.32</u>
C500	Structural	1.06	1.48	2.54
	Semantic	1.82	1.36	3.18
	Combined	<u>2.88</u>	<u>2.84</u>	<u>5.72</u>

Trial 2		R2 (Bk)	(Gn)	R*2 (Tot)
<u>Group</u>	Free-Recall		Guessing	Forced-Recall
E500	Structural	1.07	1.23	2.30
	Semantic	2.13	0.86	2.99
	Combined	<u>3.20</u>	<u>2.09</u>	<u>5.29</u>
C500	Structural	1.18	0.88	2.06
	Semantic	2.02	0.72	2.74
	Combined	<u>3.20</u>	<u>1.60</u>	<u>4.80</u>

Trial 3		R3 (Bk)	(Gn)	R*3 (Tot)
<u>Group</u>	Free-Recall		Guessing	Forced-Recall
E500	Structural	1.50	0.83	2.33
	Semantic	2.29	0.69	2.97
	Combined	<u>3.79</u>	<u>1.52</u>	<u>5.31</u>
C500	Structural	1.34	1.20	2.54
	Semantic	2.02	1.12	3.14
	Combined	<u>3.36</u>	<u>2.32</u>	<u>5.68</u>

Note: E = Experimental; C = Control; Bk = Black; Gn = Green

Table 1.2

Free- and Forced-Recall Over Three Trials for
Experimental and Control Groups for the 50 msec
Exposure

<u>Recall Trial</u>		<u>Recall Type</u>		
Trial 1		R1 (Bk)	(Gn)	R*1 (Tot)
<u>Group</u>	<u>Free-Recall</u>		<u>Guessing</u>	<u>Forced-Recall</u>
E50	Structural	1.17	1.09	2.26
	Semantic	1.80	0.99	2.79
	Combined	<u>2.97</u>	<u>2.08</u>	<u>5.05</u>
C50	Structural	0.80	1.22	2.02
	Semantic	2.36	1.08	3.44
	Combined	<u>3.16</u>	<u>2.30</u>	<u>5.46</u>

Trial 2		R2 (Bk)	(Gn)	R*2 (Tot)
<u>Group</u>	<u>Free-Recall</u>		<u>Guessing</u>	<u>Forced-Recall</u>
E50	Structural	1.41	1.13	2.54
	Semantic	2.01	0.63	2.64
	Combined	<u>3.42</u>	<u>1.76</u>	<u>5.18</u>
C50	Structural	1.14	0.86	2.00
	Semantic	2.60	1.22	3.82
	Combined	<u>3.74</u>	<u>2.08</u>	<u>5.82</u>

Trial 3		R3 (Bk)	(Gn)	R*3 (Tot)
<u>Group</u>	<u>Free-Recall</u>		<u>Guessing</u>	<u>Forced-Recall</u>
E50	Structural	1.07	1.16	2.23
	Semantic	1.94	0.84	2.78
	Combined	<u>3.01</u>	<u>2.00</u>	<u>5.01</u>
C50	Structural	0.92	1.18	2.10
	Semantic	2.00	1.82	3.82
	Combined	<u>2.92</u>	<u>3.00</u>	<u>5.92</u>

Note: E = Experimental; C = Control; Bk = Black; Gn = Green

Table 1.3

Free- and Forced-Recall Over Three Trials for
Experimental and Control Groups for the 5 msec
Exposure

<u>Recall Trial</u>		<u>Recall Type</u>		
Trial 1		R1 (Bk)	(Gn)	R*1 (Tot)
<u>Group</u>	Free-Recall		Guessing	Forced-Recall
E5	Structural	0.31	1.87	2.19
	Semantic	0.36	1.84	2.20
	Combined	<u>0.67</u>	<u>3.71</u>	<u>4.38</u>
C5	Structural	0.44	1.10	1.54
	Semantic	0.52	0.78	1.30
	Combined	<u>0.96</u>	<u>1.88</u>	<u>2.84</u>

Trial 2		R2 (Bk)	(Gn)	R*2 (Tot)
<u>Group</u>	Free-Recall		Guessing	Forced-Recall
E5	Structural	0.57	1.40	1.97
	Semantic	0.77	1.17	0.94
	Combined	<u>1.34</u>	<u>2.57</u>	<u>3.91</u>
C5	Structural	0.26	1.20	1.46
	Semantic	0.30	1.18	1.48
	Combined	<u>0.56</u>	<u>2.38</u>	<u>2.94</u>

Trial 3		R3 (Bk)	(Gn)	R*3 (Tot)
<u>Group</u>	Free-Recall		Guessing	Forced-Recall
E5	Structural	0.60	1.40	2.00
	Semantic	0.67	1.20	1.87
	Combined	<u>1.27</u>	<u>2.60</u>	<u>3.87</u>
C5	Structural	0.24	1.16	1.40
	Semantic	0.10	1.50	1.60
	Combined	<u>0.34</u>	<u>2.66</u>	<u>3.00</u>

Note: E = Experimental; C = Control; Bk = Black; Gn = Green

The Tables provide average structural, semantic, and combined free-recall (black pen), guessed recall (green pen), and total correct recall, i.e.

forced-recall (black + green) for the experimental and yoked-control subjects over the three recall trials.

Since the structural and semantic scores led essentially to similar patterns, the focus here will be on the combined scores (i.e. structural + semantic = combined). Inspection of the three Tables suggests that free-recall, as in the Haber and Erdelyi (1967) study, does tend to increase with recall trials. A 3 x 6 (Trial x Group) analysis of variance (Table 1F.1) performed on the combined (structural + semantic) free-recall scores of all subjects revealed, however, that this trend was not significant.

Table 1F.1

Summary of Analysis of Variance of the Combined
(Structural + Semantic) Free-Recall Scores Over Three
Trials (R1, R2, R3) for the Experimental and Control
Groups

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>

Groups	5	27.030	3.59*
Error (Between)	30	7.530	
Trials	2	0.715	1.07
Interaction			
(Trials x Groups)	10	0.639	0.95
Error (Within)	60	0.670	

* $p < .05$

Although the numerical trend for the experimental groups was in the right direction (3.24 to 3.79; 2.97 to 3.01; and 0.67 to 1.27 from R1 to R3 for the 500 msec, 50 msec, and 5 msec experimental groups, respectively), there was no significant difference among the three free-recall trials ($F(2,60) = 1.07$, $p > .05$). The trend of interest for R1, R2, R3 (the weights were -1, 0, +1, respectively), was not significant ($F(1,60) = 2.45$, $p > .05$ for the experimental groups, and $F(1,60) = 0.22$, $p > .05$ for the control groups). The only significant effect was that of Exposure Condition ($F(5,30) = 3.59$, $p < .05$), suggesting that the performance of the 500 msec and 50 msec experimental and control groups was superior to that of the 5 msec experimental and control subjects. The contrast analysis substantiated this inference. With contrast weights of -1, -1, and +2 for the 500 msec, 50 msec, and 5 msec groups, respectively, the contrast analysis yielded an $F(1,60) = 65.78$, $p < .01$. No Group x Trial interaction was detected ($F(10,60) = 0.95$, $p > .05$).

It should be borne in mind that the interpolated activity between the first and the last recall effort was different in the present experiment than in the earlier Erdelyi studies. Whereas in Haber and Erdelyi (1967) and Erdelyi (1970), subjects free-associated for

about 30 minutes, here the subjects thought and free-associated for shorter durations (about 7 1/2 minutes) and also attempted an intermediate recall.

The data also show, not surprisingly, that forced-recall, in general, tends to be higher than free-recall (cf. Roediger and Payne, 1987; Erdelyi et al., 1989). Consequently, it is also not surprising that, in line with Erdelyi (1970), the last forced-recall, here R*3, produced significantly greater hits than the initial free-recall, R1. A 2 x 6 (Trial x Group) analysis of variance (Table 1F.2) yielded significant effects for both Groups ($F(5,30) = 3.08, p < .05$) and Trials ($F(1,30) = 78.76, p < .01$).

Table 1F.2

Summary of Analysis of Variance of the Combined
(Structural + Semantic) Scores Over Two Trials:
R1 (Initial Free-Recall) and R*3 (Final Forced-Recall),
for the Experimental and Control Groups

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>

Groups	5	14.54	3.08*
Error (Between)	30	4.72	
Trials	1	110.26	78.76**
Interaction			
(Trials x Groups)	5	0.81	0.58
Error (Within)	30	1.40	

* $p < .05$

** $p < .01$

A contrast analysis comparing the performance of the 500 msec and 50 msec experimental and control groups versus that of the 5 msec experimental and control groups on R1 (free-recall) and R*3 (final forced-recall) yielded $F(1,24) = 25.15$, $p < .01$, indicating that the 500 msec and 50 msec experimental and control subjects garnered significantly more hits on R1 and R*3 than the 5 msec experimental and control groups. The interaction (Groups x Trials) was not significant ($F(5,30) = 0.58$, $p > .05$).

The present data, however, differ from Erdelyi's in that the experimental subjects' forced-recall performance was not superior to that of the yoked-control subjects' (Table 1F.3).

Table 1F.3

Summary of Analysis of Variance of the Combined
(Structural + Semantic) Forced-Recall Scores Over
Three Trials (R*1, R*2, R*3) for the Experimental
and Control Groups

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>

Groups	5	18.910	2.096
Error (Between)	30	9.020	
Trials	2	1.025	0.900
Interaction			
(Trials x Groups)	10	1.206	1.060
Error (Within)	60	1.135	

This suggests that in the present case the extra hits resulted from chance performance and not from a laxer B. In other words, the increase in hits obtained by the experimental subjects did not seem to be above chance or guessing levels, suggesting that experimental subjects did not possess extra information about the stimulus relative to yoked-control subjects.

The central question posed by Experiment 1 was whether bona fide hypermnesic effects could be demonstrated with the forced-recall technique; that is, with productivity held constant, would there be a tendency for forced-recall to increase over trials (i.e. from R*1 to R*2 to R*3)? Inspection of Tables 1.1 through 1.3 shows clearly that no hypermnesia was obtained in any of the exposure conditions. A 3 x 6 (Trial x Group) analysis of variance (see Table 1F.3) performed on the combined (structural + semantic) forced-recall scores of all groups revealed no significant effects for Groups ($F(5,30) = 2.09, p > .05$) or Trials ($F(2,60) = 0.90, p > .05$). No Group x Trial interaction was detected ($F(10,60) = 1.06, p > .05$).

Finally, Table 1.4 presents the average number of free-association "hits" elicited after each forced-recall trial for the experimental and control groups. The free-associations were scored only semantically, since no drawings were required from the subjects.

Table 1.4

Average Correct Free-Associations After Three Trials
for Experimental and Control Groups

<u>Group</u>	<u>FA Trial</u>		
	FA1	FA2	FA3
E500	<u>8.50</u>	<u>7.86</u>	<u>7.08</u>
C500	6.60	5.88	6.08

E50	<u>5.59</u>	<u>6.71</u>	<u>7.38</u>
C50	8.52	9.68	10.08

E5	<u>5.13</u>	<u>6.14</u>	<u>5.58</u>
C5	4.24	4.74	4.78

Note: E = Experimental; C = Control

Inspection of this Table reveals a tendency for the free-association hits to increase after trials in the 50 msec and 5 msec groups, but not in the 500 msec experimental and control groups. This tendency, however (Table 1F.4), proved not to be statistically significant ($F(5,30) = 1.81$, $p > .05$ and $F(2,60) = 1.07$, $p > .05$ for the Group and Trial factors, respectively). No Group x Trial interaction was detected ($F(10,60) = 0.90$, $p > .05$).

Table 1F.4

Summary of Analysis of Variance of the Free-Association Scores After Three Trials (R*1, R*2, R*3) for the Experimental and Control Groups

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>
Groups	5	49.75	1.81
Error (Between)	30	27.48	
Trials	2	2.17	1.07
Interaction			
(Trials x Groups)	10	1.82	0.90
Error (Within)	60	2.02	

In summary, the major finding in this study is that no net increase in memory for the stimulus was obtained over successive trials with response productivity controlled. Thus, "true" hypermnesic effects for briefly flashed stimuli do not seem to obtain under the conditions of this experiment: with a complex 3 x 4 pictorial stimulus slide flashed for short durations and a 7 1/2 minutes think/free-association task interpolated between three forced-recall trials.

It is a well-established fact, however, that hypermnesia can be obtained with sequentially presented pictorial stimuli at exposure durations of 5 sec (Erdelyi and Becker, 1974; Erdelyi and Kleinbard, 1978). Even shorter exposure durations (1 sec) have yielded hypermnesia (Erdelyi et al., 1976). Thus, the question arises whether true hypermnesic effects (forced-recall increments) might be obtained with the exposure durations used in Experiment 1, if the stimuli were presented sequentially rather than in a single flash. Experiment 2 probed this question.

Experiment 2
Hypermnesia for Serially Presented
Stimuli of Long and Very Short Durations

Hypermnesia, the net increase in recall levels over successive recall trials (or over increasing retention intervals), is a well-established phenomenon (Erdelyi, 1984; Erdelyi and Kleinbard, 1978; Erdelyi et al., 1976; Erdelyi and Becker, 1974; Payne, 1987; Payne and Roediger, 1987). Erdelyi and associates have repeatedly demonstrated this phenomenon with the sequential presentation of a large number of stimuli and multiple forced-recall trials. The typical Erdelyi experiment consists of the presentation of 60-80 stimuli (pictures or words, or pictures and words) at the rate of 5 seconds each (although shorter presentation durations, e.g., 1 second, have been used successfully; see Erdelyi et al., 1976). After the presentation of the stimuli and some instructions to eliminate recency effects, an immediate forced-recall trial (R*1) is administered to the subjects, usually lasting 7 minutes. This forced-recall trial consists of a fairly large pre-determined number of responses, both to exhaust the subjects' immediate memory of the stimuli, and to ensure that there is room for possible further memory increments in later recall tests. Two

more forced-recall trials (R^*2 , R^*3) are usually given, separated by an interpolated task (usually silent thinking) of about 7 minutes duration. The typical finding is a net increase in memory ($R^*3 > R^*1$) of about 5 items for pictorial stimuli over the three recall trials, with recall of words trending upwards, but not usually significantly. If the subjects are instructed to encode the word items as pictures during stimulus presentation, however, then significant hypermnesia for the word items also occurs, apparently at a level comparable to that for the picture items (Erdelyi et al., 1976). Payne (1987), in a recent review of hypermnesia experiments, has documented that hypermnesia for pictorial materials occurs in over 95% of the studies reviewed, whereas hypermnesia for words is less stable (it was found in less than 50% of the studies). It has also been demonstrated that semantic elaboration of word stimuli results in hypermnesic effects (Belmore, 1981; Payne & Roediger, 1987).

In the present study, several major departures from Experiment 1 were undertaken. The major change was the switch from a single complex stimulus to a list of simple items, of the type that reliably have produced hypermnesia in the past. The object of the study was to determine whether the effective stimulus materials would yield hypermnesia when the items were

presented in the subliminal range of exposure. A set of 80 stimuli (half pictures, half words) were used in Experiment 2. These stimuli consisted of a modified version of the 60 Erdelyi and Becker (1974) stimuli plus 20 more pictures drawn by Erdelyi in 1987. This updated stimulus set will be designated as the Erdelyi (1987) Stimuli. (The 80 drawings are depicted in Appendix 2A.)

Five different stimulus exposure conditions were used: 5 sec, 2 sec, 1 sec, 50 msec, and 5 msec. The 5 sec, 2 sec, and 1 sec exposure durations were chosen with the hope of replicating previous studies which produced hypermnesia for pictures in our laboratory within this range of exposures (Erdelyi, 1974; Erdelyi and Kleinbard, 1978; Erdelyi et al., 1976). No hypermnesia data exist for the very brief 50 msec and 5 msec exposures, and these were the conditions of primary interest.

The activity interpolated between recall trials was also modified. The number of free-associations was reduced from 12 to 3, thus increasing the time available to the subjects to concentrate and think about the original stimuli during the interpolated task.

In the present study no yoked-control group was used. Instead, a "0 stimulus exposure" (5 msec sham

flash) condition was employed. A critical motivation behind the utilization of the 0-Exposure Control was to assess the "subliminality" of the 50 msec and 5 msec groups for, in our approach, "absolute subliminality" is defined as chance/base-rate performance level (Erdelyi, 1986). Therefore, we wished to see whether the R*1 performance of the 50 msec and 5 msec groups (subliminality is evaluated at Test 1--R*1 not immediately) satisfied this strict criterion of subliminality. The 0-Exposure Control condition, by providing chance base-rates, would determine the extent to which these two groups approached "absolute subliminality." Also, we wished to see the course of forced-recall over three trials when no stimulus information was available.

Finally, to increase the power of the experiment, 18 subjects were tested in each group, as opposed to the 7 per experimental and 5 per control groups in Experiment 1.

In other respects, the design of the present study was similar to that of Experiment 1: an initial stimulus presentation, in this case consisting of the sequential presentation of 80 slides at the prescribed stimulus exposure duration, followed by an initial forced-recall (R*1) test and, subsequently, by two more forced-recall trials separated by thinking/free-

associating interpolated intervals. Note: the recall trials in the present study also consisted of a free-recall component, as in the previous study (see Method); however, since only the forced-recall data was subsequently analyzed (i.e. the free-recalls + guesses), the notation R1, R2, R3, for the three forced-recall trials will hereafter replace that of R*1, R*2, R*3 in Experiment 1.

The following diagram illustrates the basic design of the experiment:

<u>Stimulus</u>	<u>(R1)</u>	<u>Interval</u>	<u>(R2)</u>	<u>Interval</u>	<u>(R3)</u>
		<u>(Think/FA)</u>		<u>(Think/FA)</u>	

Although, based on previous results in our laboratory, hypermnesia, at least for pictures, was expected to occur with the 5 sec, 2 sec, and 1 sec exposure durations, the major question of this study was whether hypermnesia for very brief stimulus exposures would be obtained with the sequential presentation of those stimuli.

Method

Subjects

One-hundred-and-eight Brooklyn College undergraduate students served as subjects. They were randomly assigned to one of six stimulus exposure

duration groups: 5 sec, 2 sec, 1 sec, 50 msec, 5 msec, and 0 msec (0-Exposure Control). All subjects were volunteers from the introductory Psychology course at Brooklyn College.

Materials and Apparatus

The stimulus pool consisted of 160 35 mm black-and-white slides, 80 of them consisting of pictures (drawings) of simple objects encountered in everyday life (e.g. candle, airplane), the other 80 consisting of words, the labels or names of each of the objects (e.g. "CANDLE", "AIRPLANE"). To provide for counterbalancing of the pictures and words, two different sets were constructed from the original stimulus pool. Forty drawings were randomly selected from the set of 80 pictures. These 40 became the pictures to be shown in set A. The words in set A were the labels of the pictures not present in set A. The remaining half of the stimulus pool became set B. Thus, each set consisted of 40 pictures and 40 words. Half of the subjects in each stimulus-duration condition were shown set A, the other half, set B, with the exception of the 0-Exposure Control group, to be mentioned later. Appendix 2B (Tables 2B.1 through 2B.3) shows the composition of both sets A and B and their order of presentation to subjects. The stimuli of both sets were randomly arranged on two Kodak

carousel trays, and projected on a standard screen via a Kodak two-channel projection tachistoscope. The recall sheets for all subjects consisted of standard 8 1/2 x 11 in. sheets with lines numbered 1 to 60. The booklets for the interpolated tasks were standard 16-page examination booklets.

Procedure

The 80 stimuli (either set A or set B) were successively flashed on a screen approximately seven feet away from the subjects for durations of either 5 sec, 2 sec, 1 sec, 50 msec, or 5 msec, depending on the condition of the subjects. The 0-Exposure Control subjects were shown 5 msec flashes of eighty blank slides.

The interval between the start of exposure of two successive slides was 5 seconds for all subjects. Thus, regardless of which exposure duration group the subject belonged to, total time for presentation of the stimuli was equal. The stimuli were presented via the Kodak two-channel projection tachistoscope described in Experiment 1 (p. 12). The shutter of the top projector was 1/3 closed, to further degrade the stimuli, especially at short exposure durations. The shutter of the bottom (background) projector was set at maximum illumination. The screen was constantly illuminated by the bottom projector's exposure of a blank slide,

except during actual projection of the stimuli on the screen. The size of the rectangle projected on the screen by both projectors was 27 x 18 inches, subtending a horizontal visual angle of 17.75 degrees. The average luminance of the slides with the drawings was 252 nits, that of the word slides, 144 nits. The illumination in the experimental room during stimulus presentation was 0.1 foot/candles. Subjects were tested in batches varying from one to three individuals.

Subjects were escorted to the experimental room and seated on standard classroom chairs. The illumination in the room was provided by a 25 watt bulb. After an initial adaptation period of approximately two minutes, they were informed that 80 slides, half of them consisting of pictures, and half of them of words, would be projected on the screen one after another. Subjects were asked to look at the center of the illuminated rectangle on the screen, since the stimuli would be flashed on that location. Subjects in the 5 msec and 0-Exposure Control groups were informed that the flashes would be extremely short. Control subjects were led to believe that the blank slides actually consisted of pictures or words. After subjects indicated that they were ready and looking at the center of the illuminated rectangle on

the screen, the experimenter began the projection of the sequence of 80 slides on the screen at the prescribed stimulus exposure duration. Projection of the stimuli on the screen took approximately seven minutes ($80 \text{ stimuli} \times 5 \text{ sec} = 400 \text{sec}$).

After the stimuli were projected on the screen, both projectors were shut off and the main room lights were turned on. The experimenter handed out a recall sheet numbered 1 to 60 to the subjects. (Pilot studies have shown that subjects recall substantially fewer than 60 items, so no attempt was made to elicit 80 responses). Subjects were instructed to write, starting on the line numbered "1", the names or labels of the stimuli they remembered having seen on the screen. Subjects were encouraged to think hard and to put down everything they could remember having seen. After doing that, and when they thought they could not remember any more of the stimuli, subjects were instructed to draw a line under the last item recalled, and then to guess what the remaining items might have been, all the way to the line numbered "60". In other words, subjects had to fill in all the blanks on the recall sheet. If, during guessing, subjects thought that they remembered some items, they were instructed to put an asterisk or a star next to those items, to indicate that they were not guesses, but actual

memories to them. The items written on top of the line, plus the asterisked items, constituted the free-recall portion of the recall trial. Items below the line, without an asterisk next to them, constituted the forced-recall portion of the recall trial. Subjects in the control group, who typically reported not having been able to see any of the items, were instructed, if they could not remember any of the items, to draw a line on top of the line numbered "1", and then to proceed to guess all the way to the line numbered "60"; in other words, to produce sixty guesses. They were additionally instructed to produce "good" guesses; that is, to guess things which, in principle, are "drawable." In pilot studies in our laboratory we found that some subjects produced inappropriate "guesses" if left to their own devices (e.g. "virtue", "justice"), so that it was important to stir the subjects toward possible items in the stimulus set. The reason, then, for this additional instruction was that it was deemed preferable to have a "good" control group, to thus be able to obtain a reasonable guessing baseline for the types of stimuli shown in our laboratory. Control subjects were also instructed to put an asterisk or a star in front of any items listed under the drawn line that they thought they actually remembered having seen. Verbatim recall instructions

to subjects in all groups are included in Appendix 2C. All subjects were allowed seven minutes to perform the recall task, although in some cases a minute or two of "grace" were added to the seven minutes to provide subjects with sufficient time to fill in all sixty blanks.

At the end of the first recall attempt (R1), the experimenter collected the recall sheets, turned off the main room lights (the illumination in the room being provided by the 25 watt bulb), and handed out to subjects a standard examination booklet. (Technically, the first forced-recall should be designated, in concordance with the nomenclature initiated in Experiment 1, R*1; however, since only the combined R1 + R*1 data were to be analyzed, R1 will be used to designate the first forced-recall test. Similarly, R2 and R3 will designate the second and third forced-recall tests). Subjects were instructed to relax, to look at the screen, and to mentally review the stimuli that they thought they had seen; that is, to pretend that the stimuli were being shown again. They were also instructed that at regular intervals, the experimenter would ask them to write in the booklet the names of the first three objects that came to their minds, and then to turn the page over and to continue to review the stimuli mentally. Subjects performed

this task three times, after which they were asked to close their booklets. This Think/FA interpolated task took approximately seven minutes, the instructions to write in the booklets being delivered every two minutes. Verbatim instructions for this Think/FA task are also included in Appendix 2C.

After this task was completed, the booklets were collected, and the main room lights were switched back on, whereupon subjects were handed out a second recall sheet. The instructions for the second and third recall attempts were basically the same as those for the first recall. The instructions for the second Think/FA interval, which followed the second recall attempt (R2), were the same as those for the first Think/FA interval. Thus, there were three recall attempts, separated by two Think/FA intervals. After the experimenter collected the third recall (R3) sheets, subjects were given their credit slips together with an envelope on which they were asked to write their name and address. Subjects were told that eventually they would receive feedback on their performance and information about the purpose of the experiment. After this task was completed, subjects were thanked for their participation and dismissed. The experimental session for subjects in all groups lasted approximately 50 to 55 minutes.

Results and Discussion

Recall Level

For the purpose of blind scoring, the recall protocols of all experimental and control subjects were randomly mixed, with the recall trial and group identification removed and substituted with a code. All the scoring was done by the experimenter. Since no difference in recall scores was found between subjects tested with set "A" and subjects tested with set "B" at any of the trials (at R1, $t(106) = 1.04$; at R2, $t(106) = 0.31$; at R3, $t(106) = 0.73$), nor for the experiment as a whole ($t(322) = 0.69$), the data were combined in all subsequent analyses.

Table 2.1 presents the average forced-recall results over three trials for the picture and word stimuli for all experimental groups. Only the combined (pictures + words) scores for the 0-Exposure Control subjects are presented, since these subjects were guessing the stimuli.

Table 2.1

Average Forced-Recall Over Three Trials
for the Experimental and Control Groups

<u>Trials</u>	R1	R2	R3
	P / W / TOT	P / W / TOT	P / W / TOT
<u>Group</u>			
5 sec			
	18.72/14.44/ <u>33.17</u>	19.83/15.22/ <u>35.05</u>	22.44/15.67/ <u>38.11</u>
			(P3 - P1 = 3.72)
			(W3 - W1 = 1.23)
2 sec			
	18.61/15.50/ <u>34.11</u>	18.94/15.11/ <u>34.05</u>	20.44/15.94/ <u>36.39</u>
			(P3 - P1 = 1.83)
			(W3 - W1 = 0.44)
1 sec			
	19.22/16.22/ <u>35.44</u>	19.39/17.67/ <u>37.06</u>	19.94/17.17/ <u>37.11</u>
			(P3 - P1 = 0.72)
			(W3 - W1 = 0.95)
50 msec			
	17.83/16.06/ <u>33.89</u>	19.11/16.89/ <u>36.00</u>	19.67/16.39/ <u>36.06</u>
			(P3 - P1 = 1.84)
			(W3 - W1 = 0.33)
5 msec			
	14.89/13.44/ <u>28.33</u>	15.56/12.72/ <u>28.28</u>	15.50/13.22/ <u>28.72</u>
			(P3 - P1 = 0.61)
			(W3 - W1 = -0.22)
0-Ctrl			
	<u>13.50</u>	<u>13.00</u>	<u>11.88</u>
			(R3 - R1 = -1.62)

A look at this Table reveals that total correct recall increases as a function of trials in all the stimulus exposure conditions, but not for the 0-Exposure Control group. Individual subjects' data for all groups are presented in Appendix 2D (Tables 2D.1 through 2D.6).

The combined (pictures + words), pictures, and words recall averages for all groups over the three trials are presented in Figures 2.1, 2.2, and 2.3, respectively. Again, only the combined scores are presented for the 0-Exposure Control subjects.

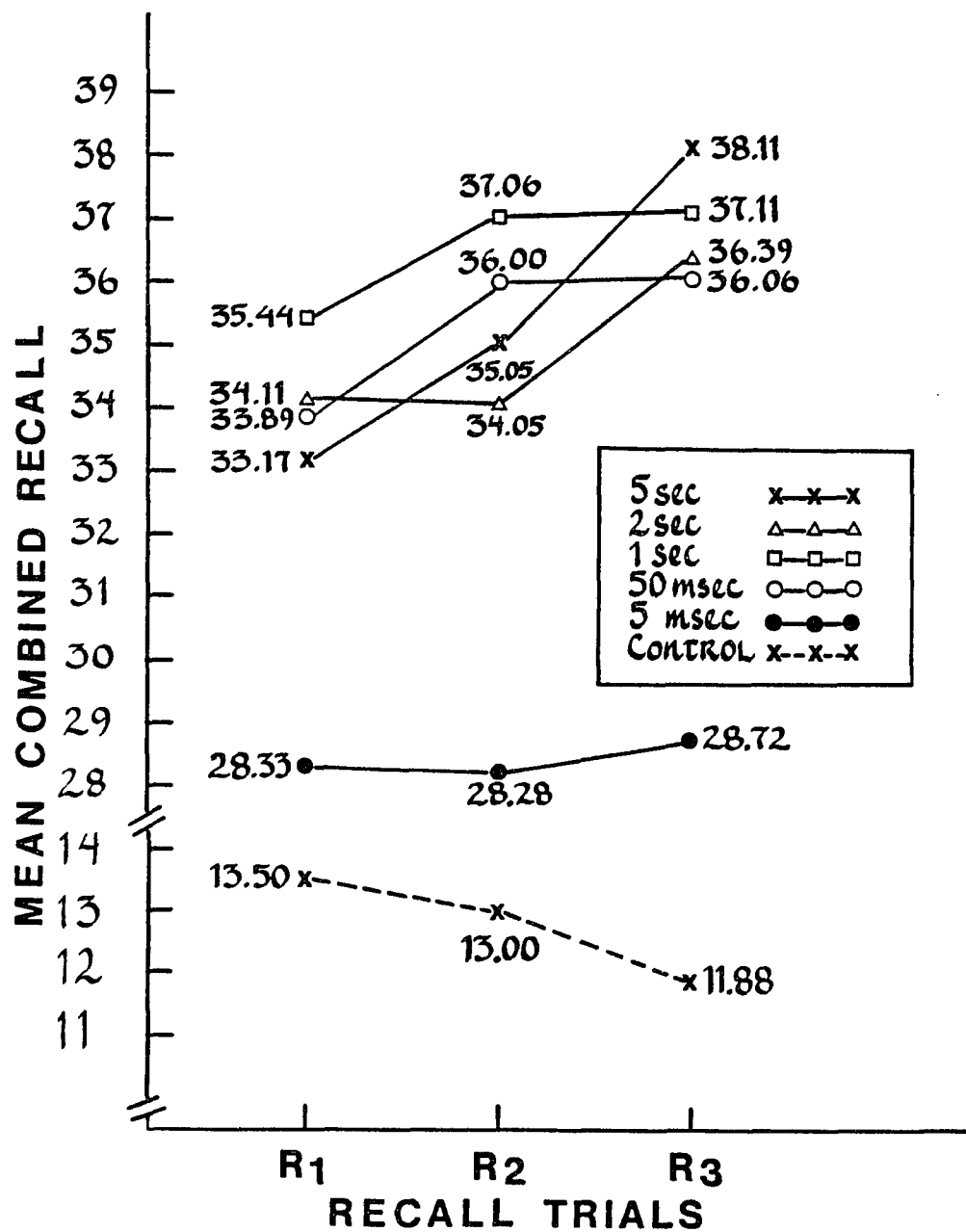


Figure 2.1. Combined (pictures + words) average recall over three trials for all groups in Experiment 2.

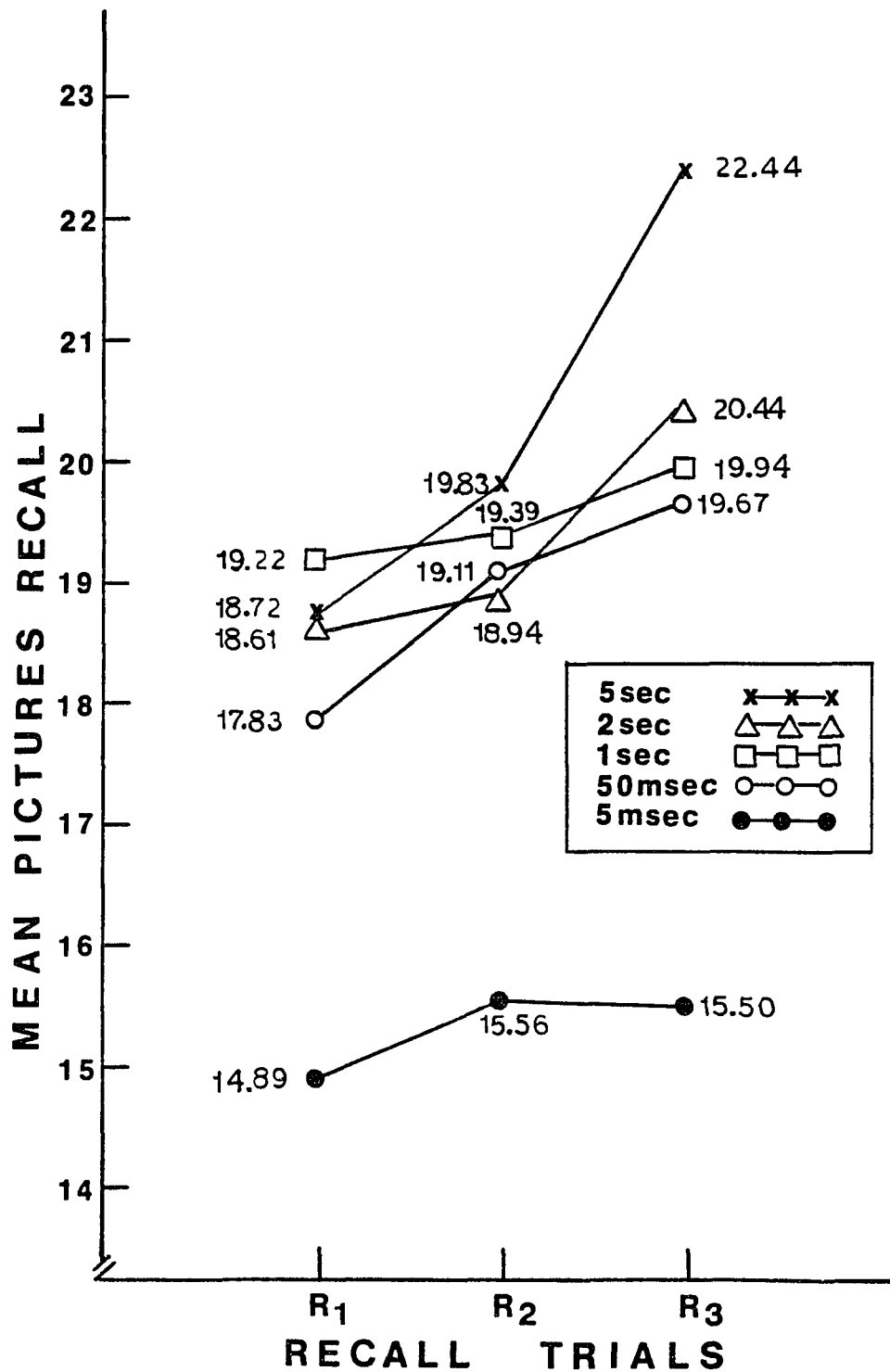


Figure 2.2. Average recall for pictures over three trials for the experimental groups in Experiment 2.

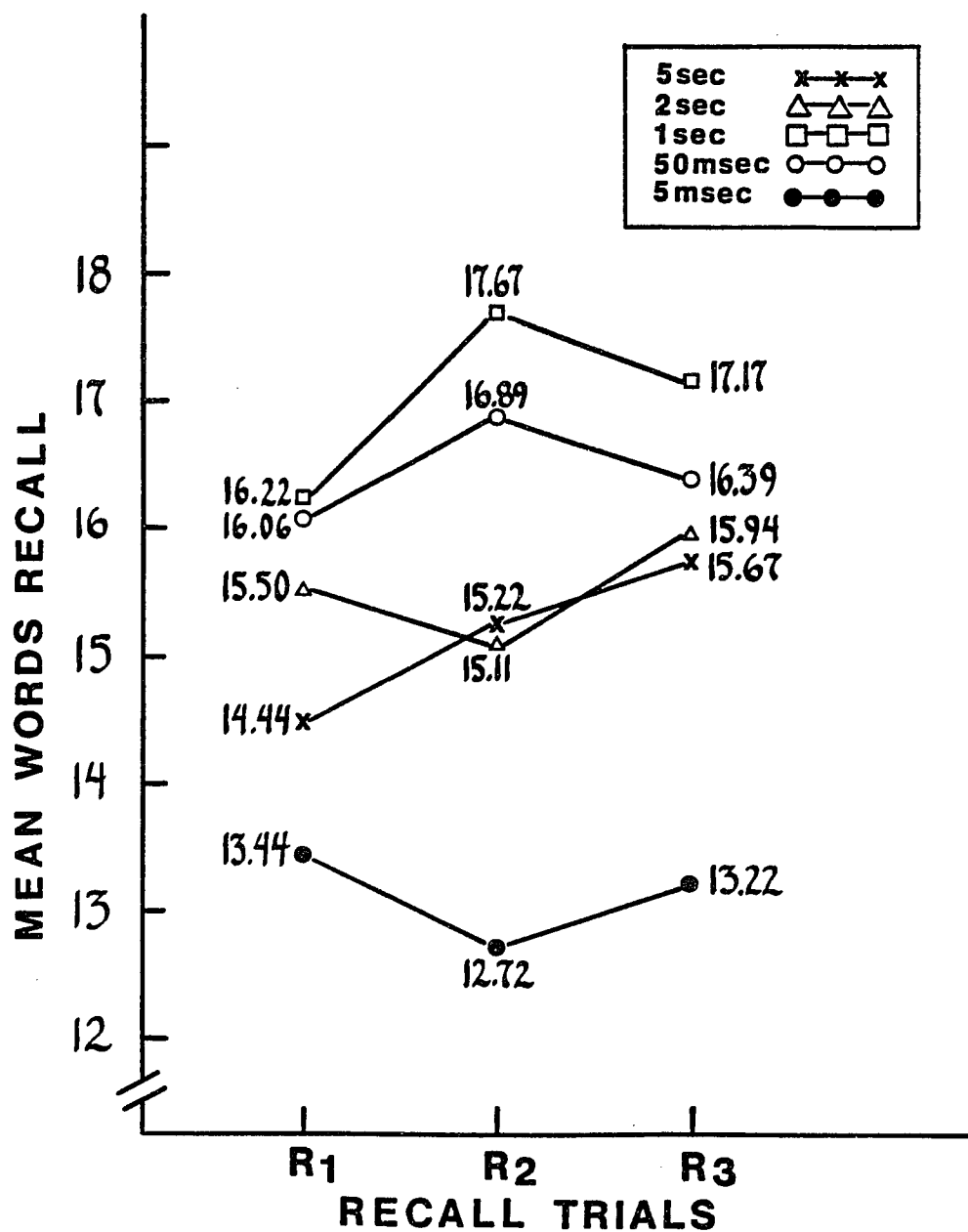


Figure 2.3 Average recall for words over three trials for the experimental groups in Experiment 2.

Visual inspection of Figures 2.2 and 2.3 suggests that the change scores from R1 to R3 for pictures are greater than those for the word stimuli, with recall for pictures being uniformly greater than recall for words.

A 5 (Groups) x 3 (Trials) x 2 (Stimulus) analysis of variance on the correct recall scores for the experimental groups (Table 2G.1) revealed that the three main effects were significant: For Groups, $F(4,85) = 3.16$, $p < .05$; For Trials, $F(2,170) = 18.54$, $p < .01$; and for Stimulus, $F(1,85) = 62.11$, $p < .01$.

Table 2G.1

Summary of Analysis of Variance of the
Correct Forced-Recall Scores Over Three
Trials for the Experimental Groups

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>
Groups	4	282.18	3.16*
Error (Groups)	85	89.40	
Within Subjects	450	(10.69)	
Trials	2	58.97	18.54**
Interaction (Groups x Trials)	8	8.72	2.74*
Error (Trials)	170	3.18	
Stimulus	1	1408.11	62.11**
Interaction (Groups x Stimulus)	4	44.43	1.96
Error (Stimulus)	85	22.67	
Interaction (Trials x Stimulus)	2	17.37	5.89**
Interaction (Groups x Trials x Stimulus)	8	4.37	1.48
Error (Trials x Stimulus)	170	2.95	

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

The main interest was to determine if hypermnesia had occurred and, if so, in which groups. The trend of interest for the three recall trials, R1, R2, and R3 (the weights were +1, 0, -1, respectively) revealed that the groups showing a significant increase in net recall over the three successive trials were the 5 sec, 2 sec, 1 sec, and 50 msec exposure groups ($F(1,170)=69.19$, $p<.01$; $F(1,170)=14.68$, $p<.01$; $F(1,170)=7.86$, $p<.01$; and $F(1,170)=13.29$, $p<.01$, respectively). The numerical trend for the 5 msec exposure group was not significant ($F(1,170)=0.13$, $p>.05$).

Although all of the experimental groups showed a significant increase in recall from R1 to R3 (or, at least, in the case of the 5 msec exposure duration, a trend in that direction), the 0-Exposure Control group showed a decrease in "recall" (correct guessing) from first to third trial ($t(17)=2.18$, $p<.05$). Since these subjects were basically guessing 60 items during each recall trial, it is surprising, and potentially important methodologically, to find that their guessing got significantly worse by their third recall attempt.

A glance at Figures 2.2 and 2.3 suggests that the upward numerical trend for words drops out with decreasing exposure durations (by the 50 msec condition), whereas the increasing trend for pictorial

items persists all the way to the 5 msec group. Further trend analyses revealed that the increase over trials of the picture items was significant only for the 5 sec exposure ($F(1,170) = 39.21, p < .01$), the 2 sec exposure ($F(1,170) = 9.51, p < .01$), and the 50 msec exposure ($F(1,170) = 9.51, p < .01$) conditions. The only significant increments across trials for the word items occurred in the 5 sec exposure group: $F(1,170) = 4.23, p < .05$.

In terms of recall level, the four longer exposure groups (5 sec, 2 sec, 1 sec, 50 msec) were not significantly different from each other. They differed, however, from both the 5 msec and the 0-Exposure Control groups. A 2 (Groups) x 3 (Trials) analysis of variance performed on the combined scores of the 5 msec and 0-Exposure Control subjects (Table 2G.2), showed the superior recall of the 5 msec group over control subjects ($F(1,34) = 51.21, p < .01$.)

Table 2G.2

Summary of Analysis of Variance of the
Correct Forced-Recall Scores Over Three
Trials for the 5 msec and 0-Exposure
Control Groups

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>

Groups	1	6611.34	51.21**
Error (Groups)	34	129.10	
Within Subjects	72	(6.09)	
Trials	2	3.37	0.56
Interaction (Groups x Trials)	2	9.93	1.64
Error (Within)	68	6.06	

**** p<.01**

Two of the interactions in the main analysis also proved significant. The Groups x Trials interaction, $F(8,170) = 2.74$, $p < .01$, was mainly due to the tendency of the 5 sec group to begin numerically lower (at R1) than the 2 sec, 1 sec, and 50 msec conditions (although the 5 sec group showed the largest increments in recall from R1 to R3). The Trials x Stimulus interaction, $F(2,170) = 5.89$, $p < .01$, demonstrated that the growth of picture recall was superior across trials to that for words, a standard finding in our laboratory.

One noteworthy aspect of the data was that the subjects in the 5 sec exposure group had lower initial recall scores than those in the 2 sec, 1 sec, and 50 msec groups (an exposure factor difference of 100 for this last group), and that they should, subsequently, show the greatest increase in recall by R3. Although this trend did not reach significance, it was further examined in Experiment 4.

Another noteworthy feature of the data was that the control group showed an amnesic tendency over successive recall trials. Beyond its intrinsic interest value, this raises the further question whether the amnesic control group should be the proper baseline against which to compare the performance of the 5 msec group. An interaction contrast (contrast-contrast) across the three trials was performed on the

differential recall change in the two groups (5 msec and control). The analysis reached significance ($F(1,170) = 5.66, p < .05$); the contrast weights were +1, 0, and -1 for the two groups at R1, R2, and R3, respectively. In Experiment 3 this trend was further examined.

Finally, the three-way interaction (Groups x Trials x Stimulus) was, perhaps mercifully, not significant: $F(8,170) = 1.48, p > .05$.

Cumulative Recall (cum Rn) and Reminiscence (cum Rn-R1)

Cumulative recall refers to the total number of stimulus items recalled throughout the recall trials, regardless of whether earlier recalled items are recalled again, or forgotten, on later trials. For example: assume that a subject initially recalled 23 of the items in the list on the first recall attempt and recalled 5 new items on the second recall attempt (items not recalled on R1). The cumulative recall score for this subject for R2 is 28 ($23 + 5 = 28$), regardless of whether any of the initially recalled items were preserved on R2. If this same subject recalls, during the third recall trial, 2 items that had not been recalled on either R1 or R2, the cumulative recall score for R3 increases to 30 ($28 + 2 = 30$).

Because forgetting of remembered items across

trials does not detract from the cumulative recall score, reminiscence functions are not equivalent to those of hypermnesia (net recall change), which take inter-trial forgetting into account. For example, let us assume that the above subject, who recalled 23 items on the first trial and then an additional 5 new items in the second trial, also forgot, in R2, 8 items he/she had included in R1. The cumulative recall score is still 28, since only correct new items are cumulated, regardless of losses. However, the hypermnesia score at R2 is -3, since net recall goes from $R1 = 23$ to $R2 = 20$ (i.e., $23 + 5 - 8$).

Formally, for n trials, $Hypermnesia = R_n - R_1$, that is, the extent to which subjects recall more items on R_n than on the initial recall trial, R_1 . On the other hand, $Reminiscence = \text{cumulative } R_n - R_1$. Reminiscence simply measures the number of new items recovered beyond the initial recall trial, R_1 . It should be apparent, therefore, that there cannot be hypermnesia without reminiscence, but that there can be reminiscence without hypermnesia. Cumulative recall almost always increases over successive recall trials (producing reminiscence), but this is by no means necessarily the case for net recall increments, since change in net recall almost always involves both loss (oblivescence) and gain (reminiscence) across trials

(see Ballard, 1913; Erdelyi, 1991).

Table 2.2 presents the average cumulative recall results over three trials for the picture and word stimuli for the experimental groups, and combined scores for the 0-Exposure Control group.

Table 2.2Average Cumulative Recall Over Three Trialsfor the Experimental and Control Groups

<u>Trials</u>	<u>R1</u>	<u>R2</u>	<u>R3</u>
	<u>P / W / TOT</u>	<u>P / W / TOT</u>	<u>P / W / TOT</u>
<u>Group</u>			
<u>5 sec</u>			
	<u>18.72/14.44/33.17</u>	<u>22.17/17.83/40.00</u>	<u>24.56/19.83/44.39</u>
			(cum P3 - P1 = 5.84)
			(cum W3 - W1 = 5.39)
<u>2 sec</u>			
	<u>18.61/15.50/34.11</u>	<u>21.56/18.22/39.78</u>	<u>23.78/20.61/44.39</u>
			(cum P3 - P1 = 5.17)
			(cum W3 - W1 = 5.11)
<u>1 sec</u>			
	<u>19.22/16.22/35.44</u>	<u>22.28/19.83/42.11</u>	<u>23.89/21.28/45.17</u>
			(cum P3 - P1 = 4.67)
			(cum W3 - W1 = 5.06)
<u>50 msec</u>			
	<u>17.83/16.06/33.89</u>	<u>22.39/19.56/41.94</u>	<u>24.50/21.28/45.78</u>
			(cum P3 - P1 = 6.67)
			(cum W3 - W1 = 5.22)
<u>5 msec</u>			
	<u>14.89/13.44/28.33</u>	<u>18.17/16.00/34.17</u>	<u>19.39/17.72/37.11</u>
			(cum P3 - P1 = 4.50)
			(cum W3 - W1 = 4.28)
<u>0-Ctrl</u>	<u>13.50</u>	<u>19.72</u>	<u>23.06</u>
			(cum R3 - R1 = 9.56)

Individual subjects' data for all exposure conditions are presented in Appendix 2F (Tables 2F.1 through 2F.6).

A look at Table 2.2 reveals that cumulative recall tends to increase about equally (an average of 10.25 items) for all groups, including the 0-Exposure Control group, with cumulative recall for pictures increasing at about the same rate as that for the word items (5.37 and 5.01, respectively). This can be better gleaned from Figures 2.4 through 2.6, which present the average combined (pictures + words), pictures, and words cumulative recall functions for the experimental groups. (The control subjects' functions are not presented in Figures 2.5 and 2.6, since it cannot be determined from their recall protocols whether these subjects were guessing pictures or words).

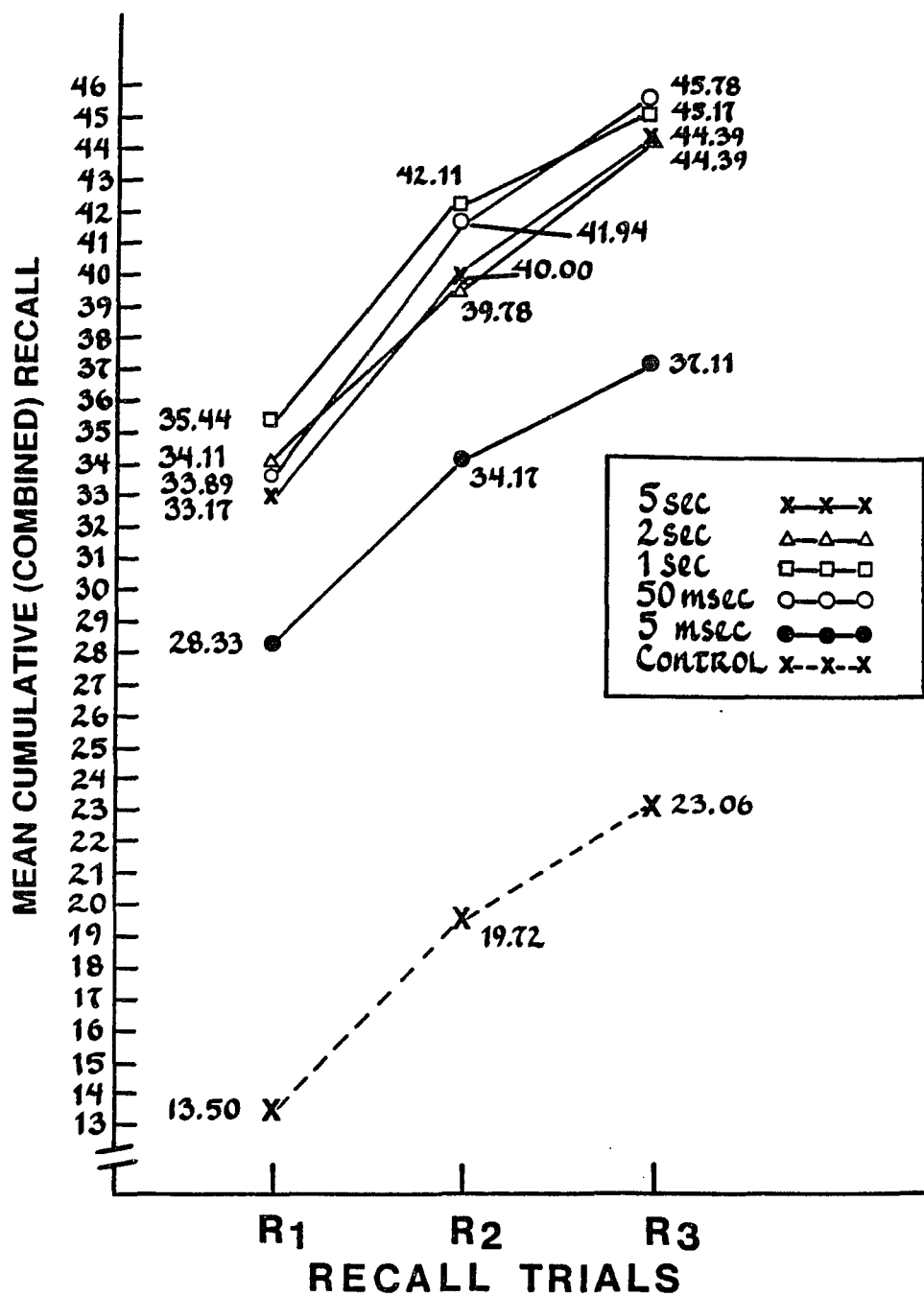


Figure 2.4. Combined (pictures + words) cumulative recall over three trials for all groups in Experiment 2.

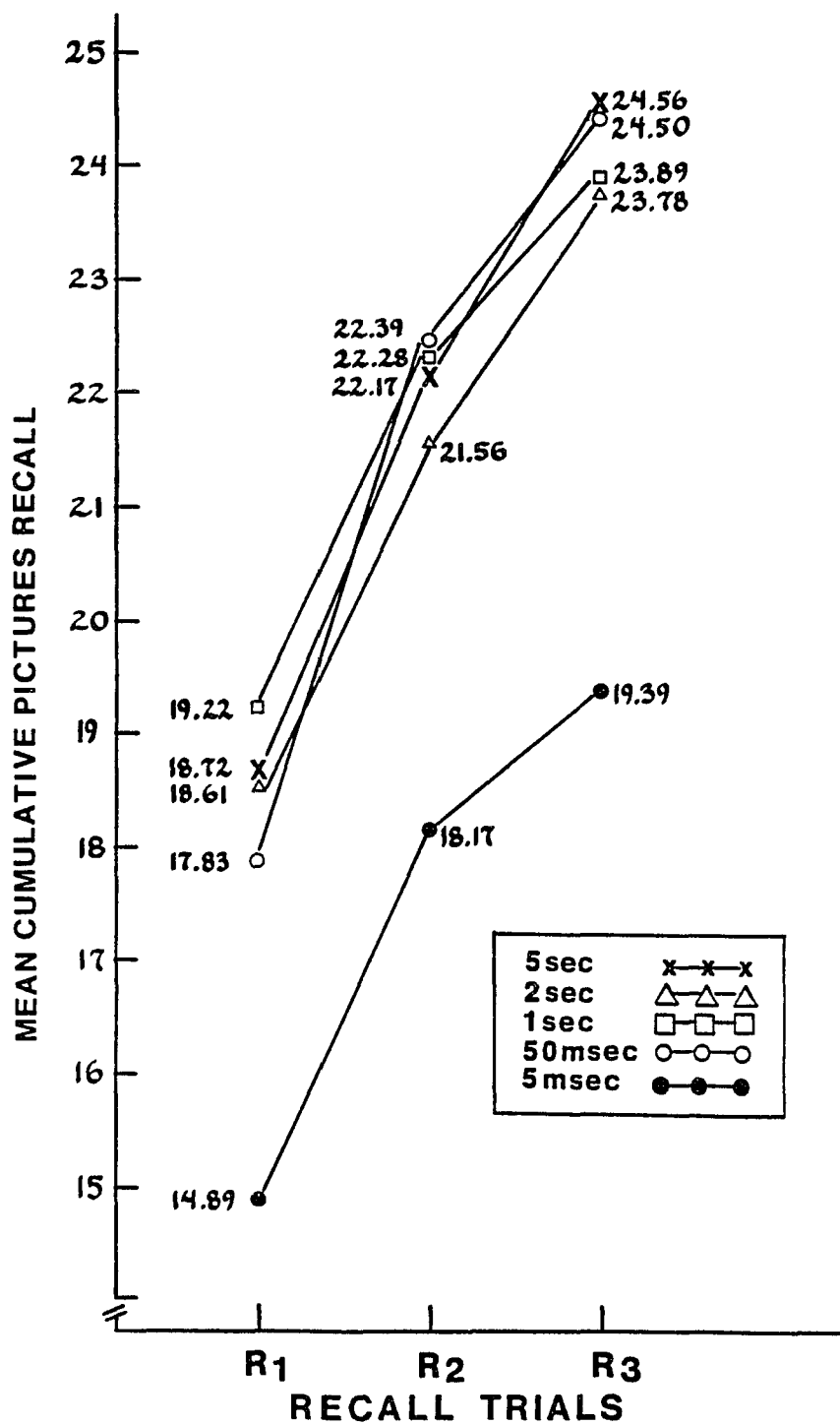


Figure 2.5. Cumulative recall for pictures over three trials for the experimental groups in Experiment 2.

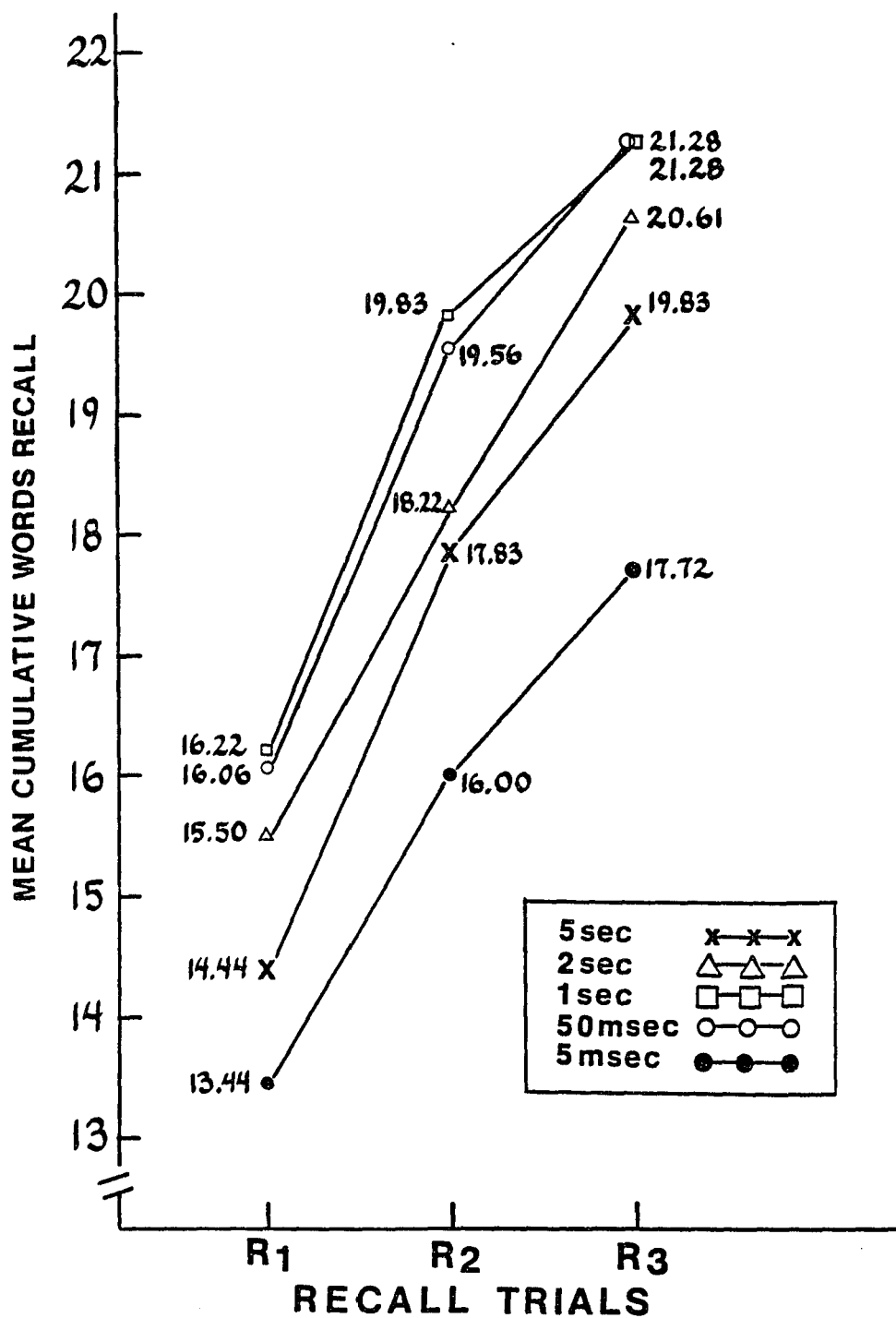


Figure 2.6. Cumulative recall for words over three trials for the experimental groups in Experiment 2.

A 5 (Groups) x 3 (Trials) x 2 (Stimulus) analysis of variance performed on the cumulative recall data of the experimental groups revealed the three main effects to be significant: $F(4,85) = 3.09$, $p < .05$; $F(2,170) = 627.25$, $p < .01$; $F(1,85) = 43.35$, $p < .01$, for Groups, Trials, and Stimulus, respectively (Table 2G.3).

Table 2G.3

Summary of Analysis of Variance of the
Cumulative Recall Scores Over Three Trials
for the Experimental Groups

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>
Groups	4	264.65	3.09*
Error (Groups)	85	85.56	
Within Subjects	450	(14.88)	
Trials	2	1241.95	627.25**
Interaction (Groups x Trials)	8	4.47	2.26*
Error (Trials)	170	1.98	
Stimulus	1	1167.48	43.35**
Interaction (Groups x Stimulus)	4	26.42	0.98
Error (Stimulus)	85	26.93	
Interaction (Trials x Stimulus)	2	1.64	1.06
Interaction (Groups x Trials x Stimulus)	8	1.46	0.95
Error (Trials x Stimulus)	170	1.54	

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

The Groups x Trials interaction also reached significance ($F(8,170) = 2.26, p < .05$), indicating the crossover on Trials 1 and 3 of the 2 sec and 5 sec groups. The 0-Exposure Control group also showed a significant increase in Reminiscence over trials ($t(17) = 8.85, p < .01$). All the appropriate contrasts comparing the performance of the experimental groups across trials for the combined (pictures + words), pictures, and word items cumulative recall scores proved significant.

Note, therefore, that all groups, by the above definition, $Rem = cum R_n - R_1$, including the 0-Exposure Control group, produced an equivalent amount of Reminiscence. This last fact raises a methodological question about the adequacy of reminiscence as a measure of true stimulus recovery.

Conclusions

The major question in this experiment was whether hypermnnesia could be obtained with short exposure durations and the sequential presentation of a fairly large number of items. The recall results indicate that net increments in recall over successive trials occurred in the 5 sec, 2 sec, 1 sec, and 50 msec exposure conditions, with recall for pictures being superior to recall for word items (a standard finding in our laboratory). These results further replicate

previous findings (Erdelyi & Becker, 1974; Erdelyi & Kleinbard, 1978; Erdelyi et al., 1976) for the 5 sec, 2 sec, and 1 sec conditions, and extend these findings to shorter exposures (50 msec). The very brief exposure condition (5 msec) failed to show a significant increase in net recall over trials, a finding which, perhaps, warrants further examination in the future, in view of the slight incremental trend (especially confronted with the 0-Exposure Control subjects' decremental trend).

The performance of the 0-Exposure Control group is puzzling in several respects.

(1) This group of subjects showed a decrement in correct guesses over successive trials. Why was not their guessing constant?

(2) The initial (R1) "recall" (correct guesses) of this group seemed rather high (an average of 13.50 out of 80 items). We worried whether control subjects had communicated with other subjects in the experiment (since all subjects came from the same pool) and had received information about stimulus items. If that were the case, then our guessing base-rate could not be trusted. It seemed important to eliminate any suspicion of contamination in the 0-Exposure Control group's performance and to check on the decremental trend over trials. This decremental trend raised the

question whether the experimental groups' incremental trends should be assessed against the negative trend of the 0-Exposure Control group, as opposed to a no-change null hypothesis. The tack taken was to wait until the new semester and test the control subjects first, before any of the other subjects who actually saw stimulus items were tested.

(3) It seemed surprising that the 0-Exposure Control group's cumulative recall increase was identical to that of the subjects who had actually viewed the stimuli. A possible explanation was that the control subjects had 60 new available guesses for each recall trial, since they were not committed to their initial R1 responses. If this were the case, however, why should not their net "recall" remain constant, rather than decrease, across trials? Perhaps the introduction of an additional control group, yoked to the first recall protocol of experimental subjects, could provide additional insights about guessing base-rates and cumulative recall functions of the standard control group since, presumably, yoked subjects would preserve some of the items initially copied from experimental subjects over successive trials, and would not have 60 new available guesses for each new trial.

There was an additional puzzle in the pattern of the data that deserved follow-up: the lower net recall

in the first recall trial (R1) of the 5 sec exposure group as compared to the 2 sec, 1 sec, and 50 msec groups. One would expect that a 5 sec exposure, 100 times longer than a 50 msec exposure, would produce a greater initial recall. Although the 5 sec subjects showed the greatest increase (mainly due to their superior recall of picture items over word items) in net recall by the third trial, why was their initial recall lower than, say, that of the 50 msec subjects? This finding seems to warrant further investigation, even though it was not statistically significant in this study and could be mere chaff.

Lastly, our failure to obtain a statistically reliable hypermnesia effect with an exposure duration of 5 msec also warranted replication, since we had obtained it with the 50 msec exposure duration, and since this was the only attempt to obtain recall hypermnesia with this extremely short exposure duration with the sequential presentation method. It was apparent that the 5 msec subjects were superior to control subjects on R1 and, so, the 5 msec group is not subliminal in the absolute sense. In Experiment 5, hypermnesia for lists that are absolutely subliminal will be examined.

Experiments 3 and 4 were designed to answer the other questions raised here and to replicate the

observed findings. Experiment 3 probed the "lower" exposure realms (5 msec and, again, a 0-Exposure Control group) with the addition of a "yoked" 0-Exposure Control group, introduced as a check on our standard 0-Exposure Control group. Experiment 4 tested the "higher" exposure ranges (5 sec, 2 sec, 1 sec, and 50 msec) in a straightforward replication of those conditions in Experiment 2.

Note: The exposure durations in Experiments 1 through 5 refer to the settings in the apparatus, and not necessarily to the effective exposure durations of the stimuli. After Experiment 4 was concluded, it was discovered, by means of an oscilloscope, that even though the settings for all other exposures in this series of experiments corresponded to the effective durations of the stimuli, the 5 msec setting had an effective duration of 14 msec. This was, most likely, due to the wear and tear of the shutter during stimulus presentation in Experiments 1 through 4. This situation was corrected before Experiment 5 was carried out, by re-calibrating the shutter so that the settings in the apparatus would correspond to the effective exposure durations of the stimuli. Notice that in Experiment 5 this factor is not crucial, since subliminality is not defined by the nominal setting in the apparatus, but by initial (R1) chance performance.

Experiment 3

Partial Replication of Experiment 2:

5 msec Exposure, 0-Exposure Control,
and Yoked 0-Exposure Control Groups

Experiments 3 and 4 were designed to answer questions arising from the results of Experiment 2. The present study attempted to address four questions.

1. Although the numerical increase in correct responses from R1 to R3 for the 5 msec exposure-duration group in the previous study did not reach statistical significance, could the incremental trends be shown to be reliable?

2. Another goal of the study was to check on what seemed to be a surprisingly high guessing base-rate for the 0-Exposure Control group (13.50 out of 80, or about 17% of the actual stimuli, at R1). One concern was the possibility that, since all of the subjects in Experiment 2 were volunteers from the same subject pool (the introductory Psychology course at Brooklyn College), subjects in some of the longer exposure-duration groups might have communicated stimulus items to future volunteers who were eventually assigned to the 0-Exposure Control group. To circumvent this possible problem, this group was now tested at the beginning of the term, before any of the other groups.

3. Another puzzle was the magnitude of cumulative recall (reminiscence) in the 0-Exposure Control group, which was of the same order as that in the experimental subjects in Experiment 2. It seemed strange that subjects exposed to the stimulus items should produce cumulative recall (reminiscence) functions no higher than subjects shown no stimuli. One possible explanation was that subjects in the 0-Exposure Control group, unlike the others, had little reason to hold on to items from trial to trial, and had, in effect, 60 (or close to 60) "new" guesses for each successive recall trial (a similar situation to that of drawing random samples without replacement). Presumably, this could have contributed to the high level of their cumulative recall function.

To address this issue, a second type of 0-Exposure condition was included in this study, in which each 0-Exposure subject was yoked to the free-recalls in trial 1 (R1) of a 5 msec experimental counterpart. To distinguish this group from the standard 0-Exposure Control group, the nomenclature "Yoked 0-Exposure Control" will be used. Subjects in the Yoked 0-Exposure Control group were treated exactly like the 0-Exposure Control subjects during "stimulus" presentation (80 5 msec blanks or sham flashes). After "stimulus" presentation, the yoked subjects were asked

to write on their recall sheet what they remembered having seen (which was, typically, nothing) and, then, they were handed a recall protocol containing the free-recalls in trial 1 (R1) of one of the 5 msec experimental subjects and asked to copy each item onto their own recall sheets. They were told that doing this might help them "remember" some of the stimuli.

After copying the protocol onto their own recall sheet, Yoked 0-Exposure Control subjects were treated, for the remainder of the session, identically to subjects in the other groups in terms of tasks and their durations, with one single exception: They were told that it was alright for them to write down, in subsequent recalls, the items that they originally copied. The purpose of this modification in the instructions was twofold: (1) To encourage these Yoked 0-Exposure Control subjects to retain the R1 items provided by their experimental counterparts; and (2) to provide a more realistic guessing base-rate comparison for post-R1 performance, since it is reasonable to assume that guesses on R2 and R3 are influenced by the initial items entered in R1.

4. Could the decremental guessing performance across trials of the 0-Exposure Control subjects be duplicated? This issue is conceptually interesting, since the 0-Exposure Control group's multitrial

performance might be argued to provide the proper retention standard against which the experimental groups should be compared or tested.

Method

Subjects

Fifty-four Brooklyn College undergraduates served as subjects. They were assigned to one of three groups: 5 msec Exposure (Experimental), 0-Exposure Control, and Yoked 0-Exposure Control. To avoid the possible contamination of the 0-Exposure Control subjects, in this study subjects were not randomly assigned. Instead, the 0-Exposure Control subjects were tested first. Then, to provide the R1's for the Yoked 0-Exposure Control subjects, the 5 msec Exposure (Experimental) subjects were tested. Finally, the Yoked 0-Exposure Control subjects were run. The subjects were volunteers from the introductory Psychology course at Brooklyn College and were tested in batches of three.

Materials and Apparatus

Since no difference was found between stimulus sets "A" and "B" in Experiment 2, only slide set "A" was employed in this study as well as in subsequent ones. For a list of the pictures and words in stimulus set "A," see Appendix 2B. The apparatus, recall sheets, and booklets for the interpolated task were

identical to those employed in Experiment 2.

Procedure

The procedure for the 5 msec Exposure and 0-Exposure control conditions was identical to that for similar groups in Experiment 2. The Yoked 0-Exposure Control subjects were initially shown the same 80 blanks (sham flashes) presented to the 0-Exposure Control group, also for 5 msec each, and, like the standard 0-Exposure Control subjects, they were asked to write the labels of all the pictures and words they remembered having seen (which were, typically, none). At this point, they were handed a protocol containing the free-recall items of the first recall trial (R1) of a counterpart 5 msec Exposure experimental subject and instructed to copy each item onto their own R1 protocol.

This protocol had been previously "doctored" by the experimenter in this fashion: only those responses which the 5 msec Exposure subjects considered memories of the stimuli (not the guesses) were copied by the experimenter on a new recall sheet. The protocols handed to the Yoked 0-Exposure Control subjects, therefore, consisted only of the responses above the line and the asterisked responses below the line that the 5 msec Exposure subjects considered as recalls or memories.

After copying these responses on their own recall sheets, Yoked 0-Exposure Control subjects were asked to draw a line under the last item copied and, then, to guess what the remaining stimuli were by filling in all the remaining lines on their recall sheet with their best guesses, all the way to line 60. This constituted their first forced-recall (R1). These subjects, like subjects in the other two groups, were also instructed to put a star or an asterisk next to any items in the guessing portion of their recall sheet (below the line) that they considered to be memories (that they remembered having seen) and not guesses.

After completion of their first forced-recall trial (R1), the Yoked 0-Exposure Control subjects were treated identically to the 0-Exposure Control and 5 msec Exposure subjects, with only one slight modification: They were told that it was alright to write down the responses they copied from the "other" subjects (the subjects they were yoked to) in subsequent recall tests. Verbatim "stimulus" presentation and recall instructions for the 0-Exposure Control and the Yoked 0-Exposure Control subjects are presented in Appendices 3D and 3E, respectively. In all other respects (i.e. tasks and their durations) this study was similar to Experiment 2.

Results and Discussion

Recall Level

For the purpose of blind scoring, the protocols of all subjects were randomly mixed, with recall trial and group identification removed and substituted by a code. The scoring of all protocols was done by the experimenter.

Table 3.1 presents the average forced-recall results over the three successive trials for the picture and word stimuli for the 5 msec exposure condition, and combined (pictures + words) results for the Yoked 0-Exposure Control and 0-Exposure Control groups.

Table 3.1

Average Forced-Recall Over Three Trials for the
Experimental and Control Groups

<u>Trials</u>	R1	R2	R3
	P / W / TOT	P / W / TOT	P / W / TOT
<u>Group</u>			
5 msec			
	17.11/10.56/ <u>27.67</u>	18.00/10.44/ <u>28.44</u>	18.34/11.44/ <u>29.78</u>
			(P3 - P1 = 1.23)
			(W3 - W1 = 0.88)
Control			
(0-Exp)	<u>13.22</u>	<u>11.56</u>	<u>12.11</u>
			(R3 - R1 = -1.11)
Control			
(Yoked)	<u>28.50</u>	<u>18.05</u>	<u>17.56</u>
			(R3 - R1 = -10.94)

Inspection of this Table reveals that total correct recall increases as a function of trials only in the 5 msec Exposure group, with the pictures increasing slightly more than the word items (1.23 vs 0.88) in this group. Individual subjects' data for the three groups are presented in Appendix 3A (Tables 3A.1 through 3A.3).

The combined (pictures + words), pictures, and words recall averages for the 5 msec condition over three recall trials are presented in Figures 3.1 and 3.2. Only the combined scores are presented for the Yoked 0-Exposure Control and 0-Exposure Control groups, since these subjects were guessing.

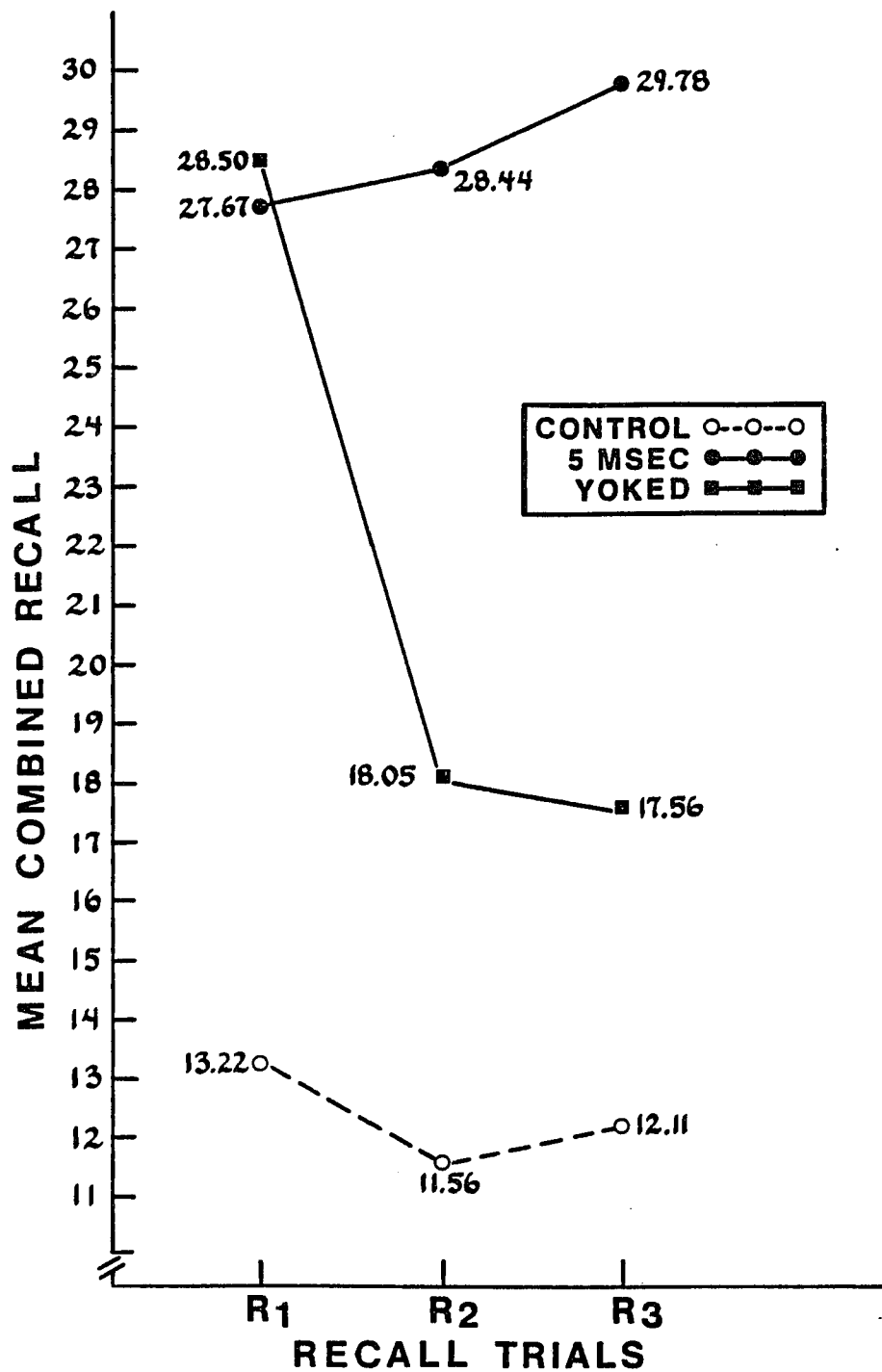


Figure 3.1. Combined (pictures + words) recall over three trials for the groups in Experiment 3.

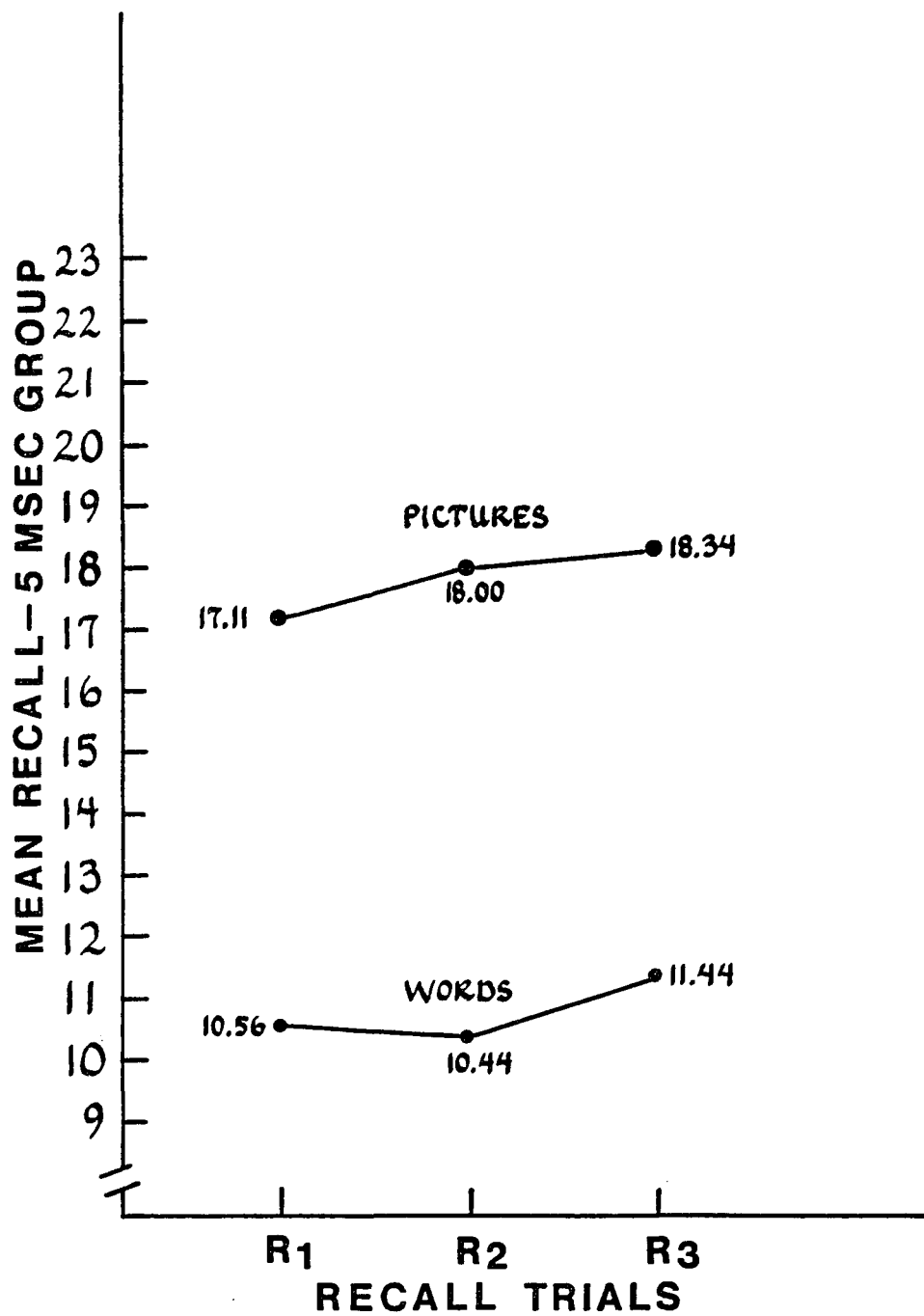


Figure 3.2. Pictures and words recall over three trials for the 5 msec group in Experiment 3.

Visual inspection of these Figures shows that the 5 msec Exposure and Yoked 0-Exposure Control conditions start with about the same average total correct recall (since one group was yoked to the other) at R1 but, with successive trials, while the 5msec group's correct recall increases, the Yoked group's correct recalls decrease substantially. The standard 0-Exposure Control group's responses also show a numerical decline with repeated testing, as was observed in Experiment 2.

A 3 (Groups) x 3 (Trials) analysis of variance performed on hits (correct recalls or guesses) revealed that the two main effects were significant: For Groups, $F(2,51) = 44.95$, $p, < .01$; for Trials, $F(2,102) = 21.23$, $p, < .01$ (Table 3C.1.)

Table 3C.1

Summary of Analysis of Variance of the
Correct Forced-Recall Scores Over Three
Trials for the Experimental and Control
Groups

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>

Groups	2	3616.33	44.95**
Error (Groups)	51	80.45	
Within Subjects	108	(23.55)	
Trials	2	229.27	21.23**
Interaction (Groups x Trials)	4	245.78	21.23**
Error (Within)	102	10.80	

** $p < .01$

The Groups $\times$ Trials interaction was also significant ($F(4,102) = 22.76, p < .01$), indicating the obviously different patterns in hits over successive trials produced by the three groups.

Of main interest was whether, this time, hypermnesia had occurred in the 5 msec Exposure condition. A contrast analysis based on the analysis of variance indicated a reliable recall increment over trials ($F(1,108) = 3.71, p < .05$). Furthermore, trend analyses for Trials (with weights +1, 0, -1, for R1, R2, R3, respectively) revealed that this significant increase was due neither to the picture ($F(1,102) = 1.24, p > .05$) nor the word items ($F(1,102) = 0.66, p > .05$) alone, but to the combination of both.

The marked decline in recall over trials for the Yoked 0-Exposure Control group was significant: $F(1,102) = 99.82, p < .01$. The standard 0-Exposure Control group's correct recall (guessing) declined only slightly across trials, and, in this study, unlike in Experiment 2, not reliably ($F(1,102) = 1.03, p > .05$). A 2 (Groups) $\times$ 3 (Trials) analysis of variance (Table 3C.2) comparing the performance of the 5 msec Exposure group with that of the 0-Exposure Control group, revealed the superiority in hits of the 5 msec group ($F(1,34) = 79.21, p < .01$.)

Table 3C.2

Summary of Analysis of Variance of the
Correct Forced-Recall Scores Over Three
Trials for the 5 msec Experimental and
0-Exposure Control Groups

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>

Groups	1	7203.00	79.21**
Error (Groups)	34	90.94	
Within Subjects	72	(9.61)	
Trials	2	8.04	0.87
Interaction (Groups x Trials)	2	25.45	2.77
Error (Within)	68	9.19	

** $p < .01$

A comparison of the 5 msec Exposure and standard 0-Exposure Control groups in this study with their counterparts in Experiment 2 reveals both marked similarities and differences.

A critical similarity was the R1 performance in the two Experiments of the 5 msec Exposure and 0-Exposure Control subjects. Both groups produced R1 levels very close to those obtained in Experiment 2:

	<u>Experiment 2</u>	<u>Experiment 3</u>
5 msec Exposure	28.33	27.67
0-Exposure Control	13.50	13.22

This similarity is particularly important for the 0-Exposure Control group, as it argues against a possible cross-talk artifact in the base-rate estimate provided by this group.

The main difference is that the 5 msec Exposure group was hypermnesic in this study but failed to reach significance in Experiment 2. The 0-Exposure Control group, on the other hand, remained slightly decremental across trials in this study (although not reliably), whereas in Experiment 2 this group showed a significant decrease in hits over successive trials.

Cumulative Recall (cum Rn) and Reminiscence (cum Rn-R1)

The next analysis concerned the cumulative recall and reminiscence scores. Table 3.2 provides the average cumulative recall data over the three trials for the picture and word stimuli for the 5 msec group, and the combined scores for the two control groups. Individual subjects' cumulative recall scores over three trials are presented in Appendix 3B (Tables 3B.1 through 3B.3.)

Table 3.2

Average Cumulative Recall Over Three Trials
for the Experimental and Control Groups

<u>Trials</u>	<u>R1</u>	<u>R2</u>	<u>R3</u>
	<u>P / W / TOT</u>	<u>P / W / TOT</u>	<u>P / W / TOT</u>
<u>Group</u>			
5 msec			
	17.11/10.56/ <u>27.67</u>	20.56/13.22/ <u>33.78</u>	22.00/14.67/ <u>36.67</u>
			(cum P3 - P1 = 4.89)
			(cum W3 - W1 = 4.11)
Control			
(0-Exp)	<u>13.22</u>	<u>18.89</u>	<u>21.56</u>
			(cum R3 - R1 = 8.34)
Control			
(Yoked)	<u>28.50</u>	<u>32.72</u>	<u>34.56</u>
			(cum R3 - R1 = 6.06)

Figures 3.3 and 3.4 provide a graphic representation of the results. (Once again, the 0-Exposure Control and Yoked 0-Exposure Control groups' functions for pictures and words are not shown, since it cannot be determined whether these subjects were guessing pictures or words.)

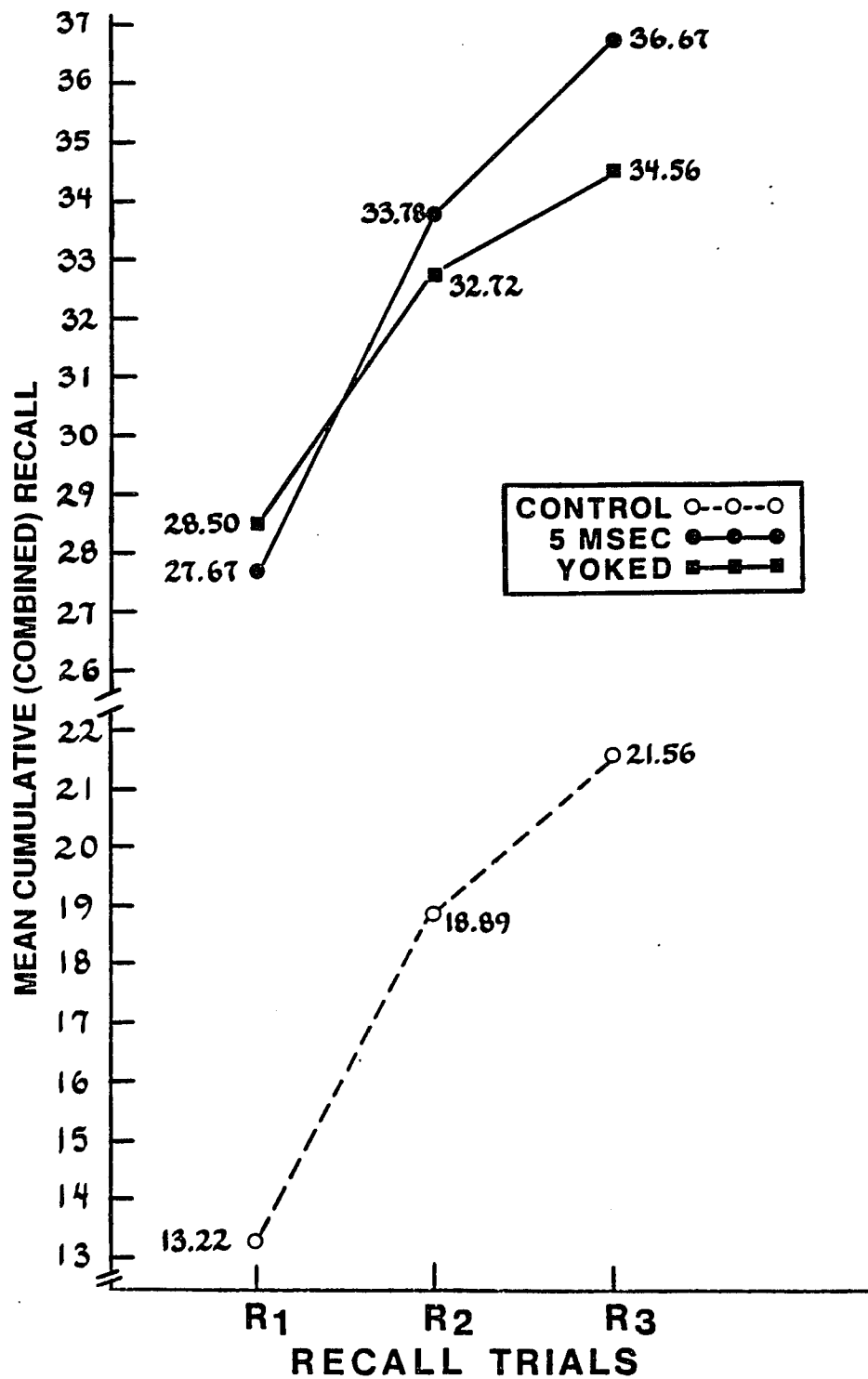


Figure 3.3. Combined (pictures + words) cumulative recall over three trials for the groups in Experiment 3.

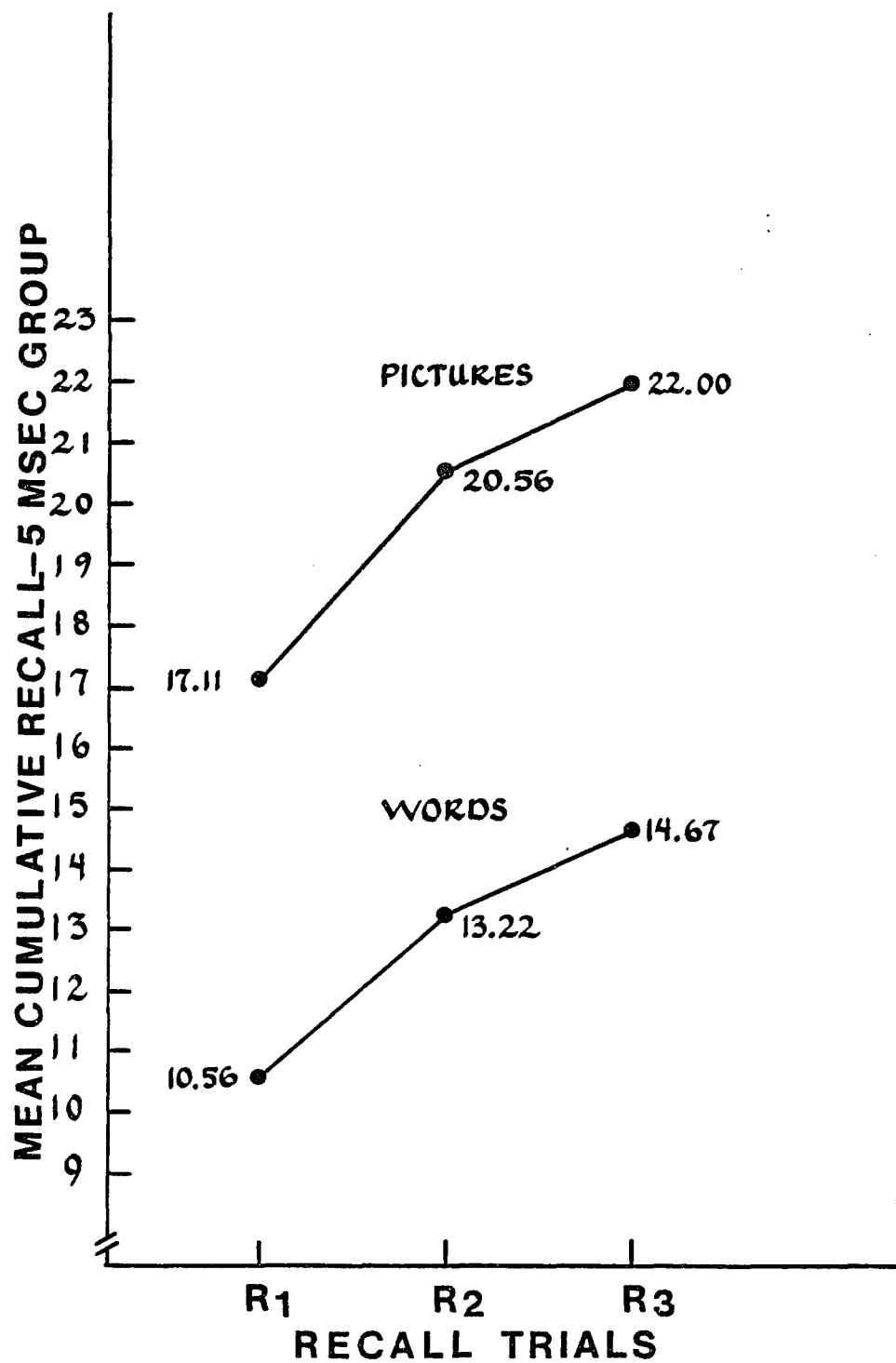


Figure 3.4. Pictures and words cumulative recall over three trials for the 5 msec group in Experiment 3.

A 3 (Groups) x 3 (Trials) analysis of variance performed on the cumulative recall data revealed that the two main effects were significant: $F(2,51) = 29.21$, $p < .01$ and $F(2,102) = 239.56$, for Groups and Trials, respectively (Table 3C.3), indicating the differences among groups in cumulative recall levels and the increase in cumulative recall in all groups.

Table 3C.3

Summary of Analysis of Variance of the
Cumulative Recall Scores Over Three Trials
for the Experimental and Control Groups

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>
Groups	2	3754.10	29.21**
Error (Groups)	51	128.52	
Within Subjects	108	(19.67)	
Trials	2	857.64	239.56**
Interaction (Groups x Trials)	4	11.01	3.08
Error (Within)	102	3.58	

** $p < .01$

Cumulative recall for pictures was superior to that for words in the 5 msec Exposure group, as indicated by a simple t-Test across trials, $t(17) = 6.85$, $p < .01$.

A look at Table 3.2 reveals that cumulative recall did not increase equally in all groups (as it had in Experiment 2). Whereas the 5 msec Exposure and the standard 0-Exposure Control groups' average cumulative recall increase over trials were 9.00 and 8.34, respectively, the increase for the Yoked 0-Exposure Control group was only 6.06. A contrast analysis failed to show that these differences were reliable ($F(1,108) = 3.56, p > .05.$)

Further contrasts (the weights were +1, 0, -1, for R1, R2, R3, respectively) revealed that both the cumulative recall of picture and word items increased significantly over trials for the 5 msec Exposure group ($F(1,108) = 10.93, p < .01$, and $F(1,108) = 7.73, p < .01$, for pictures and words, respectively.)

Conclusions

(1) In this study hypermnesia was obtained with a very short stimulus exposure duration (5 msec), accentuating the non-significant trend obtained in Experiment 2 with the corresponding group.

(2) The guessing performance of our standard 0-Exposure Control group in this study proved similar to its counterpart in Experiment 2 (although not declining significantly over trials here), suggesting that the high base-rates (about 13 out of 80) are true values and not, as feared in Experiment 2, contaminated

by cross-talk among experimental and control subjects.

(3) The subjects in the Yoked 0-Exposure Control condition evidenced a drastic decline in their guesses over successive trials, guessing fewer new items than the 0-Exposure Control subjects. It seems that Yoked subjects were not able (or not willing) to carry out the experimenter's instructions to retain R1 responses and attempt smart guesses. This suggests that the yoking tactic may not be a useful one in this context.

(4) This study produced about the same cumulative recall for the 5 msec Exposure and standard 0-Exposure control groups. If $\text{Reminiscence} = \text{Cumulative } R_n - R_1$, these findings raise doubt about the adequacy of reminiscence as a measure of stimulus accessibility, since reminiscence for the subjects exposed to the stimuli (5 msec Exposure group) and reminiscence for those subjects exposed to blanks (0-Exposure control) were indistinguishable, even though the two groups differed in recall at R1. It might also be noted that reminiscence is not subject to response criterion control, since subjects are not forced to produce an equal number of correct guesses and retentions from R1 to R3 and, in this sense, one cannot control for unique numbers or patterns of responses.

Experiment 4

Partial Replication of Experiment 2:

5 sec, 2 sec, 1 sec, and 50 msec

Exposure-Duration Conditions

This study was designed to address two interesting aspects of the data obtained in Experiment 2 for the 5 sec, 2 sec, 1 sec, and 50 msec exposure groups.

1. It will be recalled that, in Experiment 2, the 5 sec exposure group's initial recall (R1) performance was numerically lower than that of the 2 sec, 1 sec, and 50 msec exposure groups. Nevertheless, the 5 sec exposure group evidenced the highest increase in hits from R1 to R3. Could this pattern be replicated?

2. In Experiment 2, cumulative recall increased about equally for all groups (about 10.25 items) over trials, with pictures and words increasing at about the same rate. In Experiment 3, cumulative recall increased about the same for the 5 msec and 0-Exposure Control groups (9.00 and 8.34, respectively). Is it the case that magnitude of reminiscence is unaffected by stimulus exposure? This would be a peculiar finding which would be worth replicating.

Method

Subjects

Seventy-two Brooklyn College undergraduates served as subjects. They were randomly assigned to one of four stimulus exposure-duration conditions: 5 sec, 2 sec, 1 sec, and 50 msec. All subjects were volunteers from the introductory Psychology course at Brooklyn College and were tested in batches of three.

Materials and Apparatus

The materials and apparatus employed in this study were identical to those already described in Experiment 2.

Procedure

The procedure for the four groups tested in this study was identical to that for the counterpart groups in Experiment 2.

Results and Discussion

Recall Level

The scoring procedure was the same as described in Experiments 2 and 3.

Table 4.1 presents the average forced-recall results over three trials for the picture and word stimuli for all groups.

Table 4.1

Average Forced-Recall Over Three Trials
for the Different Exposure-Duration Groups

<u>Trials</u>	R1	R2	R3
	P / W / TOT	P / W / TOT	P / W / TOT
<u>Group</u>			
5 sec			
	19.22/13.39/ <u>32.61</u>	19.67/14.00/ <u>33.67</u>	20.67/15.50/ <u>36.17</u>
			(P3 - P1 = 1.45)
			(W3 - W1 = 2.11)
2 sec			
	16.72/13.11/ <u>29.83</u>	18.00/13.06/ <u>31.06</u>	19.83/13.00/ <u>32.83</u>
			(P3 - P1 = 3.11)
			(W3 - W1 = -0.11)
1 sec			
	17.77/13.44/ <u>31.22</u>	18.61/12.78/ <u>31.39</u>	19.89/14.61/ <u>34.50</u>
			(P3 - P1 = 2.12)
			(W3 - W1 = 1.17)
50 msec			
	17.44/12.78/ <u>30.22</u>	17.77/12.78/ <u>30.55</u>	19.22/14.17/ <u>33.39</u>
			(P3 - P1 = 1.78)
			(W3 - W1 = 1.39)

A look at this Table reveals that hits increase as a function of trials in all the stimulus exposure conditions. Individual subjects' recall data for all groups are presented in Appendix 4A (Tables 4A.1 through 4A.4).

The combined (pictures + words), pictures, and words correct recall averages for all groups over the three trials are presented in Figures 4.1, 4.2, and 4.3, respectively.

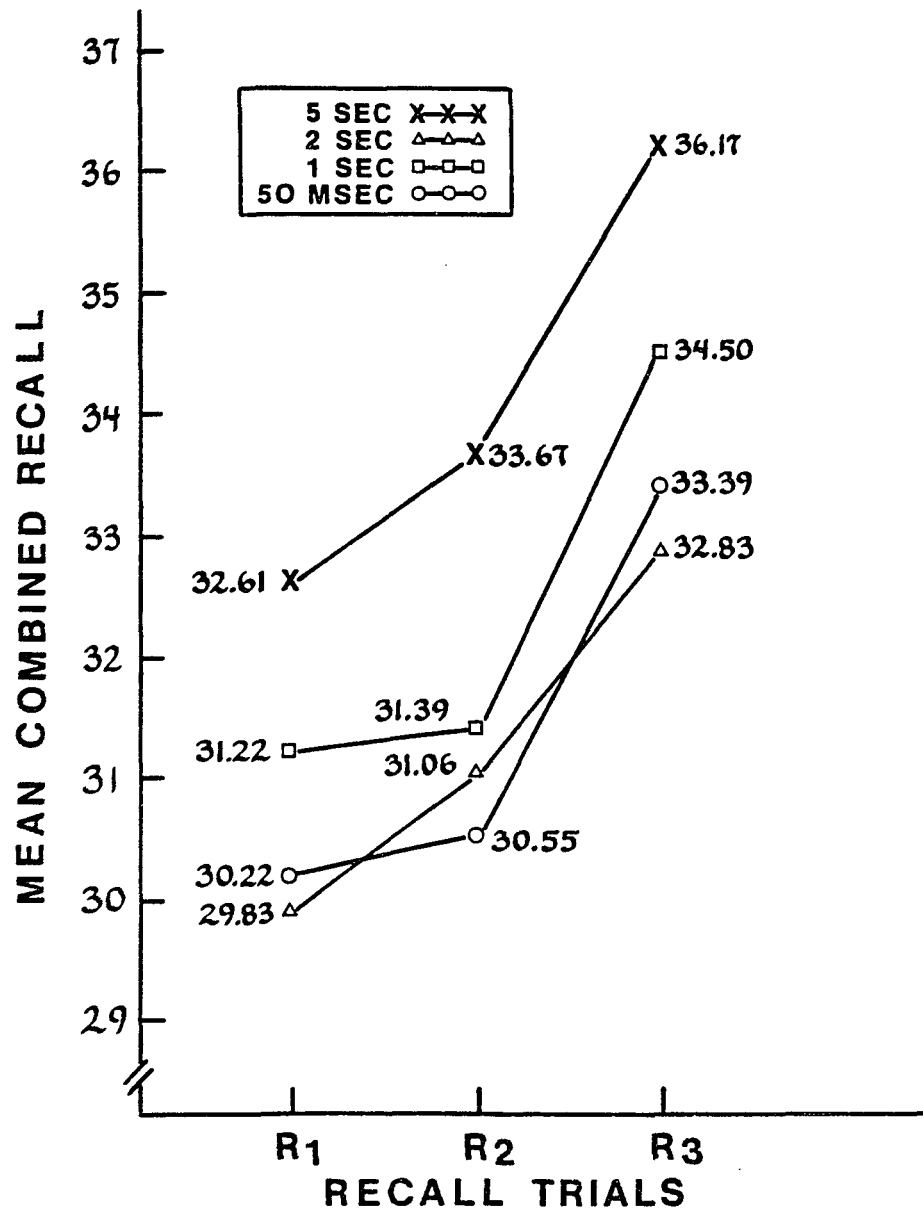


Figure 4.1. Combined (pictures + words) recall over three trials for the groups in Experiment 4.

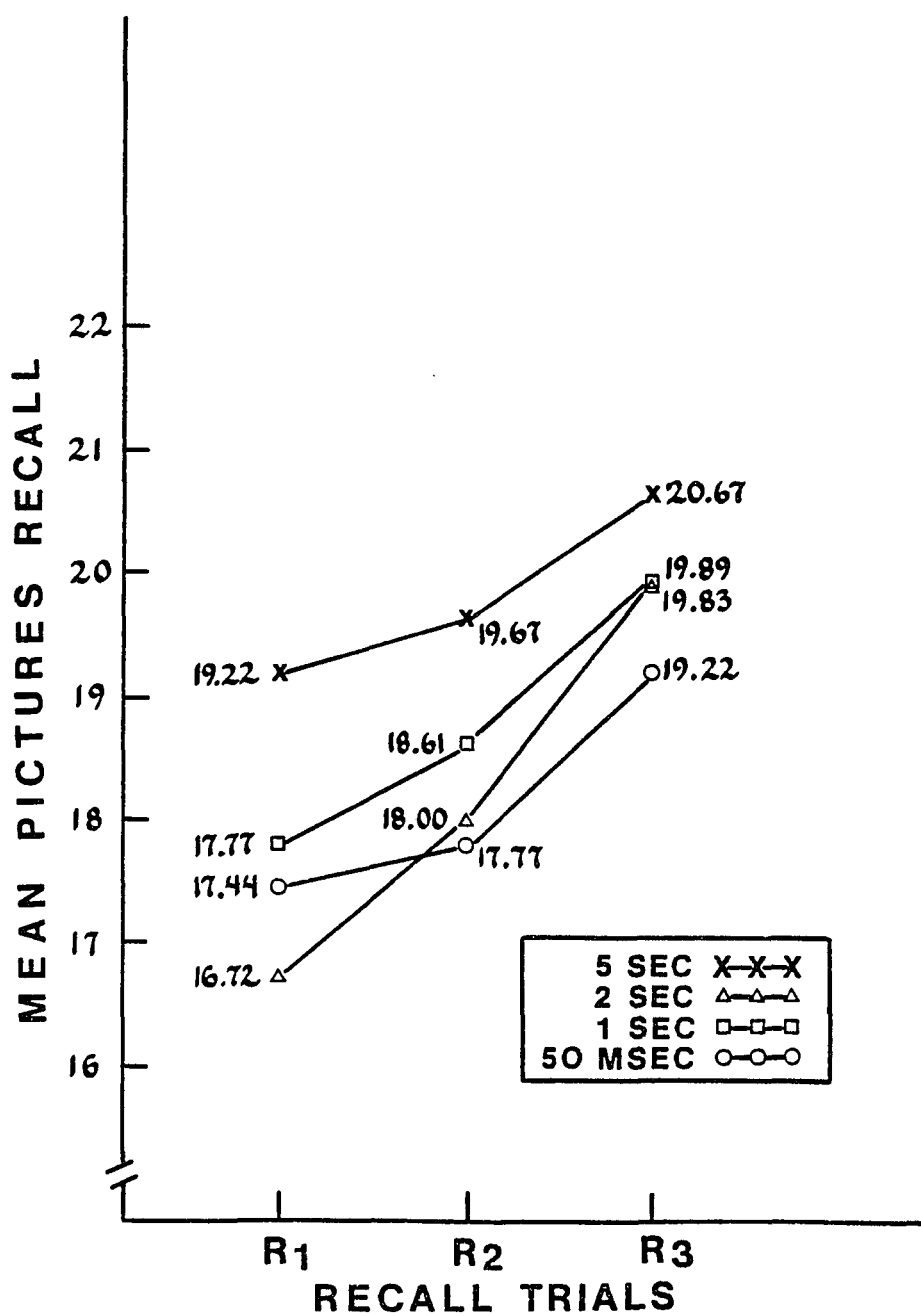


Figure 4.2. Recall for pictures over three trials for the groups in Experiment 4.

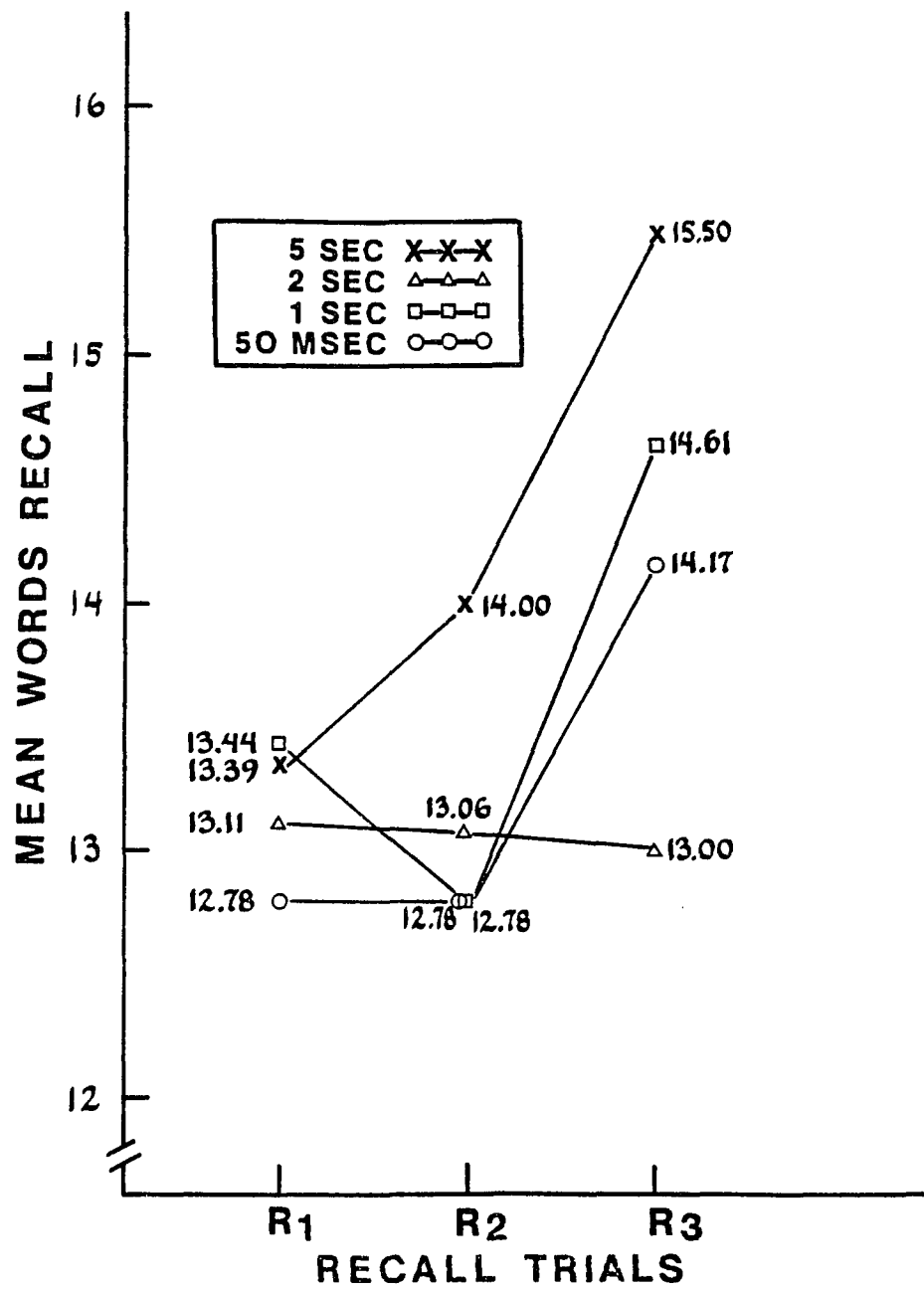


Figure 4.3. Recall for words over three trials for the groups in Experiment 4.

Visual inspection of Figure 4.1 shows all exposure groups producing hypermnesia over trials. However, the unexpected patterns in Experiment 2 were not duplicated in this study: (1) the 5 sec exposure group did not start with an initially lower recall (R1) compared to the other three groups, and (2) although the 5 sec exposure group did show the highest numerical increase in hits over trials, this greater increase, relative to the other groups, was minimal in this study (3.56 as opposed to 3.28, 3.17, and 3.00 for the 2 sec, 1 sec, and 50 msec exposure groups, respectively.)

Figures 4.2 and 4.3 present picture and word recall performance separately. Once again, overall recall for pictures was superior to that for words. Also, average hypermnesia was numerically higher for pictures (2.11) than for words (1.14).

A 4 (Groups) x 3 (Trials) x 2 (Stimulus) analysis of variance performed on the correct recall scores (Table 4C.1) revealed the main effects of Trials and Stimulus to be significant: For Trials, $F(2,136) = 29.62$, $p < .01$, indicating an increase in net recall over trials, and for Stimulus, $F(1,68) = 171.92$, $p < .01$, indicating the superiority of picture recall over word recall. None of the interactions proved significant.

Table 4C.1

Summary of Analysis of Variance of the
Correct Forced-Recall Scores Over Three
Trials for the Different Exposure-Duration
Conditions

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>

Groups	3	48.35	0.45
Error (Groups)	68	107.65	
Within Subjects	360	(14.85)	
Trials	2	105.46	29.62**
Interaction (Groups x Trials)	6	0.99	0.28
Error (Trials)	136	3.56	
Stimulus	1	2903.70	171.92**
Interaction (Groups x Stimulus)	3	1.97	0.12
Error (Stimulus)	68	16.89	
Interaction (Trials x Stimulus)	2	9.34	2.41
Interaction (Groups x Trials x Stimulus)	6	6.97	1.80
Error (Trials x Stimulus)	136	3.87	

** p<.01

Trend analyses showed that all of the four exposure groups produced hypermnesia ($F(1,136) = 31.96$, $p < .01$; $F(1,136) = 22.75$, $p < .01$; $F(1,136) = 27.16$, $p < .01$; and $F(1,136) = 25.35$, $p < .01$, for the 5 sec, 2 sec, 1 sec, and 50 msec exposure conditions, respectively.)

Further trend analyses revealed that pictures were hypermnesic in all of the groups, whereas words increased significantly only in the 5 sec and 50 msec exposure groups.

Cumulative Recall (cum Rn) and Reminiscence (cum Rn-R1)

Table 4.2 presents the average cumulative recall results over three trials for the picture and word items for all groups. Individual subjects' cumulative recall scores for all exposure conditions are presented in Appendix 4B (Tables 4B.1 through 4B.4).

Table 4.2

Average Cumulative Recall Over Three Trials
for the Different Exposure-Duration Groups

<u>Trials</u>	R1	R2	R3
<u>Group</u>	P / W / TOT	P / W / TOT	P / W / TOT
5 sec			
	19.22/13.39/ <u>32.61</u>	23.44/17.44/ <u>40.89</u>	26.00/19.94/ <u>45.94</u>
		(cum P3 - P1 = 6.78)	
		(cum W3 - W1 = 6.55)	
2 sec			
	16.72/13.11/ <u>29.83</u>	20.28/15.67/ <u>35.94</u>	22.72/17.39/ <u>40.11</u>
		(cum P3 - P1 = 6.00)	
		(cum W3 - W1 = 4.28)	
1 sec			
	17.77/13.44/ <u>31.22</u>	21.44/16.33/ <u>37.78</u>	23.89/18.72/ <u>42.61</u>
		(cum P3 - P1 = 6.12)	
		(cum W3 - W1 = 5.28)	
50 msec			
	17.44/12.78/ <u>30.22</u>	21.17/15.94/ <u>37.11</u>	23.72/18.33/ <u>42.05</u>
		(cum P3 - P1 = 6.28)	
		(cum W3 - W1 = 5.55)	

A look at this Table suggests that cumulative recall increases about equally from R1 to R3 for the 2 sec, 1 sec, and 50 msec exposure groups (10.28, 11.39, and 11.83, respectively), with the highest increase occurring in the 5 sec exposure group (13.33). The average increase for all groups in this study was 11.71, a bit higher than the average increase for the counterpart groups in Experiment 2 (10.25).

Figures 4.4 through 4.6 present the average combined (pictures + words), pictures, and words cumulative recall functions for all groups.

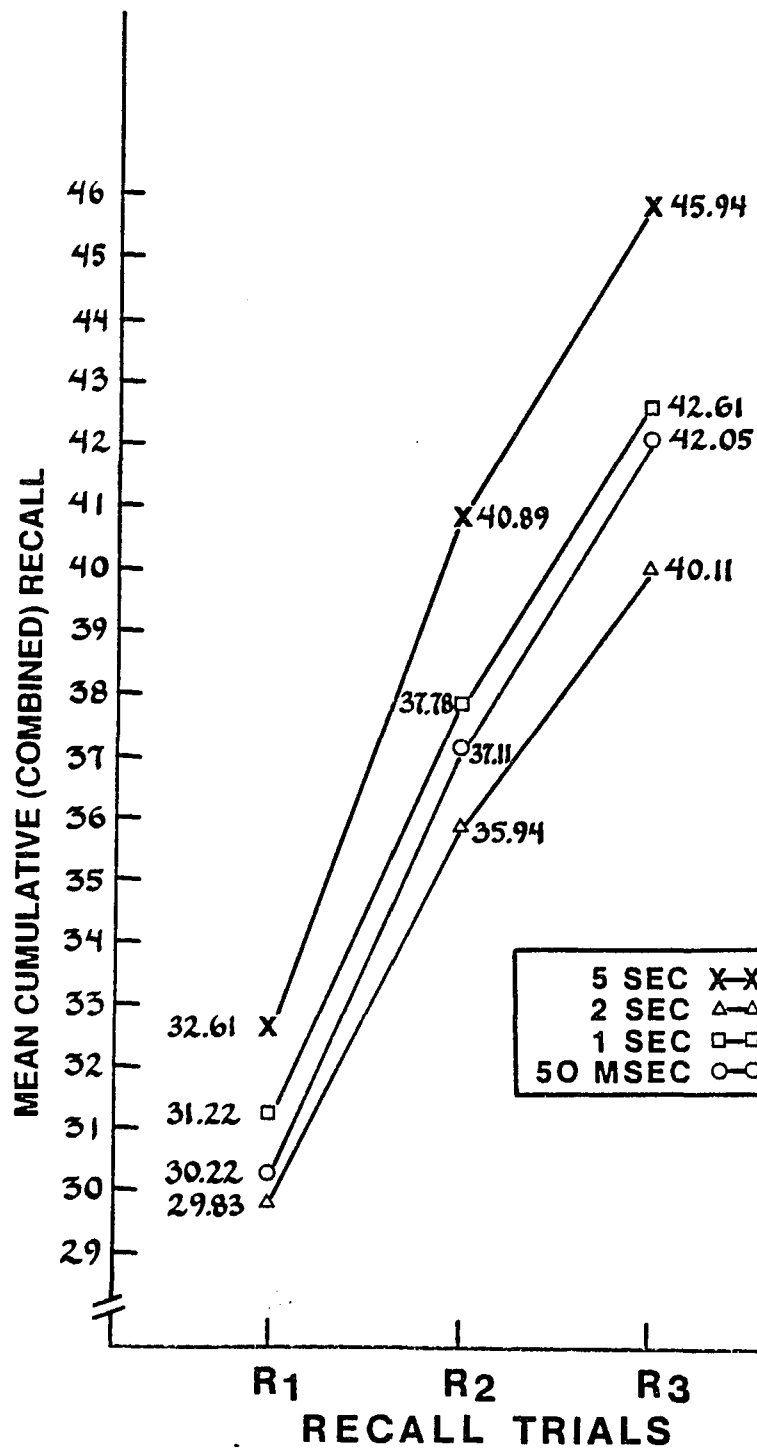


Figure 4.4. Combined (pictures + words) cumulative recall over three trials for the groups in Experiment 4.

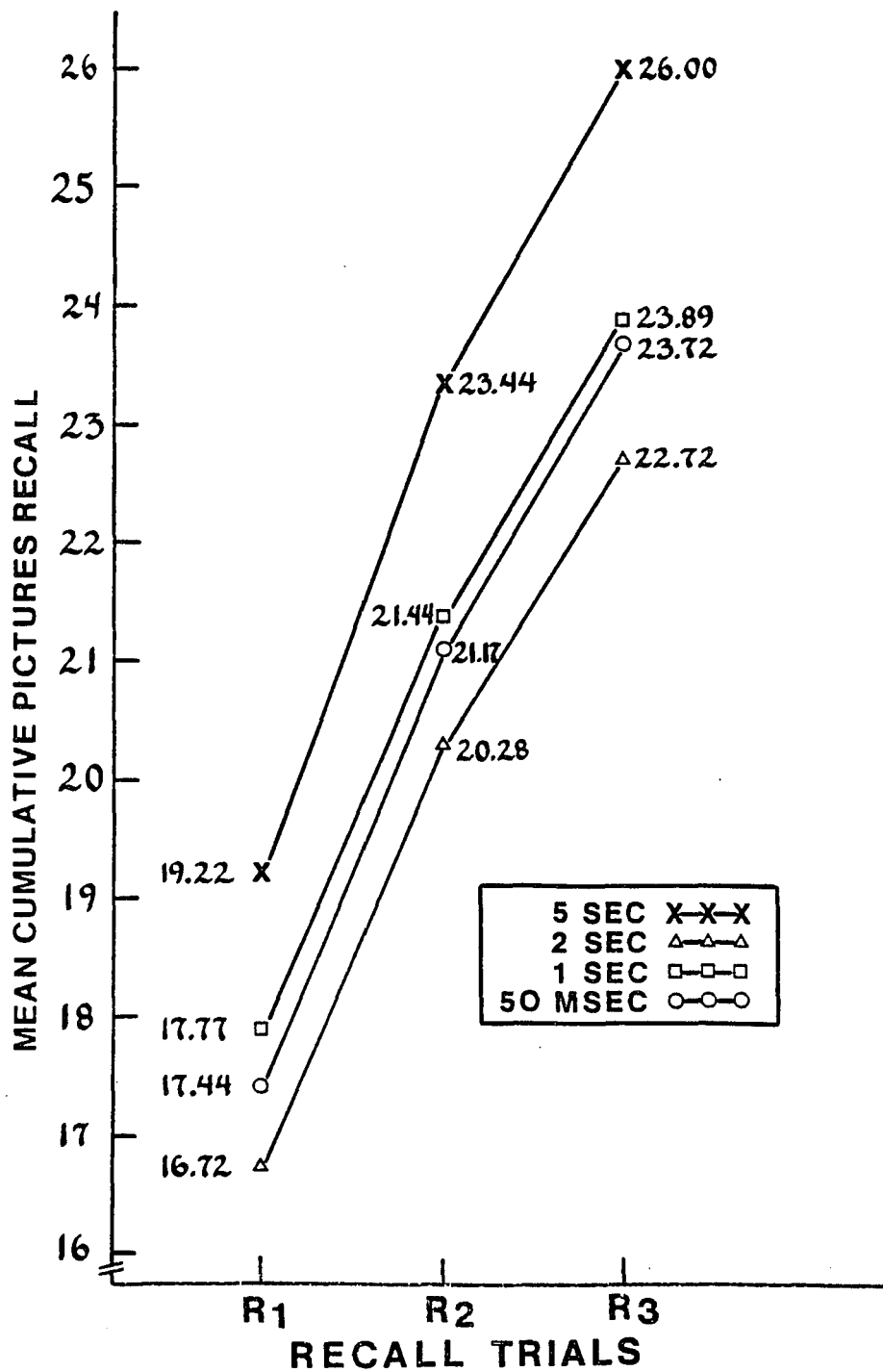


Figure 4.5. Cumulative recall for pictures over three trials for the groups in Experiment 4.

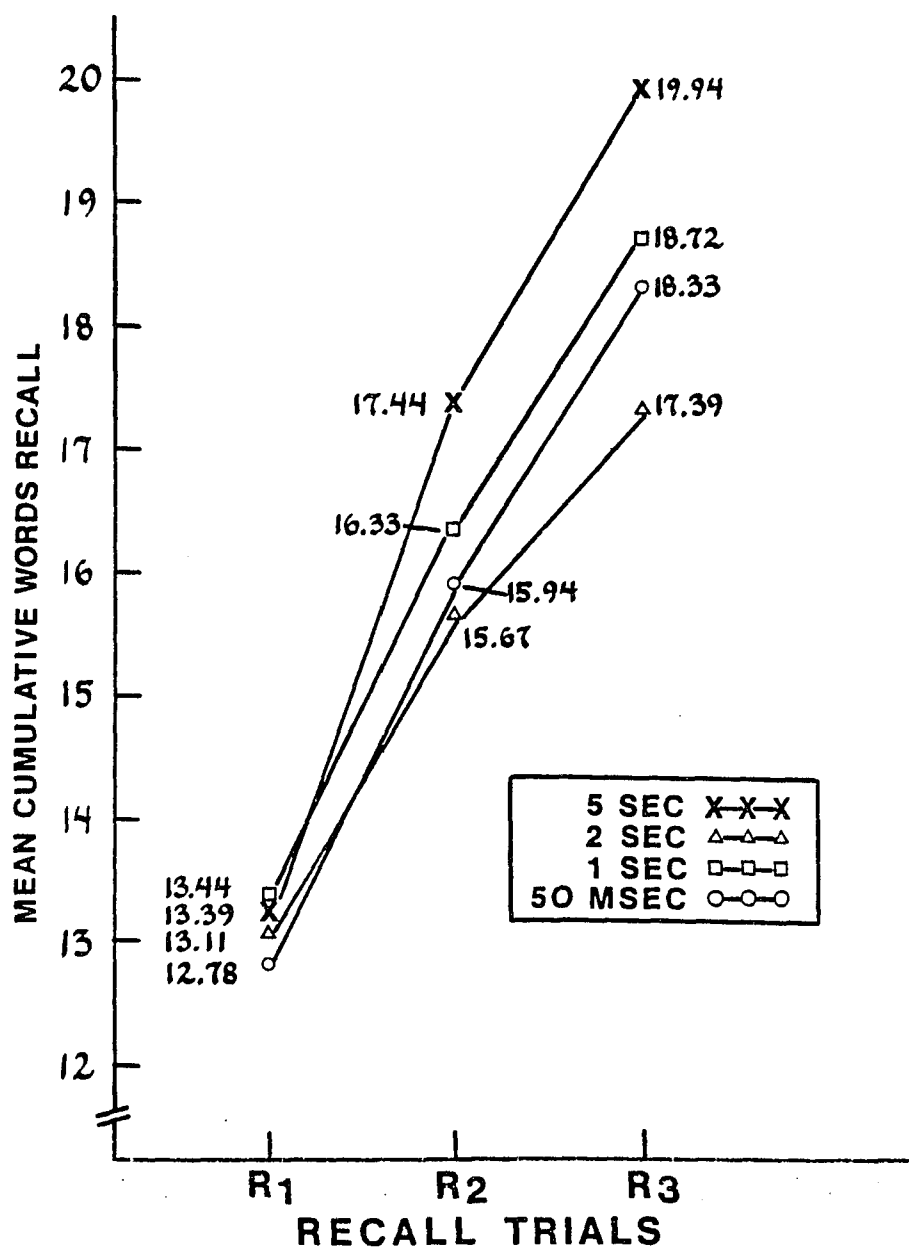


Figure 4.6. Cumulative recall for words over three trials for the groups in Experiment 4.

A 4 (Groups) x 3 (Trials) x 2 (Stimulus) analysis of variance performed on the cumulative recall scores revealed two of the main effects to be significant: For Trials, $F(2,136) = 513.75$, $p < .01$, and for Stimulus, $F(1,68) = 135.06$, $p < .01$, indicating, as expected, a significant increase in cumulative recall across trials and the superiority in cumulative recall level of pictures over words (Table 4C.2.)

Table 4C.2

Summary of Analysis of Variance of the
Cumulative Recall Scores Over Three Trials
for the Different Exposure-Duration Conditions

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>
Groups	3	99.04	0.92
Error (Groups)	68	107.96	
Within Subjects	360	(20.53)	
Trials	2	1248.40	513.75**
Interaction (Groups x Trials)	6	3.95	1.63
Error (Trials)	136	2.43	
Stimulus	1	2821.34	135.06**
Interaction (Groups x Stimulus)	3	10.22	0.49
Error (Stimulus)	68	20.89	
Interaction (Trials x Stimulus)	2	7.31	4.02*
Interaction (Groups x Trials x Stimulus)	6	0.93	0.51
Error (Trials x Stimulus)	136	1.82	

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

The Trials x Stimulus interaction also proved significant ($F(2,136) = 4.02, p < .05$), indicating greater picture reminiscence relative to word reminiscence. All the appropriate contrasts comparing the performance of all groups across trials for the combined (pictures + words), pictures, and words cumulative recall scores proved significant.

Conclusions

1. Hypermnnesia was again obtained in all exposure groups.
2. Overall recall for pictures was, once more, superior to recall for words.
3. Reminiscence was obtained for all exposure and stimulus groups, and was not affected by exposure durations.
4. The curious pattern trends observed in Experiment 2 were not replicated. Specifically, R1 for the 5 sec exposure group was not, this time, the lowest, nor was hypermnnesia for the 5 sec group substantially greater than for the other, shorter exposure groups (2 sec, 1 sec, 50 msec.)

Experiment 5

Hypermnesia for Absolute Subliminal Input

In the experiments reviewed thus far, even though two of the stimulus exposure durations were very short (5 msec and 50 msec), these durations could not be considered subliminal in the absolute sense (see Erdelyi, 1986), since the performance of subjects in those conditions was clearly superior to the base-rate performance of control subjects. According to Erdelyi's (1986) proposal, the strictest sense of subliminal is chance level performance. In signal detection theory terms, it would not be $d' = 1$, a frequent convention (cf. Macmillan, 1986), but $d' = 0$. Since d' cannot be calculated for recall data, the counterpart notion is initial recall level (R1) being equivalent to chance performance, as indexed by control subjects exposed to blank flashes.

The main purpose of this experiment, then, was to determine whether hypermnesia could be obtained for stimulus input that was absolutely subliminal at R1; i.e. where R1 started at chance level.

Since previous studies (see Experiments 2 and 3) had provided a fairly consistent estimate of chance R1 performance to be in the region of 13.50 hits (13.50 in Experiment 2, 13.22 in Experiment 3), our first task

was to degrade our stimuli further so that the initial performance of experimental subjects would not differ from that of control subjects. Because of the limitations in our apparatus, exposure duration could not be made shorter than 5 msec, the tack taken was to degrade the stimuli further by reducing the amount of light projected by the apparatus. To this end, a pilot study was conducted in which neutral density filters of different strengths were positioned directly in front of the projector lens and, in trial-and-error fashion, several filters and filter combinations chosen, in conjunction with several stimulus exposure durations. The particular filter density/exposure duration combinations employed in this pilot study produced the following mean number of hits at R1:

<u>Filter/Exposure</u>	<u>Hits</u>	<u>N</u>
<u>Combinations</u>		
0.50-5 msec	25.77	9
0.80-5 msec	16.01	8
1.00-5 msec	17.14	7
1.00-20 msec	31.09	11
1.80-50 msec	14.18	11

It should be pointed out that neutral density filters reduce the amount of light in logarithmic fashion. Thus, a 0.50 neutral density filter reduces light by a factor of 3.16 ($\text{antilog of } 0.50 = 3.16$), and

a 1.80 filter reduces light by a factor of 63 (antilog of $1.80 = 63.09$).

From the pilot results, it can be seen that the 0.50 filter-5 msec stimulus exposure duration combination condition yielded results similar to those of our previous 5 msec groups (without filters) and was clearly superior to our standard control groups. The performance of the 1.00 filter-20 msec stimulus exposure subjects was also clearly superior to that of previous control subjects. The other three groups (0.80 filter-5 msec exposure, 1.00 filter-5 msec exposure, and 1.80 filter-50 msec exposure) however, performed in a range closer to that of our past standard control groups.

Since some of the exciting subliminal effects in the literature have been reported in the exposure window of 1-10 msec (Bonnano & Stilling, 1986; Seamon, Marsh, and Brody, 1984; Seamon, Brody, and Kauff, 1983a, 1983b; Kunst-Wilson & Zajonc, 1980; Silverman, 1983), we decided to employ only the 5 msec stimulus exposure duration in this study. The next step was to decide which filter strengths to employ. The rationale was fairly simple: to keep the 0.50 filter condition as an anchor (and for further comparison with the 5 msec groups employed in previous studies), since the performance of subjects in this condition was clearly

superior to the 13.50 base-rate, and, then, to increase filter density in a somewhat systematic fashion for as many conditions as time and subject availability during the semester allowed. The filter conditions decided upon, in addition to the 0.50 one, were: 0.70, 0.80, 0.90, 1.00, 1.10, 1.20, and 1.40. The standard 0-Exposure Control condition was also included. In this study, subjects in this group were shown 80 sham flashes for 5 msec, as usual, with a 1.00 neutral density filter placed in front of the projector lens. It might be noted that in the pilot study, all subjects actually receiving stimuli at 5 msec exposure, but with a 1.00 filter, reported not having seen any of the stimuli.

The basic question investigated in this study was whether subliminal stimuli, in the absolute sense of subliminality (experimental hits = control hits at R1), could yield hypermnesia with repeated testing.

Since the performance of the 0.80 filter group in the pilot study was close enough to that of standard control subjects, we expected that subjects in conditions with a filter density stronger than 0.80 would also perform, initially, as control subjects. We did not know, of course, at which point in stimulus degradation subjects would be in the same position as control subjects (unable to perceive or register the

stimuli beyond chance). Also, we had to be open to the possibility that there exists a window of degradation within which absolute subliminal effects might take place, but not outside it. Therefore, we systematically probed a wide range of filter densities.

Method

Subjects

One-hundred-and-eight Brooklyn College undergraduates served as subjects. They were randomly assigned to one of nine filter-density groups: 0.50, 0.70, 0.80, 0.90, 1.00, 1.10, 1.20, 1.40, and 1.00 Control. The subjects were volunteers from the introductory Psychology course at Brooklyn College and were tested in batches of three.

Materials and Apparatus

The stimuli employed in this study consisted of slide set "A," previously described in Experiments 2, 3, and 4). The apparatus, recall sheets, and booklets for the interpolated task were identical to those employed in Experiments 2, 3, and 4, with one slight addition to the apparatus. This addition consisted of placing, in front of the lens of the projection tachistoscope, one or several 75 mm x 75 mm No. 96 Kodak Wratten gelatin neutral density filters of different strengths, depending upon the group being tested. These filters, previously mounted inside Geppe

glass slides, were secured onto a plastic base standing freely in front of the projector. The grooves on the plastic base (actually, a compact disc holder) allowed the slides to be removed and changed with considerable ease.

Neutral density filters, to recapitulate, have the property of reducing the light emanating from the projector by different amounts, in a logarithmic fashion, depending upon the strength of the filter. For example, a filter of neutral density 1.00 reduces the light by a factor of 10, one of neutral density 2.00, by a factor of 100, and so on. Filters of differing densities were superimposed (i.e. added), one in front of the other, to make up some of the filter density combinations employed in this study. For instance, the 1.40 filter combination was made by combining filters of three different densities: 1.00, 0.30, and 0.10; the 0.70 filter combination was made by combining a 0.50 filter with one of density 0.20, and so on. These combinations were necessary, since these particular neutral density filters are sold in densities of 0.10 through 0.90, and, thereafter, 1.00, 2.00, 3.00, etc. That is, one cannot purchase a filter of density 1.20 or 1.40. The light emanating from the projector was, in this study, reduced from a factor of 3.16 (0.50 filter group) to a factor of 25.11 (1.40

filter group).

Procedure

Stimulus exposure duration for all groups was the same: 5 msec. The only difference among the groups (besides filter density) was that the 1.00 Filter Control group subjects were shown 80 blank slides (sham flashes) at 5 msec each, with a 1.00 neutral density filter in front of the projector lens, rather than the stimuli. The instructions for all subjects were similar to the instructions for the 0-Exposure Control group in Experiments 2 and 3. Verbatim instructions are to be found in Appendix 5C. In all other respects (i.e. tasks and their durations), this study was similar to Experiments 2, 3, and 4.

Results and Discussion

Recall Level

To allow for blind scoring, the recall protocols of all subjects were randomly mixed, with trial number and group identification removed and substituted by a code. All the scoring was done by the experimenter.

Table 5.1 presents the average forced-recall results over three trials for the picture and word stimuli for the eight experimental conditions. Pictures and words are not tabulated for the 1.0 filter Control group, since subjects in this group were simply guessing.

Table 5.1

Average Forced-Recall Over Three Trials
for the Different Filter-Combination Groups

<u>Trials</u>	R1	R2	R3
	P / W /TOT	P / W /TOT	P / W /TOT
<u>Group</u> <u>(Filter)</u>			
0.5	18.50/12.92/ <u>31.42</u>	18.08/12.67/ <u>30.75</u>	18.25/11.58/ <u>29.83</u>
0.7	7.50/ 5.92/ <u>13.42</u>	8.33/ 5.92/ <u>14.25</u>	7.25/ 7.08/ <u>14.33</u>
0.8	8.75/ 7.17/ <u>15.92</u>	7.67/ 7.83/ <u>15.50</u>	8.67/ 8.25/ <u>16.92</u>
0.9	9.08/ 8.83/ <u>17.91</u>	10.33/ 9.08/ <u>19.41</u>	9.75/ 8.92/ <u>18.67</u>
1.0	6.67/ 8.17/ <u>14.83</u>	6.25/ 6.25/ <u>12.50</u>	7.33/ 7.50/ <u>14.83</u>
1.1	8.67/ 8.67/ <u>17.34</u>	7.67/ 6.83/ <u>14.50</u>	7.08/ 7.00/ <u>14.08</u>
1.2	7.33/ 6.67/ <u>14.00</u>	7.08/ 6.33/ <u>13.41</u>	7.00/ 5.58/ <u>12.58</u>
1.4	8.92/ 7.17/ <u>16.08</u>	8.67/ 7.92/ <u>16.58</u>	9.58/ 7.83/ <u>17.42</u>
Control (1.0)	<u>18.83</u>	<u>14.50</u>	<u>16.83</u>

Inspection of this Table reveals that the highest average recall over three trials occurred in the 0.50 filter group, which was far superior in number of hits to all other groups. Surprisingly, the 1.00 filter Control group's recall scores were initially numerically higher than those of the 0.70, 0.80, 0.90, 1.00, 1.10, 1.20, and 1.40 filter groups, even though these groups were actually shown the stimuli. Individual subjects' data for the nine groups are presented in Appendix 5A (Tables 5A.1 through 5A.9).

The combined (pictures + words), pictures, and words recall averages over three trials for the nine conditions are presented in Figures 5.1, 5.2, and 5.3, respectively. Again, only the combined hits are presented for the 1.0 filter Control group.

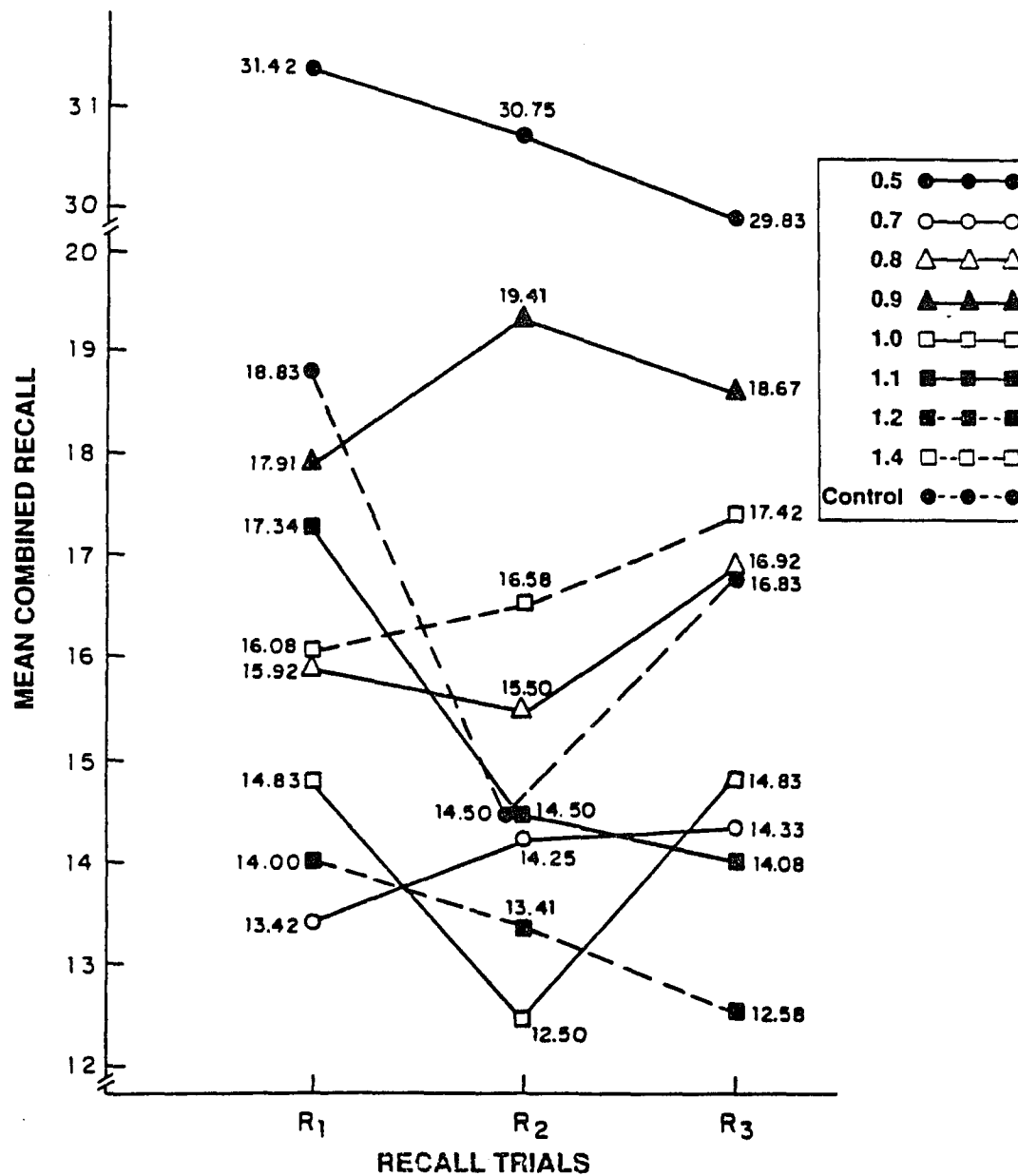


Figure 5.1. Combined (pictures + words) recall over three trials for the groups in Experiment 5.

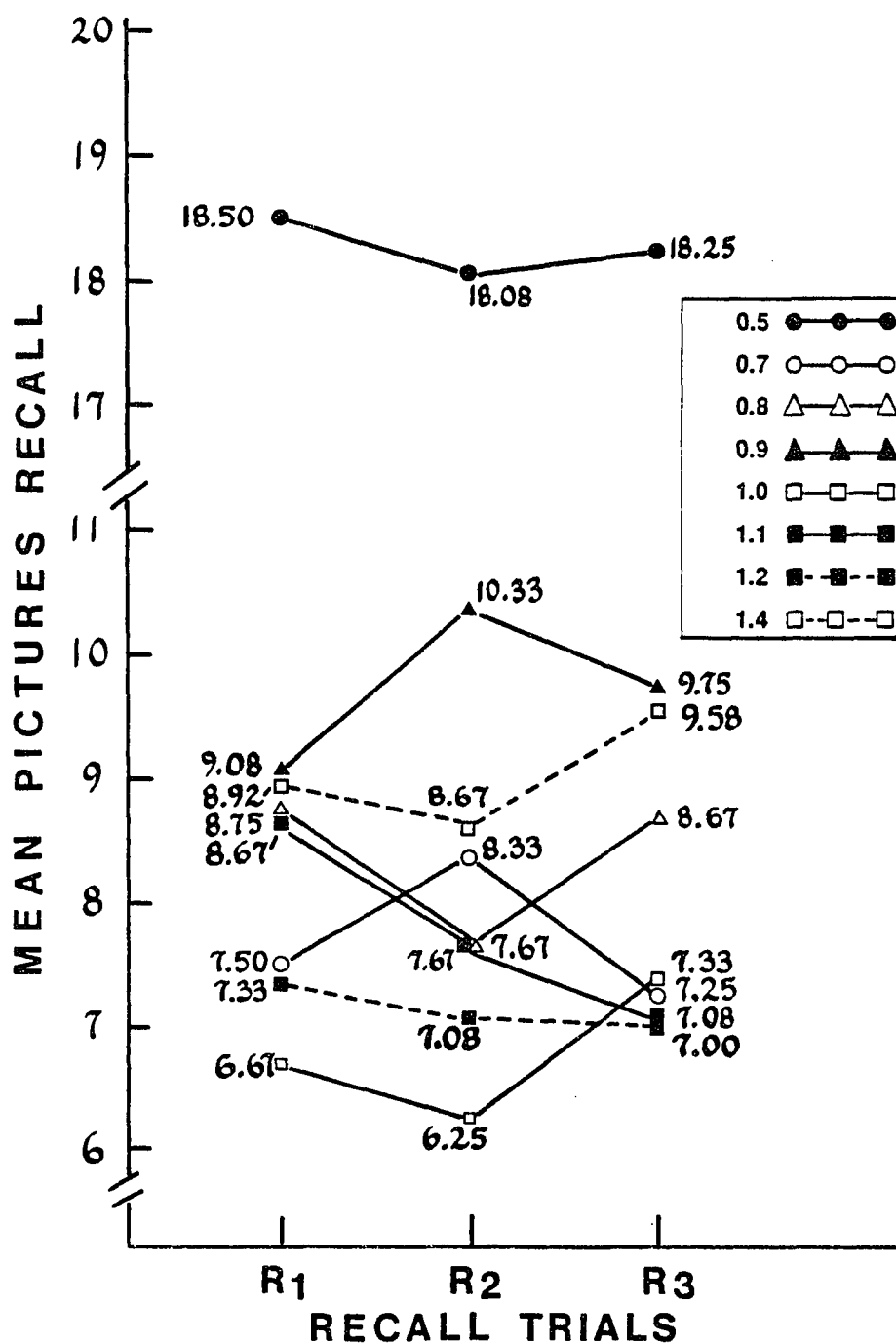


Figure 5.2. Recall for pictures over three trials for the experimental groups in Experiment 5.

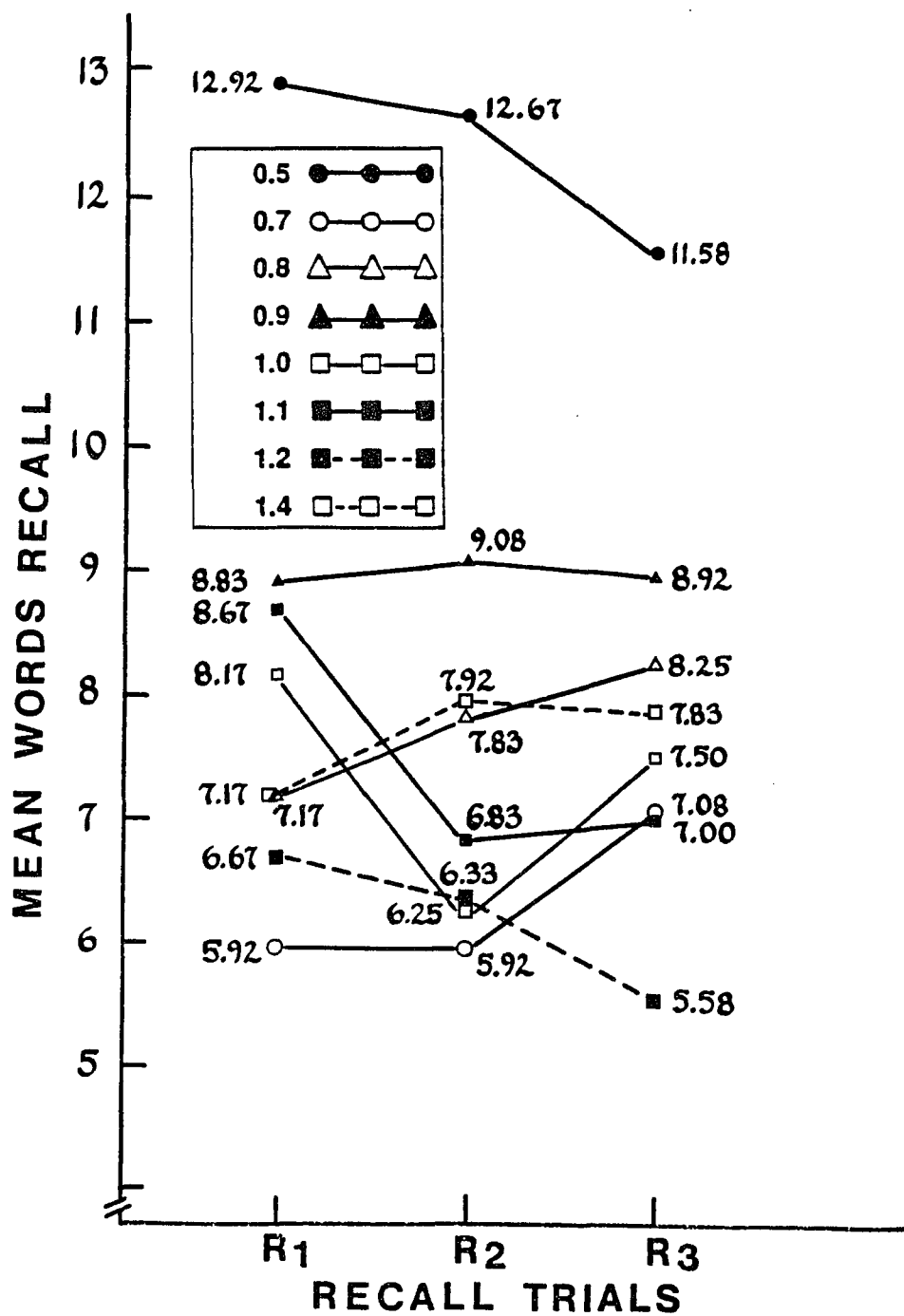


Figure 5.3. Recall for words over three trials for the experimental groups in Experiment 5.

Visual inspection of these Figures shows that, again, average recall for pictures was superior to word recall in all experimental groups (9.35 vs 8.00).

An 8 (Groups) x 3 (Trials) x 2 (Stimulus) analysis of variance performed on hits (correct recalls or guesses) on the eight experimental groups revealed the main effects of Groups and Stimulus to be significant: For Groups, $F(7,88) = 13.02$, $p < .01$; for Stimulus, $F(1,88) = 31.99$, $p < .01$. The main effect of Trials was not significant, indicating the probable absence of hypermnnesia in the groups. When specific contrasts were performed for each group, none proved to be hypermnnesic.

The Groups x Stimulus interaction was significant, $F(7,88) = 8.30$, $p < .01$. This interaction probably reflects the greater decline over trials of the word items relative to the pictures for the 0.50 filter group (see Figures 5.2 and 5.3), since, when this single group is removed, the interaction disappears. The analysis is summarized in Table 5C.1.

Table 5C.1

Summary of Analysis of Variance of the
Correct Forced-Recall Scores Over Three
Trials for the Different Filter-Combination
Experimental Conditions

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>
Groups	7	574.51	13.02**
Error (Groups)	88	44.14	
Within Subjects	480	(5.86)	
Trials	2	3.02	0.75
Interaction (Groups x Trials)	14	6.33	1.57
Error (Trials)	176	4.03	
Stimulus	1	261.36	31.99**
Interaction (Groups x Stimulus)	7	67.80	8.30**
Error (Stimulus)	88	8.17	
Interaction (Trials x Stimulus)	2	0.42	0.15
Interaction (Groups x Trials x Stimulus)	14	3.53	1.28
Error (Trials x Stimulus)	176	2.75	

** $p < .01$

Since visual inspection seemed to indicate that the significant Groups main effect was due to the superiority of the 0.50 filter group over the remaining eight groups, the analysis was redone with seven groups only (i.e. with the 0.50 filter group excluded). This 7 (Groups) x 3 (Trials) x 2 (Stimulus) analysis (Table 5C.2) revealed that the only significant main effect was that of Stimulus ($F(1,77) = 8.13, p < .01$). The Groups x Stimulus interaction, this time, was not significant, as expected, due to the exclusion of the 0.50 filter group from the analysis.

Table 5C.2

Summary of Analysis of Variance of the Correct
Forced-Recall Scores Over Three Trials for Seven
Experimental Filter-Combination Conditions:
0.70, 0.80, 0.90, 1.00, 1.10, 1.20, and 1.40

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>
Groups	6	62.64	1.41
Error (Groups)	77	44.55	
Within Subjects	420	(4.32)	
Trials	2	2.67	0.70
Interaction (Groups x Trials)	12	6.81	1.79
Error (Trials)	154	3.80	
Stimulus	1	61.46	8.13**
Interaction (Groups x Stimulus)	6	8.38	1.11
Error (Stimulus)	77	7.56	
Interaction (Trials x Stimulus)	2	0.57	0.22
Interaction (Groups x Trials x Stimulus)	12	3.63	1.38
Error (Trials x Stimulus)	154	2.63	

 ** $p < .01$

The next analysis consisted of a comparison of seven experimental groups (0.70 filter through 1.4 filter) and the 1.0 filter Control group. The Stimulus factor was not included in this analysis. This 8 (Groups) x 3 (Trials) analysis of variance indicated that only the Trials x Groups interaction was significant ($F(14,176) = 2.29, p < .05$) reflecting differential numerically incremental and decremental trends among the groups (see Figure 5.1). The analysis is summarized in Table 5C.3.

Table 5C.3

**Summary of Analysis of Variance of the Correct
Forced-Recall Scores Over Three Trials for the
0.70, 0.80, 0.90, 1.00, 1.10, 1.20, and 1.40
Filter-Combination and the 1.00 Filter Control
Conditions**

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>

Groups	7	114.64	1.33
Error (Groups)	88	85.92	
Within Subjects	192	(8.41)	
Trials	2	22.72	3.01
Interaction (Groups x Trials)	14	17.25	2.29*
Error (Within)	176	7.54	

* $p < .05$

Several patterns emerging from the data are noteworthy.

First, in this study no hypermnesia was obtained.

Second, the intertrial performance of the 0.50 filter-density group is worth underscoring. Despite the fact that the 5 msec exposures of the stimuli were occluded by a 0.50 density filter, R1 performance ($R1 = 31.42$) was greater than the corresponding R1 of previous 5 msec stimulus exposures without a filter (in Experiment 2, $R1 = 28.33$ and in Experiment 3, $R1 = 27.62$). Yet, the intertrial trends in the no-filter studies were incremental, significantly so in Experiment 3, whereas, in the present case, the recall trend was decremental, albeit not significantly. Although this differential pattern might be due to chance, it is worth considering the possibility that the 0.50 filter, without disrupting initial recall, nevertheless disrupts encoding processes necessary for the production of hypermnesia.

Third, the guessing performance of our standard 0-Exposure Control group, in this case called the 1.00 filter Control group, was initially higher than that of previous groups (18.83 as opposed to 13.50 and 13.22 in Experiments 2 and 3, respectively). This is disappointing, since we assumed that we had already gaged the guessing base-rate for the type of stimuli

employed in our laboratory at about 13 items out of 80. Of course, the discrepancy might be due to chance, though 5 items is a large deviation from past estimates. The R_1 's of the groups in the present study, excluding the 0.50 filter group, do show considerable variability, with the control subjects actually producing a higher R_1 than the 7 other groups (0.70, 0.80, 0.90, 1.00, 1.10, 1.20, and 1.40 filters). A contrast analysis of the control versus the other 7 groups at R_1 , however, did not reach significance ($F(1,88) = 3.34, p > .05$).

Finally, the 0.70, 0.80, 0.90, 1.00, 1.10, 1.20, 1.40, and 1.00 filter Control groups did not differ from one another in their intertrial performance, as shown by the third analysis of variance, from which the 0.50 filter group was excluded. This seems to show that, once the light emanating from the projector is reduced by a factor of 5 (antilog of 0.70 = 5.01) or more, subjects in all groups are in the same position as control subjects, who were shown sham flashes, with respect to recall.

Cumulative Recall (Cum R_n) and Reminiscence (Cum $R_n - R_1$)

The next analysis concerned the cumulative recall (reminiscence) scores. Table 5.2 presents the average cumulative recall results over the three trials for the picture and word stimuli for the nine groups (only the

combined scores are presented for the 1.0 filter
Control group).

Table 5.2

Average Cumulative Recall Over Three Trials
for the Different Filter-Combination Groups

<u>Trials</u>	<u>R1</u>	<u>R2</u>	<u>R3</u>
	<u>P / W / TOT</u>	<u>P / W / TOT</u>	<u>P / W / TOT</u>
<u>Group</u> <u>(Filter)</u>			
0.5	18.50/12.92/ <u>31.42</u>	20.83/15.75/ <u>36.58</u>	22.75/16.50/ <u>39.25</u>
0.7	7.50/ 5.92/ <u>13.42</u>	10.83/ 7.75/ <u>18.58</u>	13.08/ 9.25/ <u>22.33</u>
0.8	8.75/ 7.17/ <u>15.92</u>	11.17/10.08/ <u>21.25</u>	13.33/11.75/ <u>25.08</u>
0.9	9.08/ 8.83/ <u>17.92</u>	13.33/11.17/ <u>24.50</u>	14.75/11.92/ <u>26.67</u>
1.0	6.67/ 8.17/ <u>14.83</u>	9.00/10.42/ <u>19.42</u>	11.33/11.92/ <u>23.25</u>
1.1	8.67/ 8.67/ <u>17.33</u>	11.83/11.17/ <u>23.00</u>	14.17/13.00/ <u>27.17</u>
1.2	7.33/ 6.67/ <u>14.00</u>	10.33/ 9.00/ <u>19.33</u>	12.50/ 9.75/ <u>22.25</u>
1.4	8.92/ 7.17/ <u>16.08</u>	12.00/10.50/ <u>22.50</u>	14.50/12.75/ <u>27.25</u>
Control (1.0)	<u>18.83</u>	<u>25.08</u>	<u>29.33</u>

The smallest increase occurred in the 0.50 filter group (7.83); the highest in the 1.40 filter group (11.17). The average for all nine groups was 9.18, a figure comparable to previous experiments (10.38 being the average for Experiments 2, 3, and 4 combined). These data are presented visually in Figures 5.4 through 5.6, which present the average combined (pictures + words), pictures, and words cumulative recall functions for the eight experimental groups and combined scores for the 1.0 filter Control group.

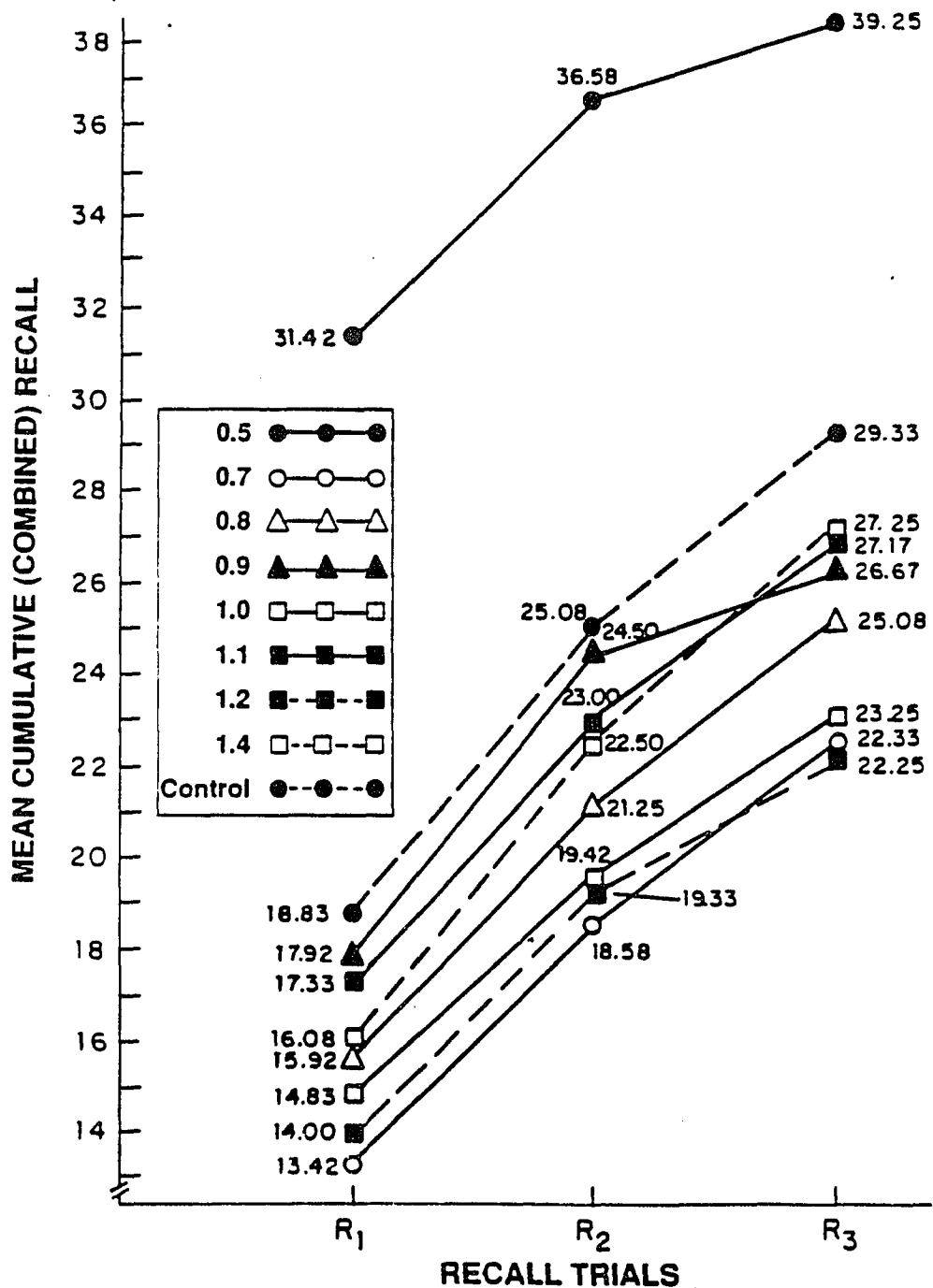


Figure 5.4. Combined (pictures + words) cumulative recall over three trials for the groups in Experiment 5.

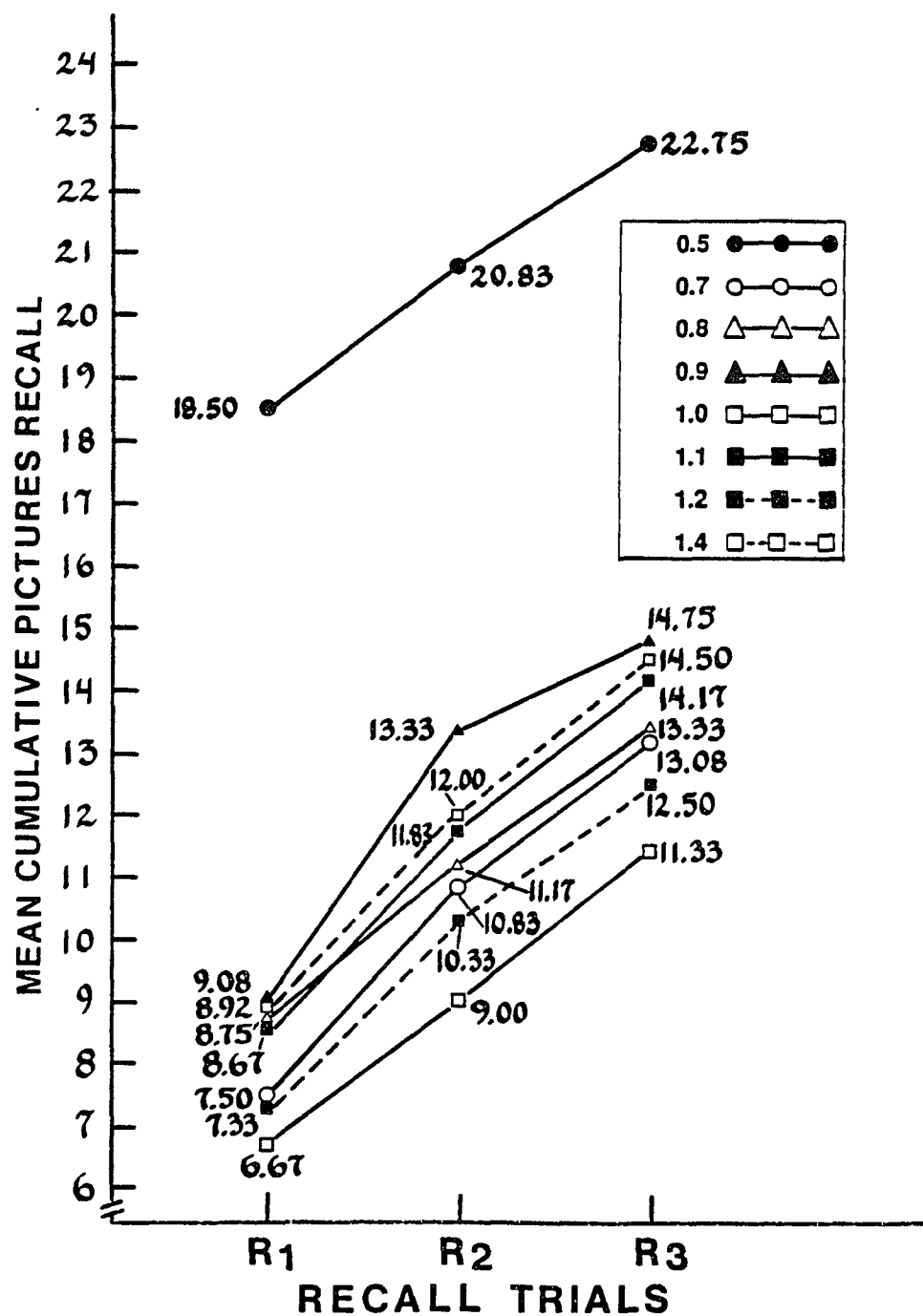


Figure 5.5. Cumulative recall for pictures for the experimental groups in Experiment 5.

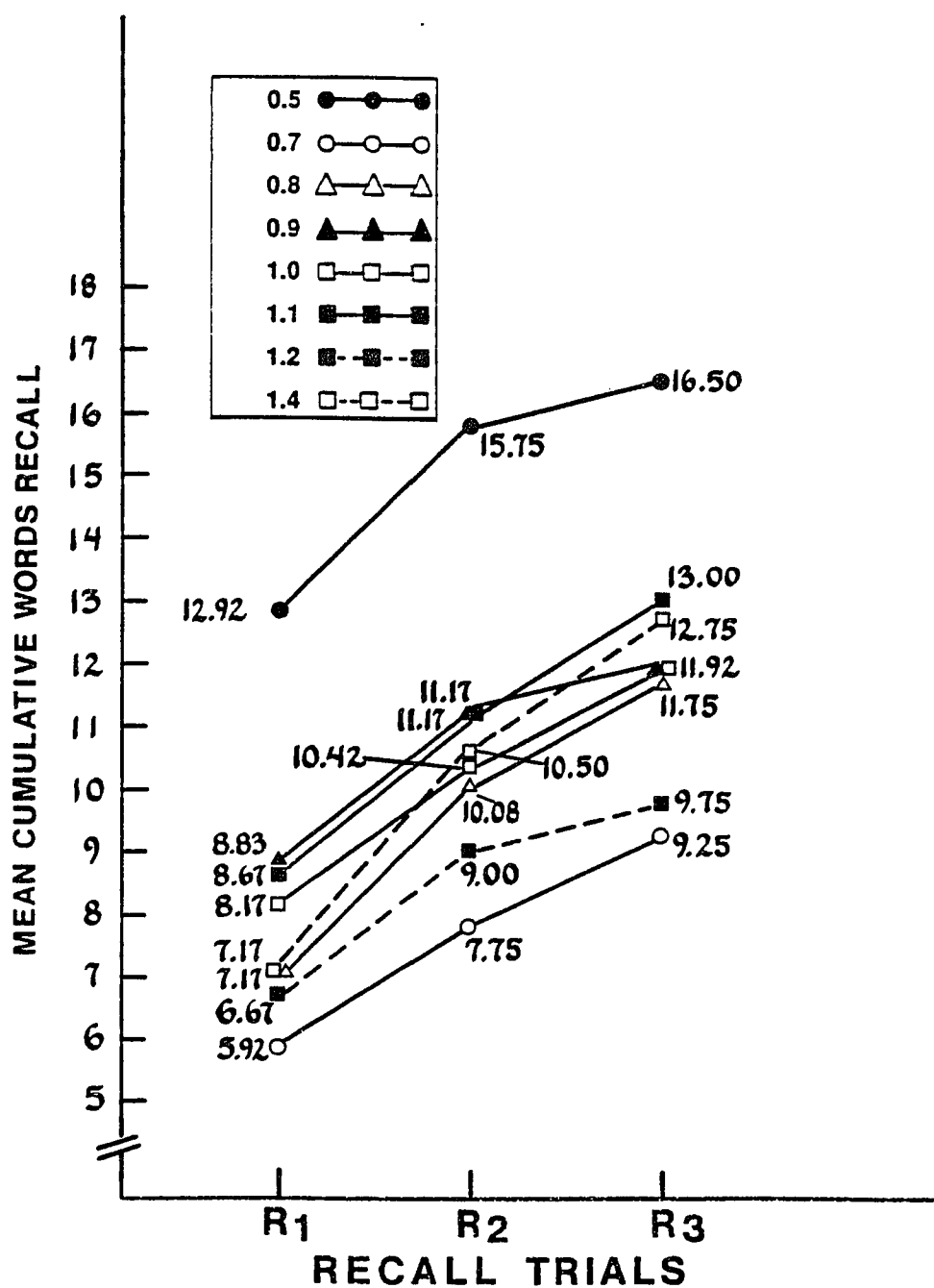


Figure 5.6. Cumulative recall for words for the experimental groups in Experiment 5.

Cumulative recall through Trial 3 (R3) for pictures, as in previous experiments, seems superior to that for the word items, with an overall average increase over trials of 5.12 for pictures as opposed to an increase of 3.93 for the words. Similarly, reminiscence for pictures seems superior to that for words, reminiscence being defined as cum R3 - R1 (Table 5.3).

Table 5.3

Reminiscence (cum R3 - R1) increase for
Pictures and Words for all Experimental Groups

<u>Group</u> <u>(Filter)</u>	<u>Reminiscence</u>	
	P	W
0.50	4.25	3.58
0.70	5.58	3.33
0.80	4.58	4.58
0.90	5.67	3.09
1.00	4.66	3.75
1.10	5.50	4.33
1.20	5.17	3.08
1.40	5.58	4.75
MEAN	<u>5.12</u>	<u>3.93</u>

Once again, it is puzzling that, despite the failure of groups from 0.70 to 1.40 filters to differ from chance (control subjects), picture reminiscence is superior to word reminiscence in these groups. Individual subjects' cumulative recall scores are presented in Appendix 5B (Tables 5B.1 through 5B.9).

An 8 (Groups) x 3 (Trials) x 2 (Stimulus) analysis of variance performed on the cumulative recall data of the eight experimental groups revealed that the three main effects were significant: For Groups, $F(7,88) = 10.11$, $p < .01$; for Trials, $F(2,176) = 443.27$, $p < .01$; and for Stimulus, $F(1,88) = 37.25$, $p < .01$, indicating the superiority in overall cumulative recall of the 0.50 filter group over the other groups, the increase of reminiscence over trials for all groups, and the superiority of cumulative recall for pictures relative to the word items (Table 5C.4).

Table 5C.4

Summary of Analysis of Variance of the
Cumulative Recall Scores Over Three Trials
for Eight Filter-Combination Experimental Conditions

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>

Groups	7	579.49	10.11**
Error (Groups)	88	57.32	
Within Subjects	480	(9.91)	
Trials	2	997.36	443.27**
Interaction (Groups x Trials)	14	2.28	1.01
Error (Trials)	176	2.25	
Stimulus	1	462.25	37.25**
Interaction (Groups x Stimulus)	7	67.46	5.44**
Error (Stimulus)	88	12.41	
Interaction (Trials x Stimulus)	2	17.91	12.88**
Interaction (Groups x Trials x Stimulus)	14	1.98	1.42
Error (Trials x Stimulus)	176	1.39	

** p<.01

The Trials x Stimulus interaction proved significant ($F(2,176) = 12.88, p < .01$), indicating the greater increase over trials of the picture stimuli relative to the word items. The Groups x Stimulus interaction also reached significance ($F(7,88) = 5.44, p < .05$), indicating the differential pictures and words increase in the cumulative recall of the groups.

Since it was again of interest to analyze the data without the supraliminal 0.50 filter group, the analysis was redone without this group. The resulting 7 (Groups) x 3 (Trials) x 2 (Stimulus) analysis of variance (Table 5C.5) revealed the main effects of Trials ($F(2,154) = 381.78, p < .01$) and Stimulus ($F(1,77) = 15.64, p < .01$) to be significant, not Groups ($F(6,77) = 1.20, p > .05$), indicating that cumulative recall was similar in all groups.

Table 5C.5

Summary of Analysis of Variance of the
Cumulative Recall Scores Over Three Trials for
Seven Experimental Filter-Combination Conditions:
0.70, 0.80, 0.90, 1.00, 1.10, 1.20, and 1.40

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>
Groups	6	71.62	1.20
Error (Groups)	77	59.91	
Within Subjects	420	(9.01)	
Trials	2	904.82	381.78**
Interaction (Groups x Trials)	12	2.23	0.94
Error (Trials)	154	2.37	
Stimulus	1	194.38	15.64**
Interaction (Groups x Stimulus)	6	27.95	2.25*
Error (Stimulus)	77	12.43	
Interaction (Trials x Stimulus)	2	17.41	13.29**
Interaction (Groups x Trials x Stimulus)	12	2.13	1.63
Error (Trials x Stimulus)	154	1.31	

* p<.05

** p<.01

The Trials x Stimulus interaction again proved significant ($F(2,154) = 17.41, p < .01$), showing the greater increase over trials of pictures relative to words. The Groups x Stimulus interaction again reached significance ($F(6,77) = 2.25, p < .05$), indicating differential increases in the groups in the cumulative recall of pictures and words.

Thus, it seems that, when the performance of the 0.50 filter group is excluded from both the recall and the cumulative recall analyses, all other experimental groups perform equally.

The last analysis on the cumulative recall scores (Table 5C.6) compared the performance of seven experimental groups (0.70 filter through 1.4 filter) and the 1.0 filter Control group (Stimulus factor not included). This 8 (Groups) x 3 (Trials) analysis of variance revealed only the main effect of Trials to be significant ($F(2,176) = 450.54, p < .01$).

Table 5C.6

**Summary of Analysis of Variance of the Cumulative
Recall Scores Over Three Trials for the 0.70, 0.80,
0.90, 1.00, 1.10, 1.20, and 1.40 Filter-Combination
and the 1.00 Filter Control Conditions**

Source of Variance	<u>df</u>	<u>MS</u>	<u>F</u>

Groups	7	189.17	1.67
Error (Groups)	88	113.43	
Within Subjects	192	(26.97)	
Trials	2	2,140.06	450.54**
Interaction (Groups x Trials)	14	4.44	0.93
Error (Within)	176	4.75	

			** p<.01

Conclusions

The major conclusion to be drawn from the data is that, when stimuli are truly subliminal (i.e. when subjects presented with the stimuli perform at R1 in a manner comparable to subjects not shown the stimuli), hypermnesia fails to occur.

Even when the stimuli are not strictly (absolutely) subliminal, but are deeply degraded, as in the 0.50 filter condition, hypermnesia fails to occur.

The absence of a significant difference between groups in cumulative recall is in itself significant, since it suggests, bafflingly, that the group that is clearly performing above chance (0.50 filter) does not produce higher cumulative recall (indeed, the trend is toward lower cumulative recall). Similarly, reminiscence for the supraliminal group is numerically lower than for any of the subliminal groups. This raises doubt about the adequacy of cumulative recall as an index of stimulus accessibility.

Subjects in the 0.70, 0.80, 0.90, 1.00, 1.10, 1.20, and 1.40 neutral density filter experimental groups performed at a level comparable to that of control subjects. The conclusion that subjects in all these groups were, therefore, guessing the stimuli seems warranted. If subjects were merely guessing, it could be asked why they should be better at guessing

pictures rather than words? In other words, is the pictures versus words difference in the subliminal groups reflecting some subtle subliminal effects? The only group where recall for words was numerically higher to that for pictures (though not reliably) was the 1.00 filter Experimental group. The cumulative recall performance of the groups over trials is not surprising. What is surprising is that reminiscence for the subliminal groups exceeded the reminiscence in the 0.50 filter group ($F(1,198) = 11.16, p < .01.$)

The performance of the 1.00 filter Control group seems high when compared to that of our previous standard control groups. However, if it is assumed that all groups with a filter density of 0.70 and higher performed at chance level (i.e. were guessing), then the averages for those groups at R1 and R3 are 16.04 and 15.71, respectively, not far from our previous estimates of about 13 items.

The dramatically differential behavior of the subjects in the 0.50 and 0.70 filter groups is intriguing. The initial difference in hits between these two groups is 18 items. This seems to be a hefty difference considering that the light was reduced from a factor of about 3 to a factor of 5. It would be interesting to observe the performance of a group between these two filter densities, namely that of a

0.60 filter group, where the light would be reduced by a factor of about 4 (antilog of 0.60 = 3.98). In fact, the design of the experiment seems to have fortuitously dichotomized the presentation of the stimuli into two regions: supraliminal (0.50 filter) and truly subliminal (0.70 filter and above), with an average difference of about 15 hits between these two regions. It would be interesting to find out how performance is affected within this region.

General Discussion

Overall Summary of Results

The major conclusion in Experiment 1 was that, with response productivity controlled, no hypermnesia was obtained for a briefly presented (500 msec, 50 msec, 5 msec) pictorial stimulus grid. These results differed from Erdelyi's (1970) in that the experimental subjects' forced-recall performance was not superior to that of their yoked counterparts (the base-rate group) and did not, therefore, evidence information unreported in the initial recall trial.

Hypermnesia was, however, obtained in several groups of subjects, and over a wide range of exposure durations, when the stimuli consisted of supraliminal picture and word lists (Experiments 2 - 4). In Experiment 2, hypermnesia was obtained for the 5 sec, 2 sec, 1 sec, and 50 msec exposure groups, with a non-significant trend for the 5 msec group. This group however, was incremental in Experiment 3. In Experiment 4, hypermnesia was obtained in all four groups: 5 sec, 2 sec, 1 sec, and 50 msec. Moreover, in Experiments 2 through 4, both the level of recall and hypermnesia for pictures were superior to those for words. In Experiment 2, picture hypermnesia was found in the 5 sec, 2 sec, and 50 msec groups. The hypermnesia obtained in the 1 sec group was due to the increase over trials of both pictures and words. In Experiment 4, pictures were incremental in all

four groups (5 sec, 2 sec, 1 sec, and 50 msec), words only in the 5 sec and 50 msec groups. Thus, hypermnesia for words was only produced twice in the 5 sec group (Experiments 2 and 4), and once in the 50 msec group (Experiment 4).

Finally, none of the experimental groups in Experiment 5, whether supraliminal (0.5 filter) or absolute subliminal, i.e., chance-level performance on initial testing (0.7 - 1.4 filters) were incremental over trials.

Hypermnesia: Picture-Word Differences.

Why does hypermnesia tend to occur more often for pictures than for words? The issue is not settled in the literature. Erdelyi and Becker (1974) proposed an imagery hypothesis.

The imagery hypothesis provides an explanation for the robust hypermnasias obtained with pictures, stories, and other imagistic materials (Ballard, 1913; Erdelyi, 1990; Popkin and Small, 1979). It can also account for hypermnesia for words that have been "deeply processed" (Belmore, 1981; Craik and Lockhart, 1972; Erdelyi, 1982; Payne and Roediger, 1987) through semantic elaboration, sentence construction, sentence embedding, etc., the notion being that imagery is generated by the "deep" processing. An alternative explanation is that the depth-of-processing itself, and not the imagery, is the effective factor. Since it is hard (perhaps impossible) to control for the amount of

imagery generated by the subjects in experiments consisting of depth-of-processing instructions, it may turn out to be correspondingly difficult/impossible to distinguish between imagistic and depth-of-processing explanations of the superiority of picture hypermnesia over that for words.

In either case, Erdelyi's explanation (Erdelyi, 1985; Erdelyi, 1994) is that the recognition component in the retrieve-recognize model he proposes (see below) is enhanced through imagery or depth-of processing relative to shallowly processed words.

An different explanation has been proposed by Roediger, payne, Gillespie, and Lean (1982) in terms of level of cumulative recall (see below), which is enhanced both by imagery and depth-of-processing instructions.

The Magnitudes of Hypermnesia and Reminiscence as a Function of Exposure Duration

Since a wide range of exposure durations (5 sec - 5 msec) was explored in Experiments 2, 3, and 4, the question arises whether the magnitude of hypermnesia is related to exposure duration. Table 6.1 presents the results for the first recall trial (R1), the third recall trial (R3), and the hypermnesia levels (R3 - R1) for the different exposure groups in Experiments 2 through 4.

Table 6.1

**First Recall Trial (R1), Third Recall Trial (R3), and
Hypermnnesia Levels (R3 - R1) for the Different Exposure
Groups in Experiments 2 Through 4**

<u>Exposure</u>	<u>Trials</u>		<u>Hypermnnesia</u>
<u>Duration</u>	R1	R3	R3 - R1
5 sec (Exp. 2)	33.17	38.11	4.94
5 sec (Exp. 4)	32.61	36.17	3.56
			Mean = <u>4.25</u>
2 sec (Exp. 2)	34.11	36.39	2.28
2 sec (Exp. 4)	29.83	32.83	3.00
			Mean = <u>2.64</u>
1 sec (Exp. 2)	35.44	37.11	1.67
1 sec (Exp. 4)	31.22	34.50	3.28
			Mean = <u>2.48</u>
50 msec (Exp. 2)	33.89	36.06	2.17
50 msec (Exp. 4)	30.22	33.39	3.17
			Mean = <u>2.67</u>
5 msec (Exp. 2)	28.33	28.72	0.39
5 msec (Exp. 3)	27.67	29.78	2.11
			Mean = <u>1.25</u>
Control (Exp. 2)	13.50	11.88	- 1.62
Control (Exp. 3)	13.22	11.56	- 1.66
			Mean = <u>- 1.64</u>

Table 6.1 suggests a trend in which hypermnesia decreases with exposure duration, though the least ambiguous exposure effect is that between the 5 sec exposure and the rest. The zero (sham exposure) produced negative hypermnesia, i.e., amnesia.

Can the same conclusion be reached about the magnitude of reminiscence ($\text{cumRn} - \text{R1}$) and exposure duration? As we have seen, repeatedly, and to our surprise, the magnitude of reminiscence in these studies was totally unaffected by exposure duration, including 0-exposure (sham flashes). Table 6.2 presents the results of the first recall trial (R1), cumulative recall (cum Rn), and reminiscence ($\text{cum Rn} - \text{R1}$), for the different exposure groups in Experiments 2 through 4.

Table 6.2

**First Recall Trial (R1), Cumulative Recall (cum Rn), and
Reminiscence (cum Rn - R1) For the Different Exposure Groups
in Experiments 2 Through 4**

<u>Exposure</u>	<u>Trial</u>	<u>Cumulative Recall</u>	<u>Reminiscence</u>
<u>Duration</u>	R1	(cum Rn)	(cum Rn - R1)
5 sec (Exp. 2)	33.17	44.39	11.22
5 sec (Exp. 4)	32.61	45.94	13.33
			Mean = <u>12.28</u>
2 sec (Exp. 2)	34.11	44.39	10.28
2 sec (Exp. 4)	29.83	40.11	10.28
			Mean = <u>10.28</u>
1 sec (Exp. 2)	35.44	45.17	9.73
1 sec (Exp. 4)	31.22	42.61	11.39
			Mean = <u>10.56</u>
50 msec (Exp. 2)	33.89	45.78	11.89
50 msec (Exp. 4)	30.22	42.05	11.83
			Mean = <u>11.86</u>
5 msec (Exp. 2)	28.33	37.11	8.78
5 msec (Exp. 3)	27.67	36.67	9.00
			Mean = <u>8.89</u>
Control (Exp. 2)	13.50	23.06	9.56
Control (Exp. 3)	13.22	21.56	8.34
			Mean = <u>8.95</u>

All experimental groups in Experiment 2 produced an equivalent amount of reminiscence (an average of 10.25). Similarly, average reminiscence for all groups in Experiment 4 was 11.71.

Overall, there was no difference in reminiscence for pictures (5.52) and words (4.85) across experiments. Thus, even though hypermnesia for words was not as readily obtained in these studies as hypermnesia for pictures, reminiscence for words was commonplace, found in all groups. One big surprise was that the reminiscence functions of the zero-exposure control groups in these studies were indistinguishable from those of the experimental groups. Thus, unlike hypermnesia, reminiscence is not at all sensitive to exposure duration, nor to the presence or absence of the stimuli. Thus, even though reminiscence is the all-pervasive incremental component of hypermnesia, it is not a sensitive measure of stimulus recovery.

Theories of Hypermnesia.

Since hypermnesia is readily obtainable, at least for supraliminal pictures, the question may be posed as to why hypermnesia occurs. That is, what possible mechanisms might be underlying the phenomenon of hypermnesia? Two major theoretical approaches have been emphasized in the literature.

(1) The Retrieve-Recognize Approach.

This approach is based on a two stage model of recall

(e.g., Erdelyi and Becker, 1974; Kintsch, 1970). In this approach the subject is first assumed (during recall) to retrieve (search, generate) a succession of possible candidate items for recall and, after each item is retrieved, the subject is assumed to make a recognition decision about the generated item. Thus, generated items which are recognized (as having been part of a list) are recalled; those items not recognized are discarded and not recalled. Hence, recall should increase to the extent that with additional trials (or time -- longer trials) more items are generated and recognized (reminiscence being the incremental component here). This view explains why reminiscence, the incremental component in hypermnesia, should increase. But why should hypermnesia, the net increase in recall over a series of trials, occur, when each trial is of the same duration (at least, in the experiments here reported)? Presumably, learning from previous trials leads to faster retrieval, faster recognition/recall, and less forgetting (oblivescence) over trials, thus allowing extra time (not available at R1) within each successive trial for the generation, and possible recognition, of additional items. Erdelyi and Becker's (1974) retrieve-recognize approach helps to explain the observed differences in hypermnesia between pictures and words by making use of the recognition component of the model: pictures are exceptionally recognizable (Nickerson, 1965; Shepard, 1967;

standing, Conezio, and Haber, 1970). Therefore, when the generated (retrieved) items are pictures, the probability that they will be recognized is very high. This leads to successful recall (Paivio, 1971) and less confusion errors (Glanzer, 1985). This, in turn, should lead to better learning and faster recall in subsequent trials. Since words are less recognizable than pictures, they will, when generated, give rise to more misses, confusion errors (false alarms) or both, the end result being relatively poorer learning from one trial to the next.

Although we have just mentioned that pictures are highly recognizable items, the basic version of the retrieve-recognize approach does not require imagery per se to account for hypermnnesia. What it does require is stimulus materials that are both highly retrievable and recognizable, although imagery may well turn out to be the critical common denominator of all types of effective stimuli or memory codes which are highly retrievable and recognizable.

How well does the retrieve-recognize approach account for the results in Experiments 2 through 4 ? First, it seems to explain the superiority in both level of recall and hypermnnesia of the picture items: Since the magnitude of reminiscence was similar for pictures and words, and since the pictures were hypermnnesic much more often than the words, the picture items might have been less forgotten over

trials (due to better learning). On the other hand, the model is rather general and not quantitative enough. For example, the model predicts that the greater the learning, the less the forgetting, but not how much less forgetting. This generality of the retrieve-recognize approach makes it quite refractory to test. Ideally, one would wish to show that items which are highly retrievable (i.e. more often reminisced) are also those items which are highly recognized once retrieved and that those same items produce more hypermnesia (due to better learning) than less retrievable/recognized items. The same argument can be made for images of deeply processed, as opposed to shallowly processed, words. The retrieve-recognize model is the explanatory basis of the more descriptive imagery hypothesis. The reminiscence results, which are generally mystifying, are not well explained by the model.

(2) The Level of Cumulative Recall (LOCR) Approach.

This model was proposed by Roediger, Payne, Gillespie, and Lean in 1982, originally under the label "level of recall" (LOR) hypothesis. It is, however, a cumulative recall model, hence the revised label (LOCR). In this model, which is purely descriptive, the magnitude of hypermnesia is determined by the asymptotic level of cumulative recall (estimated by $\text{cum } R_n$). Any factor which, for whatever reason, produces a greater asymptotic cumulative recall, estimated by $\text{cum } R_n$, will produce greater

hypermnnesia. The basis for this is that when LOCR is high (e.g., with pictures) the cumulative recall function takes more trials to reach asymptote than when LOCR is relatively low (e.g., words). Hence, the initial tests for high LOCR materials (e.g., pictures) have not exhausted cumulative recall growth, but with low LOCR stimuli (e.g., words) succeeding trials are no longer resulting in new recoveries.

Although intuitively the theory seems to make sense -- one would expect reminiscence and hypermnnesia to be correlated perfectly -- Erdelyi (1982) argued against it on the basis of past literatures and Payne (1987) demonstrated experimentally that varying levels in LOCR (cum R_n) did not result in corresponding differences in levels of hypermnnesia ($R_n - R_1$). In this series of experiments, similarly, cumulative recall level (cum R_n) was not correlated with hypermnnesia.

The major weakness of the LOCR approach seems to be that it does not take forgetting into account (Erdelyi, 1982). Since hypermnnesia is the resulting balance between reminiscence and oblivescence (Ballard, 1913; Erdelyi, 1982), any theory of hypermnnesia which does not take forgetting into account is incomplete. It should be obvious that, in these experiments, the hypermnnesias produced in the incremental groups were due, not to the magnitudes of reminiscence, since control groups showed equivalent magnitudes, but to less forgetting over trials in the

experimental groups. Moreover, since reminiscence (cum Rn - R1) almost never fails to occur (even in subjects who are merely guessing at the stimuli), it would be futile to try to predict hypermnnesia from the level of cum Rn. What LOCR does predict -- and perfectly -- is reminiscence (Erdelyi, 1994), but that is because (again, see Erdelyi, 1994) cum Rn is perfectly correlated with cum Rn - R1 and is, therefore, an alternate index of reminiscence.

Contributions of the Present Experiments to the Hypermnnesia Literature

Positive Findings

(a) The previous hypermnnesia results with supraliminal lists of pictures and words (Erdelyi and Kleinbard, 1978; Erdelyi and Becker, 1974) were replicated with the usual exposure duration of 5 sec and extended to shorter durations (2 sec, 1 sec), and to the very short exposure durations of 50 msec (Experiments 2 and 4) and 5 msec (Experiment 3). As expected, overall performance was superior for pictures than for words.

(b) A novel finding has been the downward drift, with repeated testing, of chance base-rates (see especially Experiment 2). Thus, chance performance decreases over trials and this fact raises the question of whether, in the future, the intertrial performance of the experimental groups should be compared to no-change or to that of the declining control groups.

(c) Another peculiar finding, with potentially important methodological ramifications, should also be mentioned: cumulative recall seems to be insensitive to exposure duration, to the point that it does not discriminate conditions when stimuli were presented and when they were not (sham flashes). If true, reminiscence functions should not be employed in lieu of hypermnesic ones to assess recall increments over trials, even though reminiscence is the incremental component of hypermnnesia.

Negative Findings

(a) The failure to overturn Erdelyi's (1970) results (Experiment 1) indicated that the experimental subjects did not possess, at least for the single pictorial grid stimulus matrix, more information about the stimulus than yoked control subjects. The contribution, in this sense, is a vindication of Erdelyi's (1970) results but, this time, by controlling response productivity from the very beginning (forced-recall trials throughout).

(b) The unsuccessful attempt to obtain hypermnnesia with the absolute subliminal (initial recall at chance level) lists was, to this author, a bit disheartening. The recall patterns over trials of all the subliminal filter groups (0.7 - 1.4 filter densities) were non-incremental. The argument could be made that, even if not hypermnnesic, subjects in these groups still retained some information about the stimuli since, not surprisingly, reminiscence took

place. Unfortunately, this argument does not hold, since the reminiscence function of the control group was identical to those of the experimental groups. Thus, it seems that what happened in this study was not that the balance between forgetting (oblivescence) and remembering (reminiscence) became negative (i.e. amnesic), but that the experimental subjects had no information available about the degraded stimuli and, hence, nothing to forget. The conclusion then should be that highly degraded stimulus lists, yielding chance-level initial recall, fail to produce hypermnesia. It remains unclear, however, whether the stimuli actually registered in the systems of the 0.7 - 1.4 filter density subjects. It could have been the case that the stimuli had registered but, because of their being highly degraded to start with, they were not able to be retrieved (generated) or, if retrieved, were not recognized. Since the performance over trials of the experimental groups was virtually indistinguishable from that of the control group, however, the most parsimonious conclusion should be that the degraded stimuli had no effect on the experimental subjects over a wide range of filter densities, and that these subjects were operating at chance level, just like the control subjects. In short, it seems that all the subjects in Experiment 5 (except for the clearly supraliminal 0.5 filter group) performed at chance (guessing) level.

Final Remarks

The negative hypermnesia conclusions for absolute subliminal stimuli seem to apply to recall, but may be premature for other memory indicators, namely recognition memory. Several lines of evidence (Kunst-Wilson and Zajonc, 1980; Seamon et al., 1984, 1983a, 1983b) have demonstrated the indirect (dissociation paradigm) effects of unconscious stimuli. Recent studies by Reingold and Merikle (Merikle and Reingold, 1991; Reingold, 1990) have renewed the question of hypermnesia (recovery paradigm) for absolute subliminal (chance-level) stimuli.

Reingold and Merikle were interested in demonstrating, through a procedure involving the dissociation paradigm, the indirect effects of unconscious stimuli. In this respect, the recovery issue was, for them, a secondary one. Reingold and Merikle used a visual variation of the dichotic shadowing procedure (Eich, 1984) for the study of subliminal effects: A long sequence of word-pairs was visually presented at 430 msec per pair. One of the words (indicated by an arrow) in each word-pair was to be "shadowed" (called out loud) by the subjects. After the presentation of all the word pairs, subjects were given a recognition test for the shadowed words. Not surprisingly, recognition memory for these words was quite high. If, instead, subjects were tested for the non-shadowed words, recognition memory was at chance level. However, when subjects were asked to evaluate

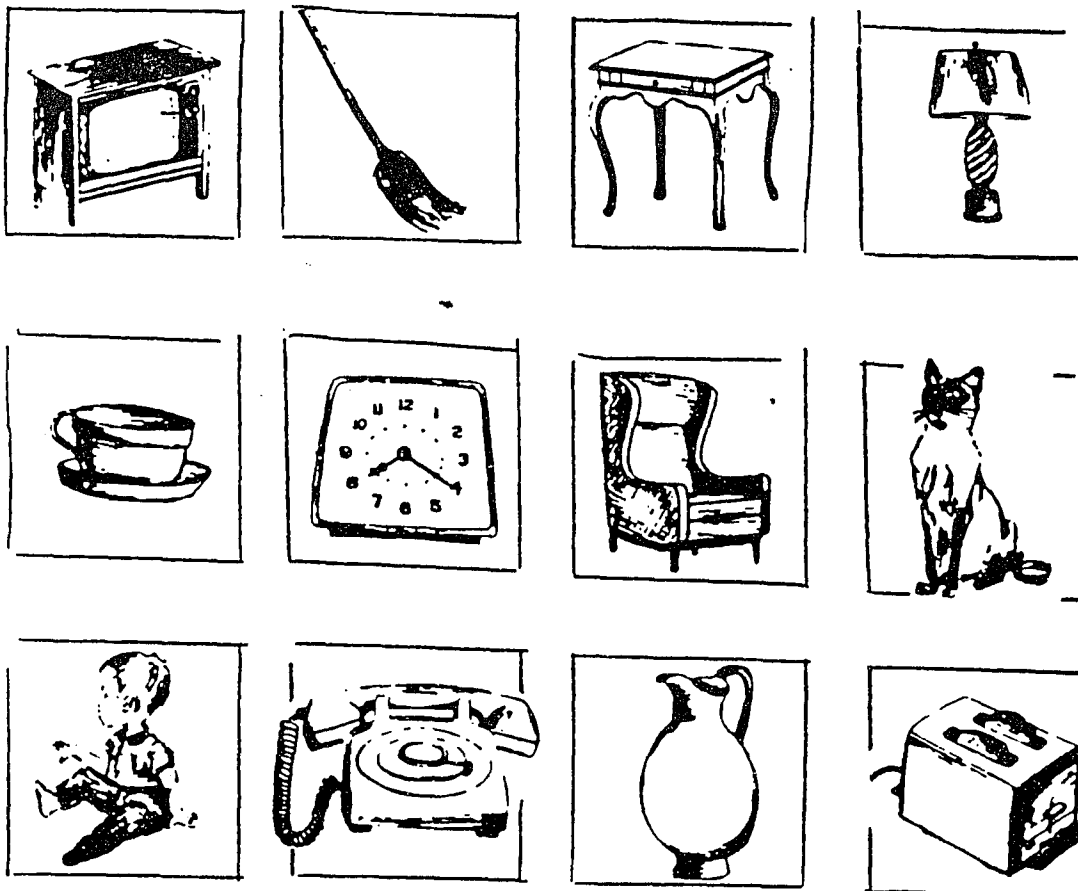
the extent to which the non-shadowed words "stood-out" (brightness judgments), performance was reliably above chance, even though all the words in the word pairs had been equally bright. These results corroborated the aforementioned results of Kunst-Wilson and Zajonc (1980) and Seamon et al. (1984; 1983a; 1983b) on the demonstration of the indirect effects (dissociation paradigm) of unconscious stimuli.

Partly in response to Erdelyi's (1986) suggestion that absolute subliminality (chance-level performance) cannot be assessed by a single test after stimulus presentation, because of the possibility that initial chance-level performance might become above-chance performance over time; that is, the possibility of hypermnnesia, Reingold and Merikle compared recognition memory for the non-shadowed words in the first-third, second-third, and third-third portions of their recognition test. Although overall recognition performance was at chance level, recognition for the non-shadowed words increased significantly from the first-third to the third-third portions of the test. Interestingly, the indirect contrast measure, above chance in the first-third portion of the test, dropped to chance level by the third-third. These results were immediately replicated by Merikle and Reingold (1991) with, basically, the same results. Thus, these authors were able to successfully demonstrate, in one fell swoop, both the

workings of the dissociation paradigm (the contrast measure) and the recovery, or hypermnesia, paradigm (incremental recognition memory for the non-shadowed words when the test was analyzed in portions). Therefore, although the conclusion that, when stimuli are highly degraded and absolutely subliminal (initial chance-level performance), recall hypermnesia fails to occur, seems inescapable at this juncture, this conclusion may be premature with respect to recognition hypermnesia. It may even turn out that recognition hypermnesia for absolutely subliminal stimuli will, in the future, be a robust phenomenon, just like recall hypermnesia is for supraliminal picture lists.

Appendix 1A

Stimulus Grid for Experiment 1.



Appendix 1B

Verbatim instructions to subjects in Experiment 1.

[Before entering the experimental room].

INSTRUCTIONS TO THE EXPERIMENTAL GROUP

"A stimulus consisting of twelve hand-drawn objects, arranged in three rows of four items each, will be flashed on a screen. You may have trouble seeing all or any of the objects. After the stimulus is presented you will be asked to draw the objects that you remember having seen and to label your drawings."

[E and S enter the room, which is illuminated by a 25 watt bulb].

"Please sit down here." [E points to the chair facing the screen].

[After S is seated, E turns both projectors on].

[There is an adaptation period of approximately two minutes for all subjects].

"Please look at the screen. I will ask you now to look at the center of the illuminated rectangle on the screen. I will count one, two, three, and then flash the stimulus. If you are ready, say "yes" and then, after counting one, two, three, I shall flash the stimulus, which will appear exactly where the illuminated rectangle is now. Thus, I will go like

this: one, two, three, flash! Are you about ready to start?

[If S says "yes"]. "Good. One, two, three, flash!"

[E flashes stimulus on screen at the appropriate duration].

[After stimulus offset, E turns off both projectors and turns on the main room lights. E picks up an answer sheet and a black pen and puts them in front of S, who remains seated at the table].

"What I will ask you to do now is to think about the stimulus and to draw and label everything you saw in the boxes on this sheet. Even though the stimulus did not consist of boxes for the objects, I want you to draw the objects you remember having seen in these boxes and to label them. Even if you are not sure of the position of an object, draw and label it anyway. Try to draw and label everything you think you saw, short of outright guessing."

[After S stops drawing, there is more prodding from E ("Are you certain that you have drawn and labeled everything you remember? Maybe there is something you left out? Some detail that you forgot to draw? Take your time and make sure you are certain that you cannot remember anything else.") to insure that S has drawn and labeled all that S can remember as having been part of the stimulus. When S says that he/she cannot remember any more objects, E proceeds].

"All right. Now I will give you a different colored pen and ask you to fill in the remaining boxes on the sheet with

best guesses of the remaining stimulus items. If, in the process of guessing, you remember a stimulus item, you can pick up the black pen and draw and label the remembered item in black. Please provide your best guesses, without repeating any responses. Do you understand?"

[E gives S the green pen].

[After the recall sheet is completed by S, E directs S to sit on the comfortable chair and switches off the main room lights].

"O.K. Now I would like you to relax, face the screen, and think about the stimulus for a few minutes. Look at the part of the screen where the stimulus was projected and try to visualize the stimulus. If you wish to close your eyes every once in a while you may do so, but try to concentrate on the stimulus. From time to time I will interrupt your silent thinking and ask you to say aloud whatever thoughts or objects come to your mind, regardless of whether they have anything to do with the stimulus. Do not censor your responses, except in one respect: call out single, discrete objects or words, not sentences or stories."

[Instructions preceding an FA sequence follow].

"Please call out whatever objects or thoughts come to your mind. I will let you know when to stop. After I say "Stop!", continue to think silently about the stimulus."

[If S does not follow instructions about calling out discrete objects or words, the instructions are repeated

again. If S stops for an inordinate amount of time (more than 30 seconds) between words, E says the following].

"What other thoughts or objects come to your mind? Please call out any objects or thoughts that come to you."

[At the end of each FA sequence E says].

"Stop. Continue to think silently about the stimulus." [E gathers, in this fashion, three FA sequences of twelve words each. Think intervals are 90 seconds long].

[R2 and R3 same as R1. Inter-recall interval between R2 and R3 same as between R1 and R2. After R3 is completed, S has one more Think/FA series, exactly as before. When the last Think interval is completed, E turns on the main room lights].

"All right. Thank you very much for your participation in this experiment. Here's your credit slip. I would also like you to self-address this envelope, so that I can let you know what this experiment was all about. I will mail you an explanation in about three or four months. Thank you."

INSTRUCTIONS TO THE CONTROL GROUP

[Instructions the same as for the experimental group before and after entering the experimental room. After the 5 msec sham flash, and after any R1 black pen reports, control Ss are given the black pen portion of the R1 of one of the experimental Ss and the following instructions].

"This may help you. At a somewhat longer stimulus exposure,

another subject in this experiment was able to draw and label this much of the stimulus. What I would like you to do is to draw these objects on your sheet and to label them. Try to copy them as accurately as possible."

[If any boxes are occupied by S's black pen drawings, S is to copy the experimental subject's drawings in other empty boxes].

[After S completes this task].

"If now something else of the stimulus has come back to you, please draw and label it."

[After S completes this part of the experiment, a green pen is handed to S by E].

"All right. Now I will give you a different colored pen and ask you to fill in the remaining boxes on the sheet with best guesses of the remaining stimulus items. If, in the process of guessing, you remember a stimulus item, you can pick up the black pen and draw and label the remembered item in black. Please provide your best guesses, without repeating any responses."

[After the recall is completed, the Think/FA series before the next recall is identical to that for the experimental Ss, except for the following].

"Please relax and think about the stimulus. You may look at the portion of the screen where the stimulus appeared, or you may close your eyes, but please think about the stimulus that was flashed on the screen, including what you copied on

your recall sheet, the objects that the other subject was able to see. From time to time I will interrupt your silent thinking and ask you to say aloud whatever thoughts or objects come to your mind, regardless of whether they have anything to do with the stimulus. Do not censor your responses, except in one respect: call out single, discrete objects or words, not sentences or stories."

[Instructions preceding an FA sequence follow].

"Please call out whatever objects or thoughts come to your mind. I will let you know when to stop. After I say "Stop!", continue to think silently about the stimulus."

[If S does not follow instructions about calling out discrete objects or words, the instructions are repeated again. If S stops for an inordinate amount of time (more than 30 seconds) between words, E says the following].

"What other thoughts or objects come to your mind? Please call out any objects or thoughts that come to you."

[E gathers, in this fashion, three FA sequences of twelve words each. Think periods last 90 seconds].

[Second recall. E gives S the black pen and a recall sheet].

"I would now like you to draw and label what you think you remember about the stimulus. It is O.K. for you to draw again what you copied before with the black pen. Please label and draw what you think was in the stimulus, anything that you think you now remember, short of outright

guessing."

[After this portion of the recall period is completed, S is instructed to fill in the rest of the boxes with a green pen, as before. The instructions for the second Think/FA series are the same as before. The instructions for R3 are the same as for R2. After R3, the control Ss are also asked to go through another Think/FA series, as before. The final part of the session, including the handing out of credit slips, is identical to that for the experimental Ss].

Appendix 1C

Manual for scoring recall drawings.

This manual contains the guidelines for scoring drawings of incompletely perceived stimuli (or, alternately, if completely perceived, drawings which do not render a faithful reproduction of those stimuli.) The basic problem confronting the scorer is to determine the extent to which elements of the stimulus slide composed of 12 discrete objects find their way into the recall protocols of subjects who were exposed to the stimulus for very short time durations. The problem is not a trivial one, since incompletely, or marginally, perceived stimuli often undergo distortions and transformations which virtually render the scoring a matter of "more or less" rather than "yes or no" judgments. An alternative way of scoring the protocols would be to consider only "full hits" and disregard any labeled drawings which were incorrect, in the wrong position (panel,) etc. If this were done, however, a vast amount of the richness of memory (and perception) would be only too hastily dismissed. A multitude of instances of "real world" perceptions and memories could be summoned to show that perception and memory are more a matter of "more or less" (incomplete) rather

than "yes or no" affairs. This need for "more or less" judgmental decisions, therefore, calls for a scorer trained in the execution of intermediary judgments.

The two basic types of scoring employed were based on structural (physical, morphological) and/or semantic (conceptual, associative) correspondences or similarities between the objects drawn and labeled by the subjects and the 12 stimulus items they were briefly presented with. Since the two scoring procedures were executed separately, each procedure will be given separate treatment.

Scoring for Structural Hits

The term "structural" signifies here the purely physical structure of objects, regardless of the meaning or semantic relatedness attached to them. Thus, if the "broom" in the stimulus (see panel 2, Appendix 1A) is drawn by a subject as a painter's brush or a rake, the fact that, for instance, "broom" and "painter's brush" are conceptually removed does not necessarily lead to a low score for the stimulus item "broom" on the physical (structural) dimension. If the painter's brush (or the rake) is drawn in a way such that it resembles physically the characteristics of the broom in the stimulus ("stick," "hairs," "bristles," "teeth," orientation, inclination, etc), the recalled painter's brush (rake) is given a score commensurate with its structural correspondence to the broom. The greater the number of distortions or transformations that a stimulus

undergoes in recall, however, the less confident can the scorer be that the drawn item partially reflects, or corresponds to, the stimulus item; therefore, the lower the scorer's confidence, the lower the "partial hits" credits.

Since being aware of the types of structural distortions that can take place should increase the scorer's sensitivity towards possible elements of the stimulus in the recalled items, a brief consideration of some important structural distortions will be presented next for elucidation and clarification.

1. **DISPLACEMENT:** taking an element of a stimulus object and (dis)placing it into a new position (panel) either by itself or in combination with another element or object, in which case condensation also occurs.

2. **CONDENSATION:** the combination of elements belonging to two or more stimulus objects into one new composite object (e.g. "baby" + "chair" = "baby sitting in chair").

3. **TRANSPOSITION (ROTATION):** changing the position of a stimulus object; i.e. drawing it upside down, rotating it, drawing a mirror image of the object, etc.

4. **CAMOUFLAGE:** embedding a stimulus object or element into a background of extraneous (non-stimulus) material.

5. **ATTENUATION:** a degenerated version of the original object in the stimulus material.

It should be obvious that these distortions and transformations can occur singly or in combination, thus

creating more problems for the scorer, who often must be able to discriminate between distorted stimulus elements and extraneous elements not belonging to the stimulus. Because of this ambiguity in the subjects' drawings, errors must be expected to occur occasionally due to the fallibility of the scorer. Errors, however, should tend to cancel each other out over successive recall protocols if the scorer is consistent in his/her scoring procedures. For instance, if the same extraneous element is scored as a bona fide stimulus element in all three recall protocols of a particular subject, no spurious "recovery effect" will take place, since the same amount is added to each recall. Undeniably, this type of scoring ("partial hits") is the result of a compromise. This compromise is not a high price to pay, however, if it preserves the richness of the subjects' drawn protocols.

Given these general guidelines, the specific mechanics for scoring structural hits now follow: (1) The greatest score for any recalled object (a "full hit") is 1.0. The smallest score, for completely foreign items (items not resembling any of the items in the stimulus either structurally or semantically) is 0.0. Scores for "partial hits" ranging between these two extremes are assigned in steps of 0.1. (2) Since each recall trial consisted of two portions, the free-recall and the forced-recall portions, the free-recall (black pen) portion should be scored first.

Regardless of which portion of the recall is being scored, however, the scoring of "full hits" should be done first. (The first thing the scorer should do is to glance over a protocol for indications of "full hits," and, initially, those that were drawn with the black pen). Thus, first the "full hits" drawn by the subject with the black pen are scored and, then, any black pen "partial hits," then the green pen (forced-recall) "full hits," and, finally, the green pen "partial hits." (3) When an object has been assigned a score of 1.0 (either structurally or semantically) no further increments to that object may occur, even if there are items or elements drawn in other panels in the protocol which resemble elements of the object which has already received "full hit" (1.0) credit. On the other hand, items drawn in other panels which reflect a similarity to a stimulus object which has not yet received a score of 1.0 (not recalled at all, or only partially recalled) can be added up and reflected in the total score for a stimulus item. In most situations, as it is often the case with marginally perceived stimuli, the "total hit" score for a given object will be a composite or summation of "partial hit" scores which sum, however, cannot exceed 1.0. Thus in the event that a "full hit" drawn object consists of more elements than were present in the original stimulus object, belonging theoretically to the original object, these extra elements may not be extracted and added to other

elements for partial credit to be given to another drawn object (unless one of the aforementioned distortions is deemed by the scorer to have occurred). Once an object has been assigned a score of 1.0 then, in general, that panel should be disregarded in the scoring of the remaining items in the recall protocol. (4) If it should happen that the sum of partial credits for a given stimulus object exceeds 1.0, the "total hit" score for that object should be brought down to 1.0. (5) Since one of the most commonly occurring errors in the subjects' protocols consists of the displacement (mispositioning) of an item in the 3 x 4 matrix recall sheet, this type of distortion acquires a special significance when scoring recall protocols. The simplest rule here should be this: to the extent that the incorrect positioning of a drawn object or element represents a given stimulus object or element, to that extent should the partial credit assigned to that object or element be smaller than if the object or element had been drawn in its correct position. This same rule, by the way, applies not only to displacement, but to the aforementioned types of distortion as well. In the final analysis, partial scores should reflect the confidence of the scorer that a drawn object or element reflects, even in a distorted manner, the presence of traces of the stimulus object or element. (6) Theoretically, then, the maximum score that a recall protocol could obtain for either structural or semantic

"hits" is 12.0, and the minimum, 0.0.

Scoring for Semantic Hits

The basic strategy for scoring semantic correspondence between drawn objects and stimulus objects is the same as the strategy for scoring structural correspondence or similarity. The difference is that now the scoring is not concerned with physical resemblance but, strictly, with the extent to which the drawn objects identify or reflect the meanings or conceptual congruence of the objects in the stimulus, regardless of physical or structural resemblance. Partial credits in semantic scoring result from drawings in the protocols that do not clearly or explicitly reflect the meaning of the stimulus objects, but which strongly suggest those meanings by conceptual function or association. Thus "girl," "man," "boy," are given partial semantic credit for the stimulus item "baby" (see panel 9, Appendix 1A.) Likewise, "animal," "dog," "squirrel," are given partial credit for the stimulus item "cat," and "calendar," "grandfather's clock," and "clock radio" are given partial credit for the stimulus item "clock" (see panels 8 and 6, Appendix 1A.)

As previously mentioned, the position of drawn objects should be used to assess their importance and the extent to which they suggest the original stimulus items and, therefore, the magnitude of the partial scores. Full semantic "hits," however, should be given the maximum score

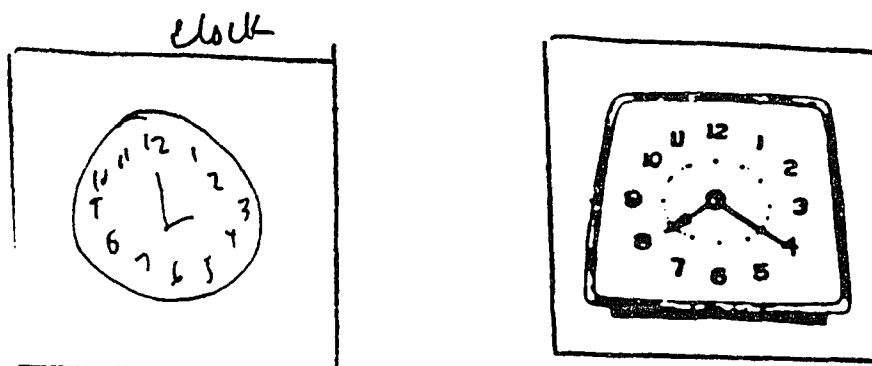
(1.0), regardless of position. In all other respects, the same mechanical procedure is to be used for semantic as for structural scoring. The scoring for structural and semantic "hits," moreover, should be done separately. (For an even more detailed account of a similar scoring procedure to that presented in this manual, see Erdelyi's (1968) thesis).

The scoring sheets were reproductions of the 3 x 4 matrix in which full, partial, and no credits were assigned to each of the 12 panels, depending on the correspondence of the subjects' recall protocols with the original stimulus items. Underneath each panel four scores were written, two corresponding to structural and semantic "hits" for black pen (free-recall) drawings, and two corresponding to structural and semantic "hits" for green pen (forced-recall) drawings. Structural and semantic free-recall scores for the 12 panels were added together to provide a combined total free-recall score. Similarly, forced-recall structural and semantic scores were combined to yield a combined total forced-recall score. Finally, all scores were added to give a "total hit" score for a particular recall protocol. Thus, each scoring sheet reflected seven scores: black pen structural, black pen semantic, green pen structural, green pen semantic, black pen structural and semantic combined, green pen structural and semantic combined, and a "total hit" score. To get a "feel" for both types of scoring and the strategies two actual scored recall

protocols will be examined in detail.

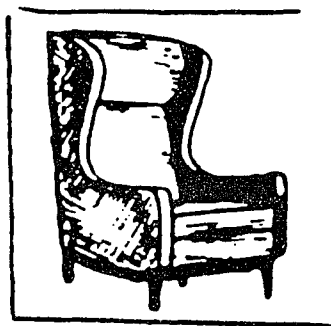
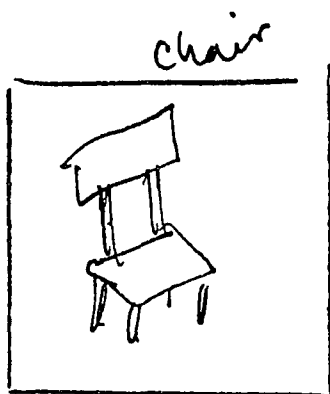
Example 1

On this particular protocol, the subject drew only two objects during the free-recall (black pen) portion of the recall trial: a clock and a chair, on panels 6 and 7 respectively. Both items were drawn in their correct stimulus positions. Since the shape of the clock is not quite similar to the clock in the stimulus,



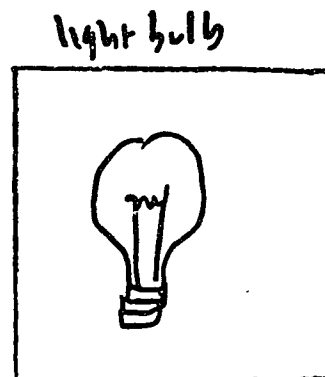
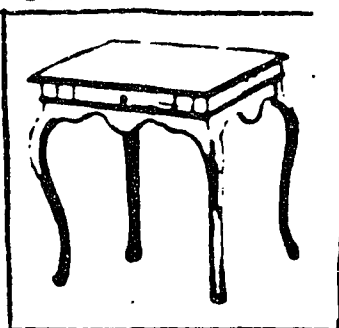
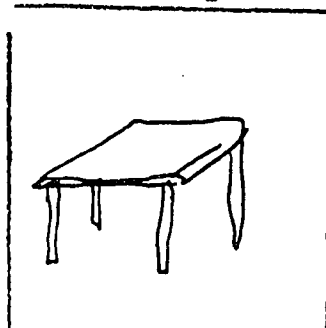
the structural score for this item is 0.9. Semantically, however, the clock obtains a score of 1.0. The chair was drawn in the correct panel, but physically it does not quite resemble the chair in the stimulus; therefore, it obtains a structural score of 0.8. Semantically, however, it is given a score of 1.0. Thus, for the free-recall (black pen) portion of this trial, the subject obtained a total structural score of 1.7 (0.9 + 0.8) hits and a total semantic score of 2.0 (1.0 + 1.0) hits.

During the forced-recall (green pen) portion of the trial, the subject drew and labeled 10 additional objects.

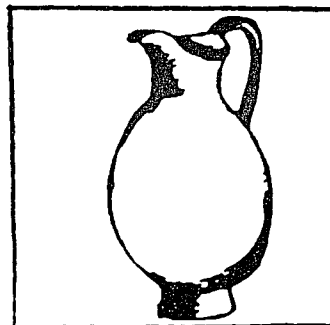


Let us first examine the table in panel 10.

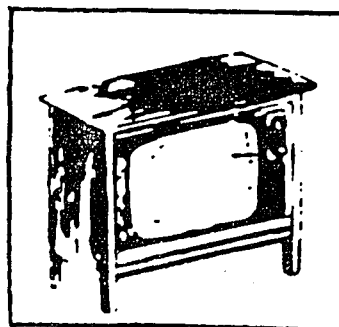
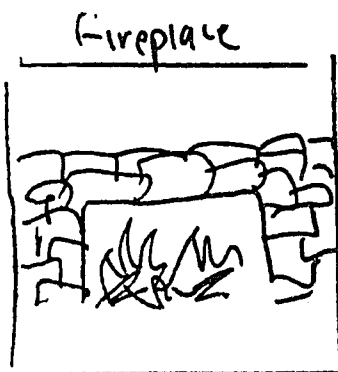
Structurally, since it has been drawn in the wrong panel, the table draws a score of 0.8. Semantically, as explained previously in this manual, it draws a score of 1.0. Since the toaster, baby, and cat in the stimulus are absent in this subject's recall protocol, and there was nothing in the other panels remotely similar to those items either structurally or semantically, the respective structural and semantic scores for these three items are 0.0 and 0.0. The lamp in the stimulus likewise draws a structural score of 0.0. However, the lightbulb drawn by the subject in panel 12, even though not in the correct lamp position, is related semantically to lamp;



hence, lamp receives a partial semantic score of 0.2. Had the lightbulb been drawn in panel 4, the lamp would have drawn a higher semantic score, perhaps as high as 0.5. Since the lightbulb is close enough in position and its general shape evokes the pitcher in the stimulus pitcher is assigned a structural score of 0.1.



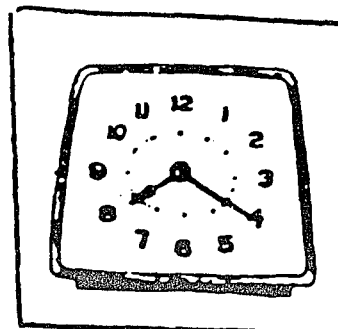
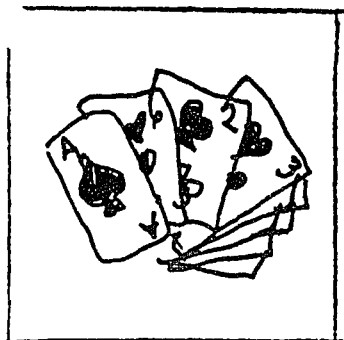
The fireplace in panel 5 evokes somewhat in shape the television in the stimulus (panel 1); therefore, television receives a conservative 0.1 structural score. Since the fireplace is far removed from the toaster in the stimulus (panel 12),



no increment accrues, structurally, to this item. Let us look now at the playing cards the subject drew in panel 9. They have been drawn in a clock-wise fashion, and have

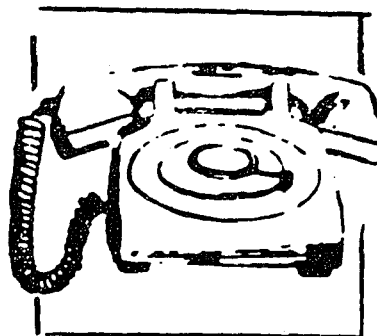
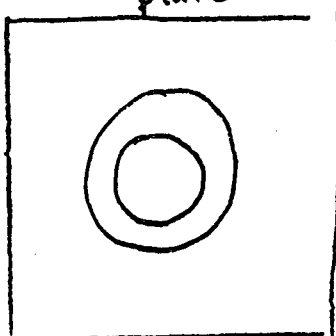
numbers assigned to them. That is sufficient reason to give

Cards



the clock in the stimulus a partial structural credit increment of 0.1. Since the clock now has a structural score of 1.0 ($0.9 + 0.1$) no further increments can now accrue to it. The plate drawn in panel 3 does not much resemble the cup and saucer in the stimulus (panel 5) and, furthermore, it was not drawn in the correct panel, so that, structurally, the stimulus cup receives a score of 0.1. However, it does physically resemble the telephone dial in the stimulus (panel 10), so that telephone receives a structural score of 0.2.

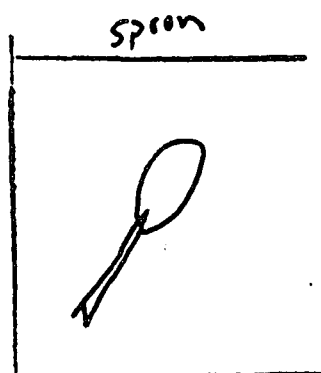
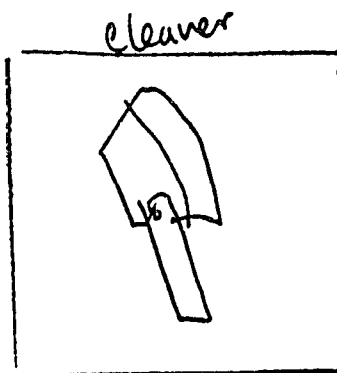
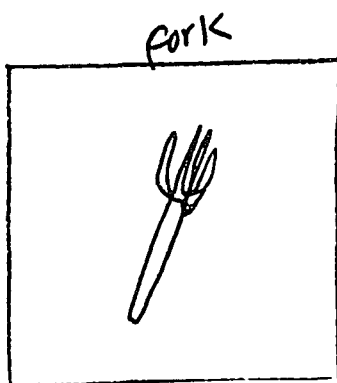
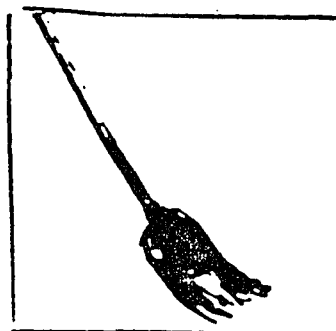
plate



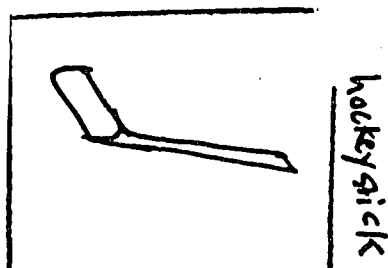
The stimulus cup, however, receives a semantic increment of 0.3 for the plate and, furthermore, another semantic partial credit of 0.1 for the spoon drawn by the subject in panel 4 (see below).

There is now one stimulus item left to deal with, the broom in panel 2. Notice that there are several items in the subject's protocol that resemble the broom, both structurally and semantically (see below).

Since a somewhat conservative scoring procedure was adopted throughout, the broom receives the following structural scores:



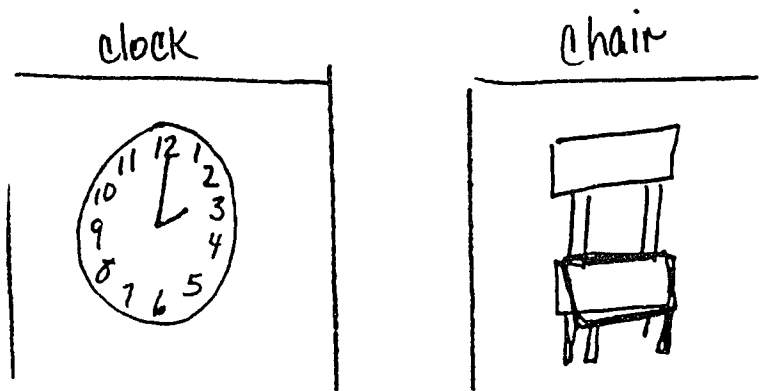
0.1 for the fork in panel 1, 0.1 for the cleaver in panel 2, 0.1 for the spoon in panel 4, and 0.1 for the hockey stick



in panel 8. Semantically, broom receives a partial score of 0.1 for the hockey stick in panel 8. For this particular recall protocol we have, therefore, the following scores: Free-Recall (black pen): Structural Total = 1.7, Semantic Total = 2.0; Forced-Recall (green pen): Structural Total = 1.8, Semantic Total = 1.7. The combined Structural and Semantic Total Hit Score for this protocol is, then, 7.2 ($1.7 + 2.0 + 1.8 + 1.7$).

Example 2

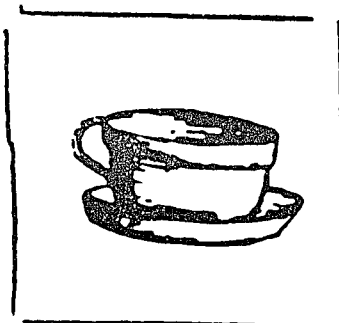
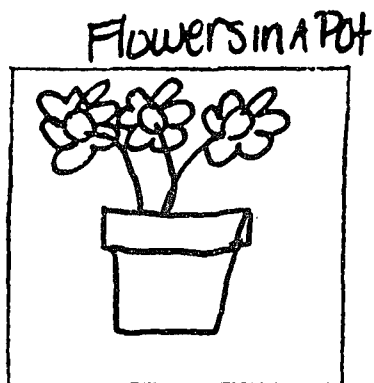
This particular recall protocol, by a different subject, also contained, in the free-recall portion of the recall trial (black pen) the clock and the chair of our previous example.



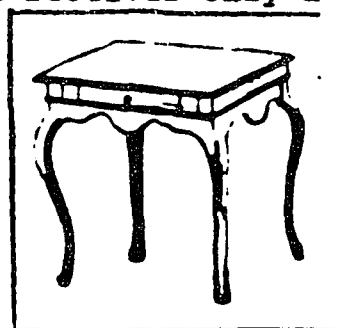
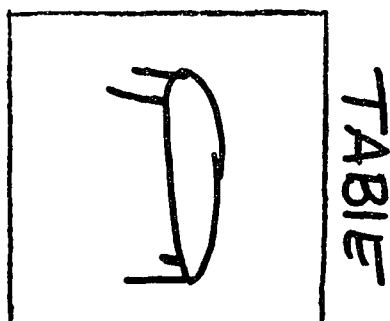
Just like before, the clock obtains structural and semantic scores of 0.8 and 1.0 respectively. The chair receives corresponding structural and semantic scores of 0.9 and 1.0. The combined score for the free-recall portion of the trial is, therefore, 3.7 ($1.7 + 2.0$).

Now let us take a look at the rest of the recall

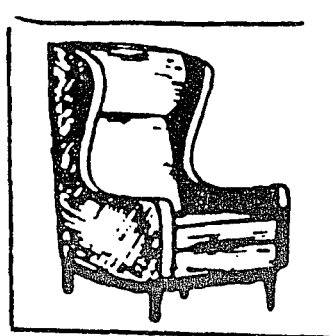
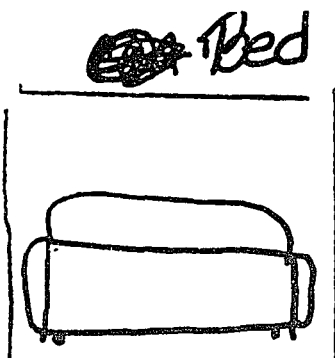
protocol, the forced-recall portion. Let us take panel 1. The flower pot in this panel physically resembles the cup and saucer in the stimulus, so that a structural score of 0.2 is



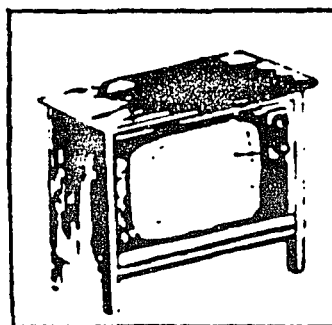
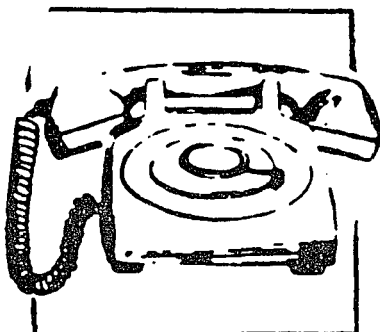
given to the cup. Had the subject drawn the flower pot in panel 5, the structural partial score for cup would have been somewhat higher, perhaps a 0.4 or 0.5. The flower pot, however, even though far removed from the pitcher stimulus is related semantically to it, so that a semantic score of 0.1 is given to pitcher. The table drawn by the subject in panel 2, because of its shape, contributes 0.1 to the structural score of the stimulus cup. This table, however, is not a very good replica of the table in the stimulus so that, structurally, the table receives only a 0.6 score.



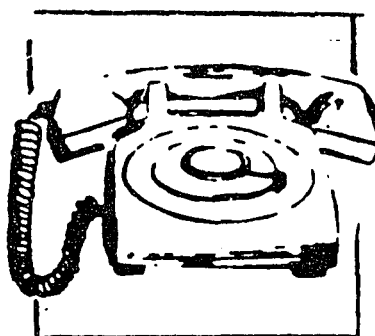
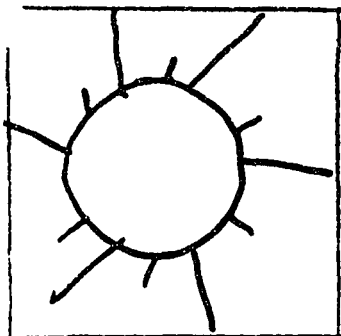
Semantically, however, the score is 1.0. The bed drawn in panel 5 is structurally related to the chair in the stimulus so that the chair receives a further increment of 0.1.



The bed, moreover, is also related to the shape of the telephone in the stimulus (panel 10), so that telephone receives a score of 0.1. Likewise, television (panel 1) also receives a structural partial score of 0.1.



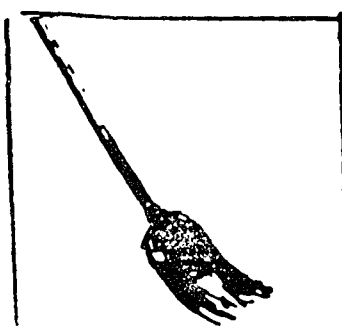
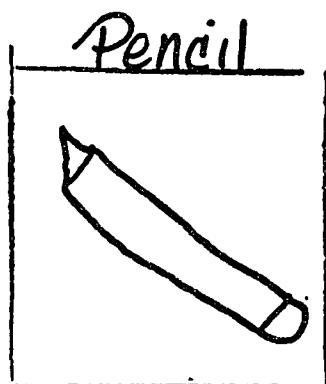
The sun drawn by the subject is structurally related to the stimulus telephone dial (0.1 increment to telephone) and to the clock dial (0.1 increment).



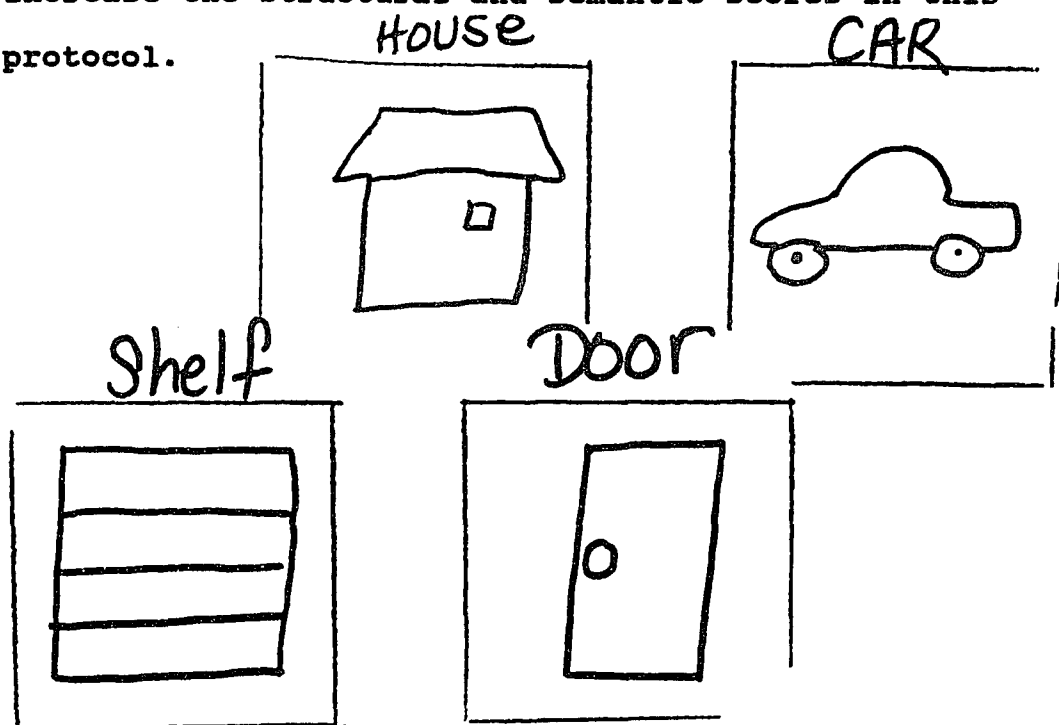
Semantically, however, sun is related to lamp (light) so, the lamp receives a semantic score of 0.2. Observe the face drawn by the subject in panel 8. Since its position is far removed from baby (stimulus panel 9), the baby stimulus item only receives a small score both structurally and semantically, 0.2 and 0.2 respectively.



The stimulus items toaster and cat receive zero (0.0) scores, both structurally and semantically. There is now only one stimulus item left, the broom (panel 2). The pencil drawn by the subject in panel 4, even though two positions away from the broom in the stimulus, retains the orientation of the broom. Thus, broom receives a structural score of 0.2.



The other items drawn by the subject: house (panel 2), car (panel 3), shelf (panel 10), and door (panel 11) do not increase the structural and semantic scores in this protocol.



It is clear that by a small stretch of the imagination they could be taken to constitute partial structural scores for the stimulus items television, toaster, table, etc.

However, as mentioned previously, the scoring for all protocols has been relatively conservative and the scorer, in this instance, did not deem appropriate the increase in hits of this protocol by any further partial credits. The important consideration throughout the scoring procedure, however, was to keep the scoring consistent across all protocols so that, over 108 scored recalls, errors would tend to cancel each other out. It is important to remember that the scoring was done blindly: the scorer did not know

in advance whether a particular recall protocol belonged to an experimental or a yoked-control subject, or whether it pertained to the first, second, or third recall trial. To conclude with our second example, the breakdown of scores looks like this: Free-Recall: Structural Total = 1.7, Semantic Total = 1.8; Forced-Recall: Structural Total = 1.8, Semantic Total = 1.5. The combined Structural and Semantic Total Hit score for this particular recall protocol is therefore, 6.8 (1.7 + 1.8 + 1.8 + 1.5).

Appendix 1E

Free-association scores of each subject, in each group,
after all three trials, for Experiment 1.

		<u>FA Trial</u>		
<u>Group</u>		FA1	FA2	FA3
<u>E500</u>	<u>Subjects</u>			
	1	5.30	3.50	---
	2	15.50	11.70	---
	3	7.00	9.20	---
	4	4.70	2.60	3.30
	5	11.30	9.60	8.00
	6	8.50	11.00	9.90
	7	7.20	7.40	7.10
	SUM	59.50	55.00	28.30
	MEAN	8.50	7.86	7.08

<u>E50</u>	<u>Subjects</u>			
	1	3.30	5.10	---
	2	2.80	3.90	---
	3	12.30	11.20	---
	4	4.10	5.40	5.10
	5	8.00	11.90	10.90
	6	5.90	7.90	7.80
	7	2.70	1.60	5.70
	SUM	39.10	47.00	29.50
	MEAN	5.59	6.71	7.38

<u>E5</u>	<u>Subjects</u>			
	1	3.60	5.40	---
	2	7.10	7.70	8.00
	3	4.70	5.60	---
	4	7.40	6.40	6.20
	5	4.80	4.30	4.00
	6	6.30	6.10	4.10
	7	2.00	7.50	5.60
	SUM	35.90	43.00	27.90
	MEAN	5.13	6.14	5.58

FA TrialGroup

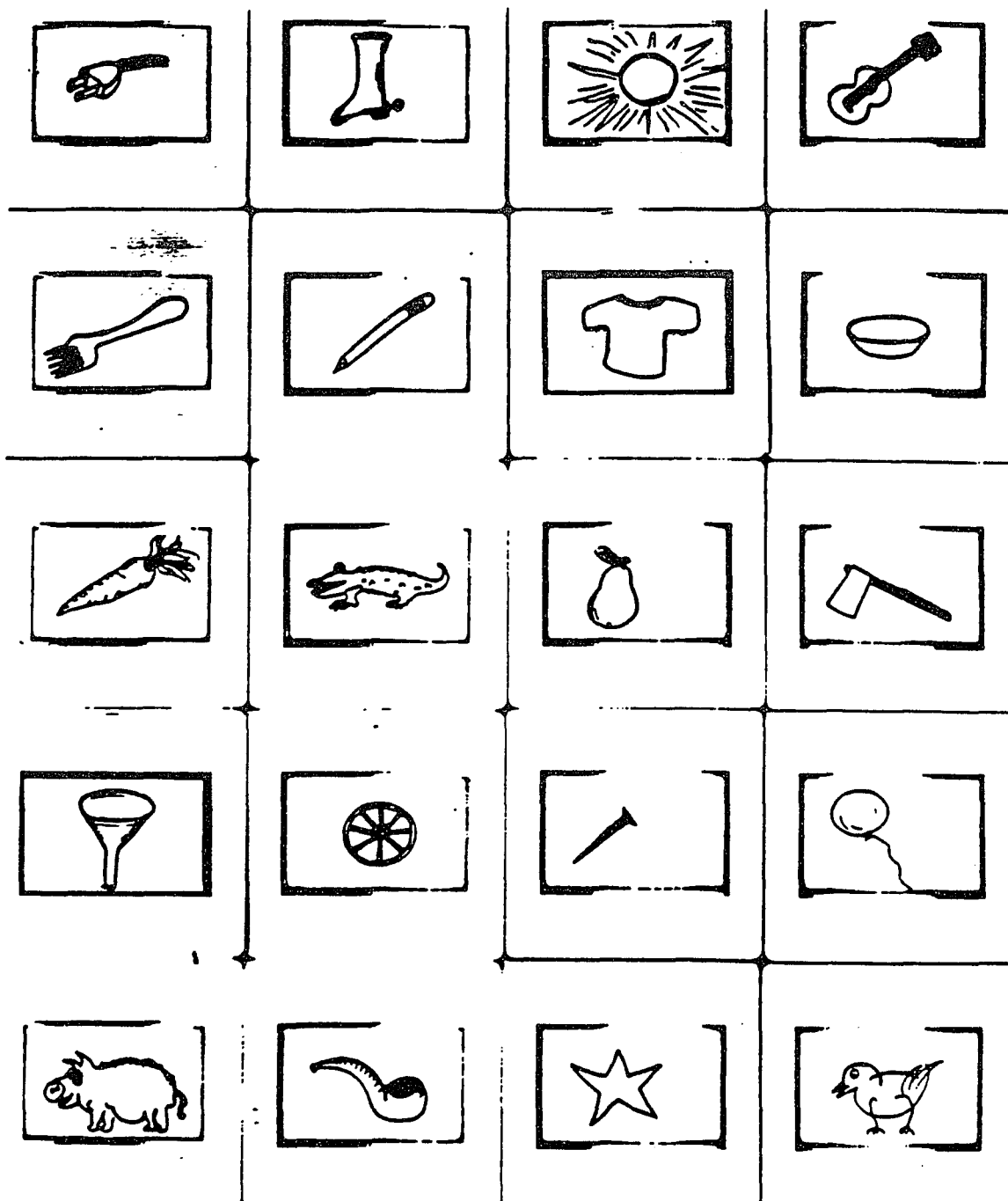
		FA1	FA2	FA3
C500	Subjects			
	1	3.60	4.10	4.50
	2	7.90	3.50	9.10
	3	9.90	9.90	8.40
	4	4.00	4.80	2.30
	5	7.60	7.10	---
	SUM	33.00	29.40	24.30
	MEAN	6.60	5.88	6.08

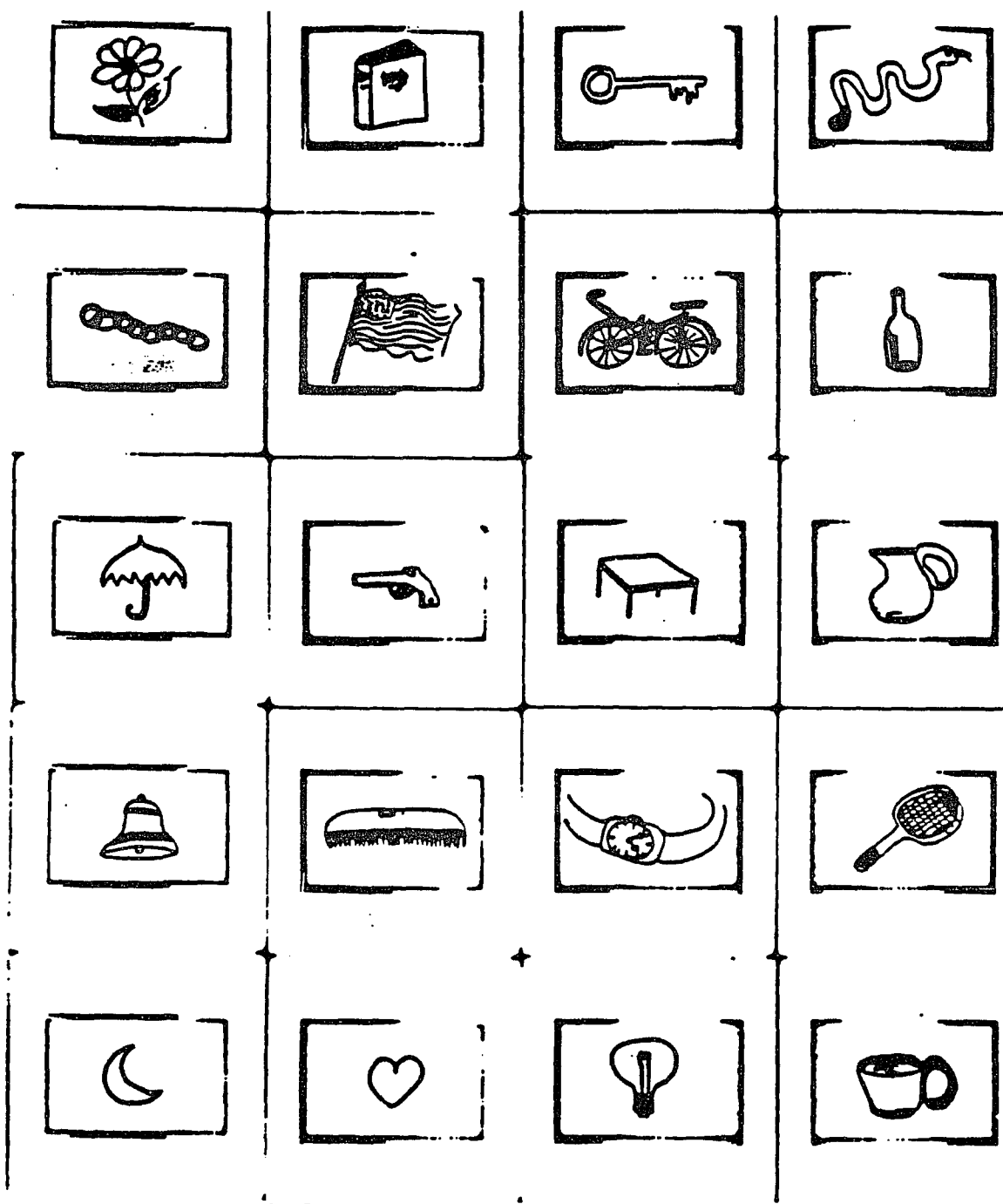
C50	Subjects			
	1	10.80	9.90	11.90
	2	7.00	13.20	12.50
	3	12.10	14.80	16.20
	4	0.70	1.80	0.90
	5	12.00	8.70	8.90
	SUM	42.60	48.40	50.40
	MEAN	8.52	9.68	10.08

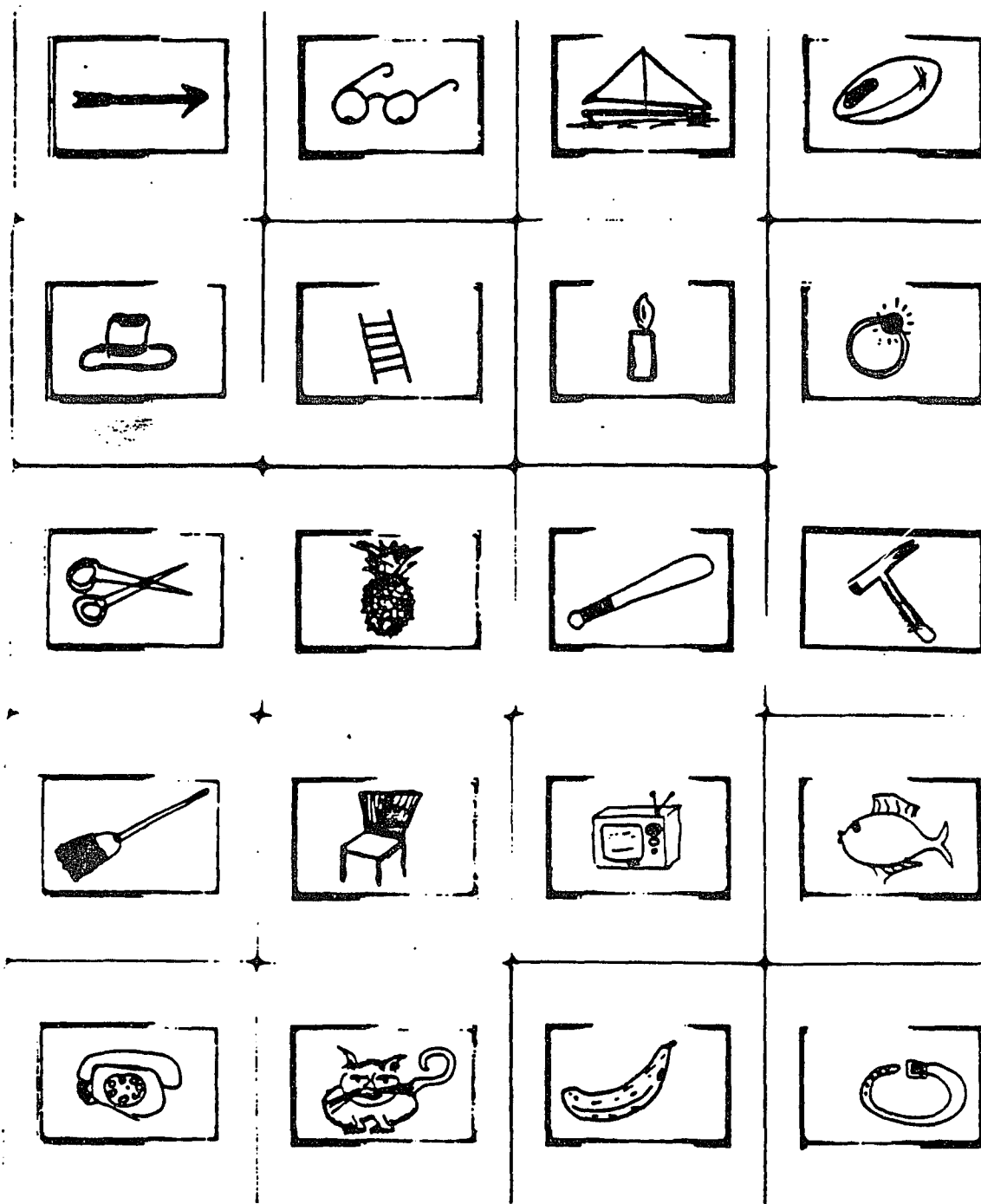
C5	Subjects			
	1	5.60	4.70	6.30
	2	4.70	7.20	6.20
	3	4.10	2.30	4.20
	4	3.40	4.40	4.90
	5	3.40	5.10	2.30
	SUM	21.20	23.70	23.90
	MEAN	4.24	4.74	4.78

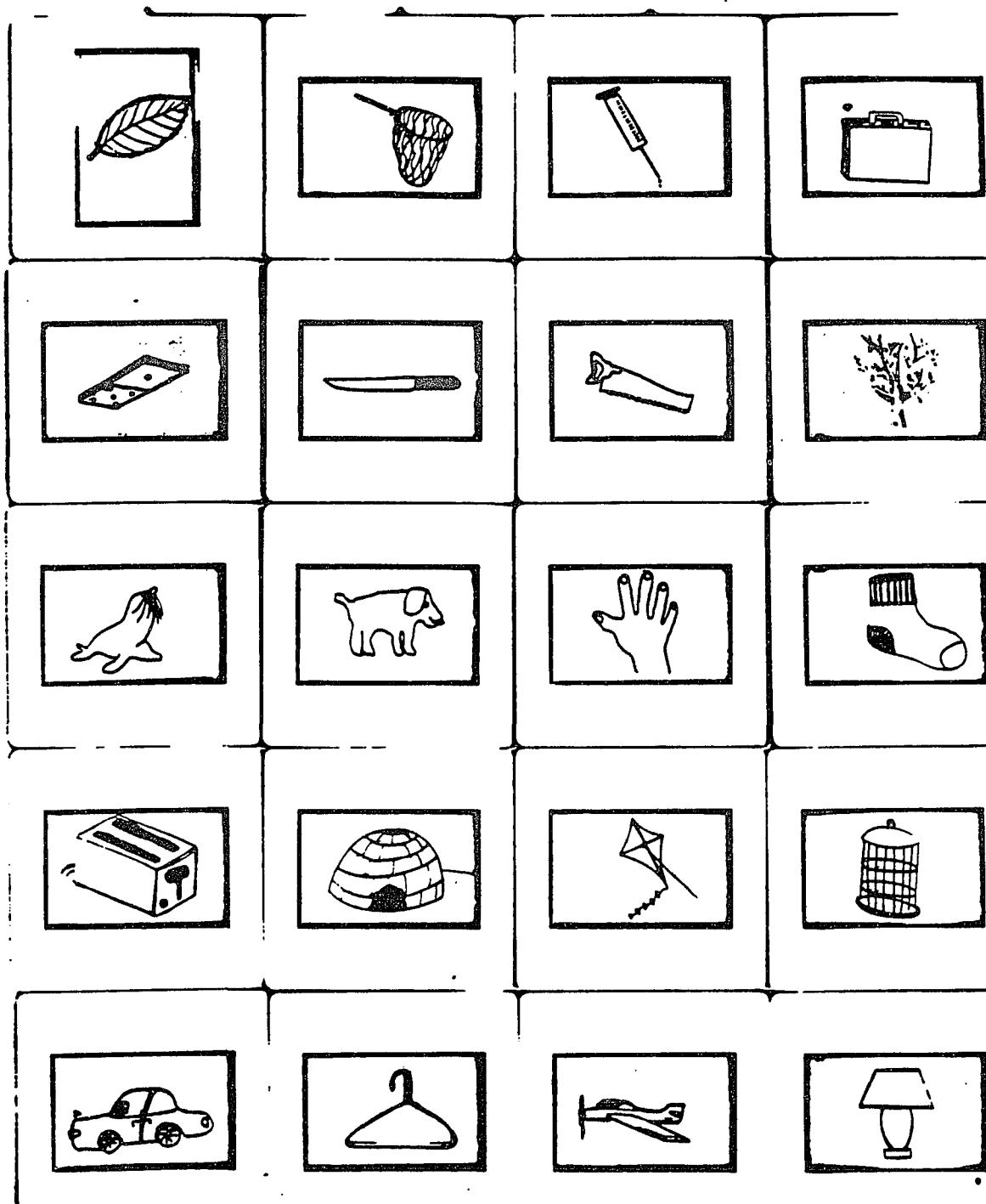
Appendix 2A

Picture stimuli in Experiment 2.









Appendix 2B

Stimulus sets "A" and "B" and their order of presentation.

PICTURES IN SET A:

CANDLE
CHAIR
UMBRELLA
HAT
RACKET
BOAT
HEART
BELL
TELEVISION
BROOM
TELEPHONE
RING
GUITAR
FLAG
WATCH
PIG
AX
ARROW
CHAIN
KEY
PENCIL
BICYCLE
ALLIGATOR
MOON
COMB
BAT
PLUG
PEAR
CARROT
FORK
NAIL
AIRPLANE
STAR
FISH
GLASSES
CAT
SNAKE
BIRD
WHEEL
BALLOON

WORDS IN SET A:

BOOK
PINEAPPLE
IGLOO
GUN
CUP
TOASTER
SEAL
PIPE
PITCHER
DOG
TREE
BOOT
BOTTLE
SOCK
BOWL
LADDER
CAGE
HAND
SAW
KITE
LIGHTBULB
SHIRT
FLOWER
SCISSORS
TABLE
HAMMER
SUN
FOOTBALL
BANANA
BELT
LEAF
NET
SYRINGE
LAMP
BRIEFCASE
CAR
HANGER
KNIFE
DOMINO
FUNNEL

PICTURES IN SET B:

BOOK
PINEAPPLE
IGLOO
GUN
CUP
TOASTER
SEAL
PIPE
PITCHER
DOG
TREE
BOOT
BOTTLE
SOCK
BOWL
LADDER
CAGE
HAND
SAW
KITE
LIGHTBULB
SHIRT
FLOWER
SCISSORS
TABLE
HAMMER
SUN
FOOTBALL
BANANA
BELT
LEAF
NET
SYRINGE
LAMP
BRIEFCASE
CAR
HANGER
KNIFE
DOMINO
FUNNEL

WORDS IN SET B:

CANDLE
CHAIR
UMBRELLA
HAT
RACKET
BOAT
HEART
BELL
TELEVISION
BROOM
TELEPHONE
RING
GUITAR
FLAG
WATCH
PIG
AX
ARROW
CHAIN
KEY
PENCIL
BICYCLE
ALLIGATOR
MOON
COMB
BAT
PLUG
PEAR
CARROT
FORK
NAIL
AIRPLANE
STAR
FISH
GLASSES
CAT
SNAKE
BIRD
WHEEL
BALLOON

Order of Presentation of Stimuli For Sets "A" and "B"

1-CANDLE	41-KITE
2-BOOK	42-LIGHTBULB
3-CHAIR	43-GUITAR
4-PINEAPPLE	44-SHIRT
5-IGLOO	45-FLAG
6-UMBRELLA	46-WATCH
7-GUN	47-PIG
8-CUP	48-FLOWER
9-HAT	49-AX
10-RACKET	50-SCISSORS
11-BOAT	51-TABLE
12-TOASTER	52-ARROW
13-SEAL	53-HAMMER
14-PIPE	54-SUN
15-PITCHER	55-CHAIN
16-HEART	56-BICYCLE
17-BELL	57-PENCIL
18-DOG	58-FOOTBALL
19-TELEVISION	59-KEY
20-BROOM	60-ALLIGATOR
21-TREE	61-MOON
22-BOOT	62-COMB
23-BOTTLE	63-BANANA
24-SOCK	64-BAT
25-BOWL	65-BELT
26-TELEPHONE	66-LEAF
27-LADDER	67-PLUG
28-RING	68-PEAR
29-CAGE	69-CARROT
30-HAND	70-NET
31-SAW	71-FORK
32-STAR	72-SYRINGE
33-CAT	73-NAIL
34-KNIFE	74-LAMP
35-SNAKE	75-BRIEFCASE
36-WHEEL	76-CAR
37-DOMINO	77-FISH
38-BIRD	78-HANGER
39-BALLOON	79-AIRPLANE
40-FUNNEL	80-GLASSES

Appendix 2C

Verbatim instructions to subjects in Experiment 2.

STIMULUS PRESENTATION INSTRUCTIONS

EXPERIMENTAL SUBJECTS

"This experiment deals with your ability to remember a fairly large number of stimuli. A series of slides, some of them pictures, some of them words, will be projected on the screen in front of you. Each item will be exposed for about 5 seconds (5 sec group), about 2 seconds (2 sec group), about 1 second (1 sec group), a fraction of a second (50 msec group), a very small fraction of a second (5 msec group.) Please pay close attention while they are being projected on the screen, as each item will be exposed only once. You will be asked to remember as many items as possible after all the words and pictures are shown. Do you have any questions? O.K. I will now project the stimuli on the screen. Ready?

CONTROL GROUP

"This experiment deals with your ability to remember a fairly large number of stimuli. A series of slides, some of them pictures, some of them words, will be projected on the screen in front of you. Each item will be exposed for a very small fraction of a second. Please pay close attention while they are being projected on the screen, as each item

will be exposed only once. Do not feel uncomfortable if you cannot consciously detect any of the stimuli, for they are deeply subliminal. We purposely made them too short for conscious perception. This does not mean, however, that the stimuli will not register unconsciously, as long as you pay close attention to the stimulus flashes. You will be asked to remember as many items as possible after all the words and pictures are shown. Do you have any questions? O.K. I will now project the stimuli on the screen. Ready?

[For projection of stimuli, room conditions are the same as for Experiment 1.]

FIRST RECALL INSTRUCTIONS (R1) FOR ALL GROUPS

[E turns all lights on and hands out a recall sheet numbered 1 to 60.]

"I would now like you to recall as many of the pictures and words presented to you as you can. When recalling a picture, I do not want you to draw it. Instead, I want you to write its name on the recall sheet. Thus, whether recalling a picture or a word, your response should always be a word."

[Control group hint: "All the items projected on the screen, whether pictures or words, represented objects that could, in principle, be drawn".]

"Please look at the response sheet. This is the procedure: write on the recall sheet, in the order that they occur to you, all the items from the stimulus series that you are

able to recall. Write the first item you recall in the space provided for #1, the second in the space provided for #2, and so on. Write only one item per numbered space. If you should recall as many as 60 items, then stop and wait for further instructions. If you happen to get stuck before reaching #60, stop, think, and try to recall more items. If you draw a complete blank, or no items return to you soon, then draw a line under the last item that you recalled, and make an educated guess for each of the remaining items until you reach #60. For example: suppose that you start to recall and you reach #19 and you cannot seem to remember any other items. Then stop, think, and try to recall some more items. If nothing comes to you soon, then draw a line under the last item recalled, and make educated guesses for each of the remaining blanks, until you reach #60. If, during guessing, you remember an item from the stimulus series, write it down, and put an asterisk or a star next to it, to indicate that, even though the item is in the guessing part of the recall sheet, you meant it as an item that you truly recalled. Please do not repeat any items, whether recalled or guessed. Your recall sheet should consist of 60 different words. I will give you a total of 7 minutes to fill in all 60 spaces, so please try to work hard at the task. I will let you know when there are 2 and 1 minutes left. Do you have any questions? O.K. Ready? O.K. Now try to recall as many of the words and pictures as you can."

[E says: "Two minutes left", "One minute left". When the seventh minute has elapsed, E says: "Stop".]

"Has everyone finished?"

[If not, E gives S's one extra minute - maximum two minutes - of 'grace'.]

"O.K. I will give you one extra minute to fill in the remaining blanks. Please fill in all the blanks as quickly as possible, even if you have to make wild guesses."

[At the end of the eighth or ninth minute E collects the recall sheets.]

FIRST THINK/FA INTERVAL INSTRUCTIONS: ALL SUBJECTS

[After E collects the recall sheets, he dims the lights and hands a booklet to each S.]

"The next part of the experiment is quite simple. I would like you to remain seated and to think about the pictures and words that were projected on the screen. Please do not talk or engage in other activities; just sit back and silently think about the stimuli presented to you. You may close your eyes, if you wish. This thinking period is part of the experiment, and I will let you know when this part is completed. Occasionally, during this thinking interval, I will interrupt and ask you to write in the booklet the first three objects that come to your mind. It does not matter whether the objects come from the stimulus series or not. Do not worry about that. Just write down, as soon as they pop into your mind, the first three objects that come to

mind, whatever they are. So write down the names of the first three objects that come to you as quickly as possible and then turn the page over. [E demonstrates.] After you do this, continue to think silently about the items that were shown to you on the screen. Any questions? O.K. Just relax, then, and think about the stimuli."

[E interrupts S's thinking three times--every two minutes--during the think interval.]

"Please write down, as quickly as possible, the names of the first three objects that come to your mind, and turn the page over."

[E collects booklets at the end of the think interval. The total length of this interval is seven minutes.]

SECOND RECALL INSTRUCTIONS (R2) FOR ALL GROUPS

[E turns all the lights on and hands Ss another recall sheet numbered 1 to 60.]

"I would like to test again your memory for the pictures and words presented to you at the beginning of the experiment. I want you to try very hard, and to recall as many of the items as you possibly can. The procedure is the same as for the previous recall trial. When you finish recalling, draw a line, and fill in the remaining spaces on the sheet with your best guesses. Do not forget to indicate with an asterisk or star any items that you truly recall while you are engaged in guessing. You will again have seven minutes to complete this task, and, again, I will let you know when

two and one minutes remain. Any questions? O.K. You may start."

['Grace' period the same as for R1. At the end of R2, E collects recall sheets.]

SECOND THINK/FA INTERVAL INSTRUCTIONS: ALL SUBJECTS

[E dims lights and hands out booklets.]

"This is another 'think' sequence. Relax and think about the stimuli originally shown to you. I will again interrupt your silent thinking occasionally, to ask you to write down the names of the first three objects that come to your mind, just like before. Any questions? O.K. Relax and think about the stimuli."

[E again interrupts S three times. At the end of this think interval, E collects the booklets.]

THIRD RECALL INSTRUCTIONS (R3) FOR ALL GROUPS

[E turns all lights on and hands out new recall sheets numbered 1 to 60.]

"This will be your last recall attempt. I would, again, like you to try very hard to remember as many of the pictures and words as possible from the series of stimuli originally shown to you. The procedure is the same as for the other two recall trials. Do not forget to draw a line after your last recall and, also, to put an asterisk or star next to any truly recalled item during the guessing portion. I will again give you seven minutes to complete the task and let you know when two and one minutes remain. Any

questions? O.K. Ready? You may start."

['Grace' period same as before. After 'grace' period, E collects recall sheets.]

[S's are asked to self-address envelope, receive credit slips, and are thanked for their participation in the experiment in a similar fashion to that of Experiment 1.]

Appendix 2D

Recall data for individual subjects (all groups) in Experiment 2.

Recall Over Three Trials for the Experimental
(5 sec Exposure) Group

<u>Recall Trial</u>		R1		R2		R3	
		P	W	P	W	P	W
Subjects							
	1	19	19	22	19	22	18
	2	25	22	24	21	26	24
	3	12	8	14	10	18	11
	4	21	21	17	20	27	17
	5	22	18	23	23	28	23
	6	15	13	20	19	20	17
	7	19	17	20	11	23	15
	8	21	15	22	10	25	15
	9	24	12	25	12	30	13
	10	16	14	19	16	17	13
	11	24	14	24	14	26	13
	12	19	16	17	16	22	20
	13	17	11	19	14	17	15
	14	15	16	15	17	18	16
	15	14	5	18	8	20	8
	16	16	9	14	13	18	14
	17	21	13	21	14	23	12
	18	17	17	23	17	24	18

SUM		337	260	357	274	404	282
MEAN		18.72	14.44	19.83	15.22	22.44	15.67

Recall Over Three Trials for the 0-Exposure Control Group

<u>Recall Trial</u>	R1	R2	R3
Subjects			
1	15	18	13
2	13	11	13
3	11	4	4
4	19	20	18
5	18	16	18
6	16	17	18
7	15	10	15
8	17	11	15
9	5	6	6
10	8	10	10
11	8	12	5
12	13	16	6
13	11	16	11
14	22	25	23
15	9	11	8
16	12	9	6
17	17	6	10
18	14	16	15

SUM	243	234	214
MEAN	13.50	13.00	11.89

Appendix 2E

**Cumulative recall data for individual subjects (all groups)
in Experiment 2.**

Cumulative Recall Over Three Trials for the
Experimental (5 sec) Group

Cumulative Guessing Over Three Trials for the
Control (0-Exposure) Group

<u>Recall Trial</u>	R1	R2	R3
Subjects			
1	15	24	26
2	13	24	32
3	11	15	18
4	19	30	38
5	18	22	25
6	16	20	25
7	15	16	21
8	17	23	26
9	5	8	8
10	8	11	11
11	8	15	16
12	13	21	24
13	11	23	26
14	22	28	32
15	9	16	17
16	12	20	22
17	17	21	29
18	14	18	19

SUM	243	355	415
MEAN	13.50	19.72	23.06

Recall Over Three Trials for the Yoked 0-ExposureControl Group

<u>Recall Trial</u>	R1	R2	R3

Subjects

1	35	14	17
2	13	8	6
3	33	20	18
4	21	15	18
5	27	22	25
6	33	20	17
7	27	19	19
8	24	13	12
9	29	12	14
10	34	18	19
11	31	17	12
12	30	24	23
13	31	24	18
14	37	15	16
15	33	22	19
16	23	12	15
17	23	21	21
18	29	29	27

SUM	513	325	316

MEAN	28.50	18.06	17.56

Recall Over Three Trials for the
0-Exposure Control Group

<u>Recall Trial</u>	R1	R2	R3
Subjects			
1	13	18	17
2	5	10	11
3	18	10	15
4	6	7	11
5	23	19	17
6	2	4	5
7	12	7	3
8	22	19	20
9	11	13	13
10	12	12	9
11	13	15	10
12	6	6	9
13	21	9	11
14	17	17	19
15	23	5	13
16	6	8	6
17	8	9	10
18	20	20	19

SUM	238	208	218
MEAN	13.22	11.56	12.11

Cumulative Recall Over Three Trials for the
Yoked 0-Exposure Control Group

<u>Recall Trial</u>	R1	R2	R3
Subjects			
1	35	37	37
2	13	15	16
3	33	36	38
4	21	25	25
5	27	32	35
6	33	34	34
7	27	32	34
8	24	29	30
9	29	31	33
10	34	42	45
11	31	33	36
12	30	38	42
13	31	36	36
14	37	40	42
15	33	36	39
16	23	27	31
17	23	28	31
18	29	38	38

SUM	513	589	622
MEAN	28.50	32.72	34.56

Cumulative Recall Over Three Trials for the
0-Exposure Control Group

<u>Recall Trial</u>	R1	R2	R3
Subjects			
1	13	23	24
2	5	13	14
3	18	22	25
4	6	8	12
5	23	24	25
6	2	5	6
7	12	19	22
8	22	28	32
9	11	19	24
10	12	17	19
11	13	23	24
12	6	9	14
13	21	26	27
14	17	24	29
15	23	28	29
16	6	9	10
17	8	14	18
18	20	29	34

SUM	238	340	388
MEAN	13.22	18.89	21.56

Appendix 3D

Stimulus presentation and recall instructions for the experimental subjects and 0-Exposure and Yoked 0-Exposure control subjects in Experiment 3.

"This experiment deals with your ability to remember a fairly large number of stimuli. A series of slides, some of them pictures, some of them words, will be projected on the screen in front of you. Each item will be exposed for a very small fraction of a second. Please pay close attention while they are being projected on the screen, as each item will be exposed only once. Do not feel uncomfortable if you cannot consciously detect any of the stimuli, for they are subliminal. We purposely made them too short for conscious perception, though subjects differ. Some will not see a single stimulus consciously, whereas others may catch some of the stimuli. Even if you do not think you see a stimulus, this does not mean that the stimulus was not registered unconsciously, so, even if you do not think that you are perceiving anything consciously, pay close attention to the stimulus flashes and do not give up. You will be asked to remember as many items as possible after all the words and pictures have been shown. Do you have any questions? O.K. I will now project the stimuli on the screen. Ready?

[During stimulus presentation, the conditions in the

experimental room are identical to those for stimulus presentation in Experiments 1, 2, 2A, and 2B].

FIRST RECALL INSTRUCTIONS (R1) FOR ALL EXPERIMENTAL GROUPS
[E turns all lights on and hands out to Ss a recall sheet numbered 1 to 60.]

"I would now like you to recall as many of the pictures and words presented to you as you can. When recalling a picture, I do not want you to draw it. Instead, I want you to write its name on the recall sheet. Thus, whether recalling a picture or a word, your response should always be a word. All the items, whether they are words or pictures, represent objects that can be drawn. Please look at the response sheet. This is the procedure: write on the recall sheet, in the order that they occur to you, all the items from the stimulus series that you are able to recall. Write the first item you recall in the space provided for #1, the second in the space provided for #2, and so on. Write only one item per numbered space. If you should recall as many as 60 items, then stop and wait for further instructions. If you happen to get stuck before reaching #60, stop, think, and try to recall more items. If you draw a complete blank, or no items return to you soon, then draw a line under the last item that you recalled, and make an educated guess for each of the remaining items until you reach #60. For example: suppose that you start to recall and you reach #19, and you cannot seem to remember any other

items. Then stop, think, and try to recall some more items. If nothing comes to you soon, then draw a line under the last item recalled, and make educated guesses for each of the remaining blanks, until you reach #60. If, during guessing, you remember an item from the stimulus series, write it down, and put an asterik or a star next to it, to indicate that, even though the item is in the guessing part of the recall sheet, you meant it as an item that you truly recalled. Please do not repeat any items, whether recalled or guessed. Your recall sheet should consist of 60 different words. Remember to guess items that are drawable. This will increase your chances of getting some of them right, even though you think you have not seen them. I will give you a total of 7 minutes to fill in all 60 spaces, so please try to work hard at the task. I will let you know when there are 2 and 1 minutes left. Do you have any questions? O.K. Ready? O.K. Now try to recall as many of the words and pictures as you can.

[Instructions for R2, R3, and think intervals T1 and T2 are identical to those for Experiment 2.]

CONTROL SUBJECTS

[Recall instructions for the 0-Exposure control subjects are identical to those for the control subjects in Experiment 2.]

RECALL INSTRUCTIONS FOR THE YOKED 0-EXPOSURE CONTROLSUBJECTSFIRST RECALL (R1) INSTRUCTIONS

[After stimulus presentation -- blanks -- E turns on all the lights and hands out a recall sheet numbered 1 to 60.]

"I would now like you to recall as many of the pictures and words presented to you as you can. When recalling a picture, I do not want you to draw it. Instead, I want you to write its name on the recall sheet. Thus, whether recalling a picture or a word, your response should always be a word."

[E immediately hands out to each S a recall protocol (R1) from one of the Ss in the 5 msec group in experiment 2. This protocol consists of the handwritten (by E) responses above the line and the asterisked responses from one of the 5 msec group Ss.] "This may help you. At a much longer stimulus exposure, another subject in this experiment was able to recall as many items as you see on the sheet I just handed to you. Before you write your own responses, I would like you to copy those items on the response sheet exactly as they appear on the sheet I just gave you. After you do this, I want you to recall as many items as you can. Write them under the items that you copied. So, this is the procedure: first, copy the items of the other subject, and then try to recall as much as you can. Make sure that you do not repeat any items, however. If you should be able to

recall items all the way to #60, then stop and wait for further instructions. If you happen to get stuck before reaching #60, stop, think, and try to recall more items. If you draw a complete blank, or no items return to you soon, then draw a line after the last item that you recalled, and make an educated guess for each of the remaining items until you reach #60. For example: suppose that, after you copy the responses from the other subject, and after you recall all the other items that you can, you reach #40 and you cannot seem to remember any more items. Then stop, think, and try to recall some more items. If nothing comes to you soon, then draw a line under the last item that you recalled, and make educated guesses for each of the remaining blanks, until you reach #60. In case you cannot recall any items on your own after you copied the items from the other subject, follow the same procedure: draw a line and guess until you reach #60. If, during guessing, you remember any item from the stimulus series, write it down and put an asterisk or a star next to it, to indicate that, even though the item is in the guessing part of the recall sheet, you meant it as an item that you truly recalled. Please do not repeat any items, whether your own or whether belonging to the other subject, and whether recalled or guessed. Your recall sheet should consist of 60 different words. I will give you a total of seven minutes to fill in all 60 spaces, so please try to work hard at the task. I

will let you know when there are two and one minutes left. Do you have any questions? O.K. Ready? O.K. Now copy the responses of the other subject on your recall sheet first, and then try to recall as many of the pictures and words as you can."

[R2 and R3 are similar (Ss do not copy the protocol), but with this addition: "Yes, you can write down items that you remember having copied from the other subject before."]

[Instructions for thinking intervals (T1, T2) identical to those for the other groups and included with instructions for Experiment 2.]

Appendix 4A

Recall data for individual subjects (all groups) in Experiment 4.

Recall Over Three Trials for the Experimental
(5 sec Exposure) Group

Appendix 5A

Recall data for individual subjects (all groups) in Experiment 5.

Recall Over Three Trials for the Experimental
(0.5 Filter) Group

Recall Over Three Trials for the Experimental
(0.7 Filter) Group

<u>Recall Trial</u>	R1		R2		R3	
	P	W	P	W	P	W
<u>Subjects</u>						
1	2	6	6	4	4	7
2	7	5	7	6	8	5
3	6	3	4	0	4	1
4	13	9	12	6	12	8
5	7	6	8	8	7	10
6	8	7	10	8	8	10
7	6	3	10	4	9	6
8	8	3	11	2	5	7
9	9	9	10	8	7	7
10	11	9	9	7	6	7
11	8	8	6	11	11	9
12	5	3	7	7	6	8
SUM	90	71	100	71	87	85
MEAN	7.50	5.92	8.33	5.92	7.25	7.08

Recall Over Three Trials for the Control(1.0 Filter) Group

<u>Recall Trial</u>	R1	R2	R3
<u>Subjects</u>			
1	20	15	16
2	7	9	6
3	18	16	19
4	22	22	28
5	23	17	19
6	22	13	17
7	17	11	18
8	19	12	13
9	19	14	23
10	23	20	21
11	21	18	15
12	15	7	7

SUM	226	174	202
MEAN	18.83	14.50	16.83

Cumulative Recall Over Three Trials for the
Experimental (0.7 Filter) Group

<u>Recall Trial</u>	R1		R2		R3	
	P	W	P	W	P	W
<u>Subjects</u>						
1	2	6	6	8	8	10
2	7	5	8	6	10	7
3	6	3	7	3	9	4
4	13	9	14	10	18	11
5	7	6	12	9	13	12
6	8	7	13	11	13	12
7	6	3	10	4	12	7
8	8	3	15	4	19	7
9	9	9	10	9	10	9
10	11	9	16	10	19	12
11	8	8	10	11	16	11
12	5	3	9	8	10	9
SUM	90	71	130	93	157	111
MEAN	7.50	5.92	10.83	7.75	13.08	9.25

Cumulative Recall Over Three Trials for the
Experimental (1.4 Filter) Group

<u>Recall Trial</u>	R1		R2		R3	
	P	W	P	W	P	W
<u>Subjects</u>						
1	5	7	10	12	14	14
2	7	8	12	12	14	12
3	10	9	12	13	13	15
4	10	7	14	8	17	10
5	9	7	15	11	21	17
6	7	9	10	12	12	12
7	3	4	3	5	3	5
8	14	7	16	11	20	12
9	11	9	13	14	14	14
10	7	6	9	8	10	11
11	11	7	14	10	18	14
12	13	6	16	10	18	17
SUM	107	86	144	126	174	153
MEAN	8.92	7.17	12.00	10.50	14.50	12.75

Cumulative Recall Over Three Trials
for the Control (1.0 Filter) Group

<u>Recall Trial</u>	R1	R2	R3
<u>Subjects</u>			
1	20	27	30
2	7	15	18
3	18	25	30
4	22	29	31
5	23	25	28
6	22	27	30
7	17	19	27
8	19	27	32
9	19	30	39
10	23	29	33
11	21	31	33
12	15	17	21

SUM	226	301	352

MEAN	18.83	25.08	29.33

Appendix 5C

Verbatim instructions to all subjects in Experiment 5.

STIMULUS PRESENTATION INSTRUCTIONS (ALL GROUPS)

"This experiment deals with your ability to remember a fairly large number of stimuli. A series of slides, some of them pictures, some of them words, will be projected on the screen in front of you. Each item will be exposed for a very small fraction of a second. Please pay close attention while they are being projected on the screen, as each item will be exposed only once. Do not feel uncomfortable if you cannot consciously detect any of the stimuli, for they are subliminal. We purposely made them too short for conscious perception, though subjects differ. Some will not see a single stimulus consciously, whereas others may catch some of the stimuli. Even if you do not think you see a stimulus, this does not mean that the stimulus was not registered unconsciously, so, even if you do not think that you are perceiving anything consciously, pay close attention to the stimulus flashes and do not give up. You will be asked to remember as many items as possible after all the words and pictures have been shown. Do you have any questions? O.K. I will now project the stimuli on the screen. Ready?

[During stimulus presentation, the conditions in the experimental room are identical to those for stimulus

presentation in Experiments 1, 2, 3, and 4.]

FIRST RECALL INSTRUCTIONS (R1) FOR ALL EXPERIMENTAL GROUPS

[E turns all lights on and hands out to Ss a recall sheet numbered 1 to 60.]

"I would now like you to recall as many of the pictures and words presented to you as you can. When recalling a picture, I do not want you to draw it. Instead, I want you to write its name on the recall sheet. Thus, whether recalling a picture or a word, your response should always be a word. All the items, whether they are words or pictures, represent objects that can be drawn. Please look at the response sheet. This is the procedure: write on the recall sheet, in the order that they occur to you, all the items from the stimulus series that you are able to recall. Write the first item you recall in the space provided for #1, the second in the space provided for #2, and so on. Write only one item per numbered space. If you should recall as many as 60 items, then stop and wait for further instructions. If you happen to get stuck before reaching #60, stop, think, and try to recall more items. If you draw a complete blank, or no items return to you soon, then draw a line under the last item that you recalled, and make an educated guess for each of the remaining items until you reach #60. For example: suppose that you start to recall and you reach #19, and you cannot seem to remember any other items. Then stop, think, and try to recall some more items.

If nothing comes to you soon, then draw a line under the last item recalled, and make educated guesses for each of the remaining blanks, until you reach #60. If, during guessing, you remember an item from the stimulus series, write it down, and put an asterik or a star next to it, to indicate that, even though the item is in the guessing part of the recall sheet, you meant it as an item that you truly recalled. Please do not repeat any items, whether recalled or guessed. Your recall sheet should consist of 60 different words. Remember to guess items that are drawable. This will increase your chances of getting some of them right, even though you think you have not seen them. I will give you a total of 7 minutes to fill in all 60 spaces, so please try to work hard at the task. I will let you know when there are 2 and 1 minutes left. Do you have any questions? O.K. Ready? O.K. Now try to recall as many of the words and pictures as you can.

[Instructions for R2, R3, and Think/FA intervals are identical to those for Experiment 2.]

CONTROL SUBJECTS

Instructions for control subjects are identical to those for the control subjects in Experiment 2.

References

- Allers, R., & Teler, J. (1924). (J. Wolff, D. Rapaport, & A. H. Annin, Trans.). On the utilization of unnoticed impressions in associations. Psychological Issues, 2, (No. 3), Monograph 7, 121-150.
- Baddeley, A. D. (1976). The psychology of memory. New York: Basic Books.
- Ballard, P. B. (1913). Oblivescence and reminiscence. British Journal of Psychology (Monograph Supplements), 1, No. 2, Preface-82.
- Bartlett, F. C. (1932). Remembering. Cambridge, England: Cambridge University Press.
- Belmore, S. M. (1981). Imagery and semantic elaboration in hypermnesia for words. Journal of Experimental Psychology: Human Learning and Memory, 7, 191-203.
- Bonnano, G. A., & Stilling, N. A. (1986). Preference, familiarity, and recognition after repeated brief exposures to random geometric shapes. American Journal of Psychology, 99, 403-415.
- Bornstein, R. F., Leone, D. R., & Galley, D. J. (1987). The generalizability of subliminal mere exposure effects: Influence of stimuli perceived without awareness on social behavior. Journal of Personality and Social Psychology, 53, 1070-1079.
- Bowers, K. S., & Meichenbaum, D. (Eds.) (1984). The unconscious reconsidered. New York: Wiley.
- Buxton, C. E. (1943). The status of research in reminiscence. Psychological Bulletin, 40, 313-340.
- Darley, C. F., & Murdock, B. B. (1971). Effects of prior free recall testing on final recall and recognition. Journal of Experimental Psychology, 91, 66-73.
- Dixon, N. F. (1981). Preconscious processing. Chichester: Wiley.
- Ebbinghaus, H. (1885). Memory. (H.A. Ruger & C.E. Bussenius, trans.). New York: Dover, 1964.
- Eich, E. (1984). Memory for unattended events: Remembering with and without awareness. Memory and Cognition, 12, 105-111.

- Ellenberger, H. F. (1970). The discovery of the unconscious. New York: Basic Books.
- Erdelyi, M. H. (1968). The recovery of unavailable perceptual input. Unpublished doctoral dissertation, Yale University, New Haven, Connecticut.
- Erdelyi, M. H. (1970). Recovery of unavailable perceptual input. Cognitive Psychology, 1, 99-113.
- Erdelyi, M. H. (1972). The role of fantasy in the Poetzl (emergence) phenomenon. Journal of Personality and Social Psychology, 24, 186-190.
- Erdelyi, M. H. (1974). A new look at the New Look: Perceptual defense and vigilance. Psychological Review, 81, 1-25.
- Erdelyi, M. H. (1981). Not now: Comments on Loftus and Loftus. (Comment.) American Psychologist, 36, 527-528.
- Erdelyi, M. H. (1982). A note on the level of recall, level of processing, and imagery hypotheses in hypermnnesia. Journal of Verbal Learning and Verbal Behavior, 21, 656-661.
- Erdelyi, M. H. (1984). The recovery of unconscious (inaccessible) memories: Laboratory studies of hypermnnesia. In G. Bower (Ed.), The psychology of learning and motivation: Advances in research and theory (pp. 95-127). New York: Academic Press.
- Erdelyi, M. H. (1985). Psychoanalysis: Freud's cognitive psychology. New York: Freeman.
- Erdelyi, M. H. (1986). Experimental indeterminacies in the dissociation paradigm of subliminal perception. The Behavioral and Brain Sciences, 9, 30-31.
- Erdelyi, M. H. (1988). Hypermnnesia: Effect of hypnosis, fantasy, and concentration. In H. M. Pettinati (Ed.), Hypnosis and memory (pp. 64-94). New York: Guilford.
- Erdelyi, M. H. (1990). Repression, reconstruction, and defense: History and integration of the psychoanalytic and experimental frameworks. In J. L. Singer (Ed.), Repression and dissociation: Defense mechanisms and personality styles (pp. 1-31). Chicago: Chicago University Press.

- Erdelyi, M. H. (1994). The recovery of unconscious memories: Hypermnesia and reminiscence. Manuscript in preparation.
- Erdelyi, M. H., & Appelbaum, A. (1973). Cognitive masking: The disruptive effect of an emotional stimulus upon the perception of contiguous neutral items. Bulletin of the Psychonomic Society, 1, 59-61.
- Erdelyi, M. H., & Becker, J. (1974). Hypermnesia for pictures: Incremental memory for pictures but not words in multiple recall trials. Cognitive Psychology, 6, 159-171.
- Erdelyi, M. H., Finkelstein, S., Herrell, N., Miller, B., & Thomas, J. (1976). Coding modality vs. input modality in hypermnnesia: Is a rose a rose a rose? Cognition, 4, 311-319.
- Erdelyi, M. H., & Kleinbard, J. (1978). Has Ebbinghaus decayed with time? The growth of recall (hypermnesia) over days. Journal of Experimental Psychology: Human Learning and Memory, 4, 275-289.
- Erdelyi, M. H., & Goldberg, B. (1979). Let's not sweep repression under the rug: Toward a cognitive psychology of repression. In J. F. Kihlstrom and F. J. Evans (Eds.), Functional disorders of memory (pp. 355-401). Hillsdale, New Jersey: Erlbaum.
- Erdelyi, M. H., & Stein, J. B. (1981). Recognition hypermnnesia: The growth of recognition hypermnnesia (d') over time with repeated testing. Cognition, 9, 23-33.
- Erdelyi, M. H., Finks, J., & Feigin-Pfau, M. (1989). The effect of response bias on recall performance, with some observations on processing bias. Journal of Experimental Psychology, 118, 245-254.
- Eriksen, C. W. (1958). Unconscious processes. In M. R. Jones (Ed.), Nebraska symposium on motivation: 1958. Lincoln, Nebraska: University of Nebraska Press.
- Fisher, C. (1954). Dreams and perception. Journal of the American Psychoanalytic Association, 3, 380-445.
- Fisher, C. (1956). Dreams, images, and perception: A study of unconscious-preconscious relationships. Journal of the American Psychoanalytic Association, 4, 5-48.

- Fisher, C. (1960a). Subliminal and supraliminal influences on dreams. The American Journal of Psychiatry, 116, 1009-1017.
- Fisher, C. (1960b). Introduction. In J. Wolff, D. Rapaport, and S. H. Annin (Eds. & Trans.), Preconscious stimulation in dreams, associations, and images. Psychological Issues, 2 (No. 3), Monograph 7, 1-40.
- Fisher, C. (1988). Further observations on the Poetzl phenomenon: The effects of subliminal visual stimulation on dreams, images, and hallucinations. Psychoanalysis and Contemporary Thought, 11, 3-56.
- Fisher, C., & Paul, I. H. (1959). The effect of subliminal stimulation on images and dreams: A validation study. Journal of the American Psychoanalytic Association, 7, 35-83.
- Freud, S. (1900). The interpretation of dreams. (J. Strachey, Trans.). In J. Strachey (Ed.), The standard edition of the complete psychological works of Sigmund Freud (Vols. 4-5). London: Hogarth Press, 1958.
- Giddan, N. S. (1967). Recovery through images of briefly flashed stimuli. Journal of Personality, 35, 1-19.
- Goldiamond, I. (1958). Indicators of perception: I. Subliminal perception, subception, unconscious perception: An analysis in terms of psychophysical indicator methodology. Psychological Bulletin, 55, 373-411.
- Green, D. M., & Swets, J. A. (1966). Signal detection theory and psychophysics. New York: Wiley.
- Haber, R. N., & Erdelyi, M. H. (1967). Emergence and recovery of initially unavailable perceptual material. Journal of Verbal Learning and Verbal Behavior, 6, 618-628.
- Holender, D. (1986). Semantic activation without conscious identification in dichotic listening, parafoveal vision, and visual masking: A survey and appraisal. The Behavioral and Brain Sciences, 9, 1-66.
- Ionescu, M. (1992). Hypermnesia for subliminal stimuli. Unpublished doctoral dissertation, The Graduate School of the City University of New York, New York.

- Ionescu, M. D., & Erdelyi, M. H. (1992). The direct recovery of subliminal stimuli. In R. F. Bornstein and T. S. Pittman (Eds.), Perception without awareness: Cognitive, clinical, and social perspectives (pp. 143-169). New York: Guilford.
- Jacoby, L. L., & Witherspoon, D. (1982). Remembering without awareness. Canadian Journal of Psychology, 32, 300-312.
- Johnson, H., & Eriksen, C. W. (1961). Preconscious perception: A reexamination of the Poetzl phenomenon. Journal of Abnormal and Social Psychology, 62 497-503.
- Kihlstrom, J. F. (1987). The cognitive unconscious. Science, 237, 1445-1452.
- Klatzky, R. L., & Erdelyi, M. H. (1985). The response criterion problem in tests of hypnosis and memory. International Journal of Clinical and Experimental Hypnosis, 33, 246-257.
- Kunst-Wilson, W. R., & Zajonc, R. B. (1980). Affective discrimination of stimuli that cannot be recognized. Science, 207, 557-558.
- Laurence, J.-R., & Perry, C. (1984). Mental processing outside of awareness: The contributions of Freud and Janet. In K. S. Bowers & D. Meichenbaum (Eds.), The unconscious reconsidered (pp. 9-48). New York: Wiley.
- Macmillan, N. A. (1986). The psychophysics of subliminal perception. Behavioral and Brain Sciences, 9, 38-39.
- McDaniel, M. A., & Masson, M. E. J. (1985). Altering memory representations through retrieval. Journal of Experimental Psychology: Learning, Memory, and Cognition, 11, 371-385.
- Mandler, G., Nakamura, Y., & Van Zandt, B. J. S. (1987). Nonspecific effects of exposure on stimuli that cannot be recognized. Journal of Experimental Psychology: Learning, Memory, and Cognition, 13, 646-648.
- Marcel, A. J. (1983a). Conscious and unconscious perception: Experiments on visual masking and word recognition. Cognitive Psychology, 15, 197-237.
- Marcel, A. J. (1983b). Conscious and unconscious perception: An approach to the relation between phenomenal experience and cognitive processes. Cognitive Psychology, 15, 197-237.

- Merikle, P. M., & Reingold, E. M. (1991). Comparing direct (explicit) and indirect (implicit) measures to study unconscious memory. Journal of Experimental Psychology: Learning, Memory, and Cognition, 17, 224-233.
- Neisser, U. (1967). Cognitive psychology. New York: Appleton-Century-Crofts.
- Paivio, A. (1971). Imagery and verbal processes. New York: Holt, Rinehart, and Winston.
- Parkin, A. J. (1987). Memory and amnesia: An introduction. Oxford: Blackwell.
- Payne, D. G. (1986). Hypermnesia for pictures and words: Testing the recall level hypothesis. Journal of Experimental Psychology: Learning, Memory, and Cognition, 12, 16-29.
- Payne, D. G. (1987). Hypermnesia and reminiscence in recall: A historical and empirical review. Psychological Bulletin, 101, 5-27.
- Payne, D. G., & Roediger, H. L. (1987). Hypermnesia occurs in recall but not in recognition. American Journal of Psychology, 100, 145-165.
- Pettinati, H. M. (Ed.) (1988) Hypnosis and memory. New York: Guilford.
- Poetzl, O. (1917). The relationship between experimentally induced dream images and indirect vision. In J. Wolff, D. Rapaport, & S. H. Annin (Eds. and Trans.), Psychological Issues, 2 (No. 3), Monograph 7, 41-120.
- Popkin, S. J., & Small, M. V. (1979). Hypermnesia and the role of imagery. Bulletin of the Psychonomic Society, 13, 378-380.
- Reingold, E. M. (1990). Using indirect and direct measures to study unconscious processes. Unpublished doctoral dissertation, University of Waterloo, Ontario.
- Reingold, E. M., & Merikle, P. M. (1988). Using direct and indirect measures to study perception and awareness. Perception & Psychophysics, 44, 563-575.
- Roediger, H. L., & Craik, F. I. M. (1989). Varieties of memory and consciousness: Essays in Honour of Endel Tulving. Hillsdale, N.J.: Erlbaum.

- Roediger, H. L., & Payne, D. G. (1985). Recall criterion does not affect recall level or hypermnesia: A puzzle for generate/recognize theories. Memory & Cognition, 13, 1-7.
- Roediger, H. L., & Thorpe, L. A. (1978). The role of recall time in producing hypermnesia. Memory and Cognition, 6, 296-305.
- Roediger, H. L., Srinivas, K., & Waddill, P. (1989). How much does guessing influence recall? Comments on Erdelyi, Finks, and Feigin-Pfau. Journal of Experimental Psychology: General, 118, 255-257.
- Schachter, D. L. (1987). Implicit memory: History and current status. Journal of Experimental Psychology: Learning, Memory, and Cognition, 13, 501-518.
- Seamon, J. G., Brody, N., & Kauff, D. M. (1983a). Affective discrimination of stimuli that are not recognized: Effects of shadowing, masking, and cerebral laterality. Journal of Experimental Psychology: Learning, Memory, and Cognition, 3, 544-555.
- Seamon, J. G., Brody, N., & Kauff, D. M. (1983b). Affective discrimination of stimuli that are not recognized: Effect of delay between study and test. Bulletin of the Psychonomic Society, 21 (31), 187-189.
- Seamon, J. G., Marsh, R. L., & Brody, N. (1984). Critical importance of exposure duration for affective discrimination of stimuli that are not recognized. Journal of Experimental Psychology: Learning, Memory, and Cognition, 10, 465-469.
- Shapiro, S. R., & Erdelyi, M. H. (1974). Hypermnesia for pictures but not words. Journal of Experimental Psychology, 103, 1218-1219.
- Shepard, R. N. (1967). Recognition memory for words, sentences, and pictures. Journal of Verbal Learning and Verbal Behavior, 6, 156-163.
- Shevrin, H., & Luborsky, L. (1958). The measurement of preconscious perception in dreams and images: An investigation of the Poetzl phenomenon. Journal of Abnormal and Social Psychology, 58, 285-294.

- Silverman, L. H. (1983). The subliminal psychodynamic method: Overview and comprehensive listing of studies. In J. Masling (Ed.), Empirical studies of psychoanalytic theory. (Vol. 1, pp. 69-103). Hillsdale, NJ: Erlbaum.
- Standing, I., Conezio, J., & Haber, R. N. (1970). Perception and memory for pictures: Single-trial learning of over 2,500 visual stimuli. Psychonomic Science, 19, 73-74.
- Swets, J. A. (Ed.). (1964). Signal detection and recognition in human observers. New York: Wiley.
- Swets, J. A., Tanner, W. P., & Birdsall, T. G. (1961). Decision processes for perception. Psychological Review, 68, 301-340.
- Whitehouse, W. G., Dinges, D. F., Orne, E. C., & Orne, M. T. (1988). Hypnotic hypermnesia: Enhanced memory accessibility or report bias? Journal of Abnormal Psychology, 97, 289-295.
- Williams, O. (1926). A study of the phenomenon of reminiscence. Journal of Experimental Psychology, 9, 368-387.
- Winer, B. J. (1971). Statistical principles in experimental design (2nd Ed). New York: McGraw-Hill.
- Woodworth, R. S. (1938). Experimental psychology. New York: Holt, Rinehart and Winston.
- Woodworth, R. S., & Schlosberg, H. (1954). Experimental Psychology (2nd Ed.). New York: Holt.
- Yarmey, A. D. (1976). Hypermnesia for pictures but not for concrete or abstract words. Bulletin of the Psychonomic Society, 8, 115-117.