Long-Term Memory for a Common Object

RAYMOND S. NICKERSON AND MARILYN JAGER ADAMS

Bolt Beranek and Newman Inc.

A series of experiments was done to determine how completely and accurately people remember the visual details of a common object, a United States penny. People were asked to: draw a penny from unaided recall; draw a penny given a list of its visual features; choose from among a list of possible features those which do appear on a penny; indicate what was wrong with an erroneous drawing of a penny; and select the correct representation of a penny from among a set of incorrect drawings. Performance was surprisingly poor on all tasks. On balance, the results were consistent with the idea that the visual details of an object, even a very familiar object, are typically available from memory only to the extent that they are useful in everyday life. It was also suggested that recognition tasks may make much smaller demands on memory than is commonly assumed.

Many things can be recognized on the basis of their visual characteristics. Moreover, laboratory studies have shown that people are quite adept at discriminating between complex pictures they have seen a short time before and those they have not, even when given hundreds (Nickerson, 1965; Shepard, 1967) or thousands (Standing, 1973; Standing, Conezio, & Haber, 1970) of pictures to remember and allowed to inspect each for only a few seconds. Both of these observations are consistent with the idea of a visual memory that readily assimilates and retains an abundance of information about the stimuli to which it is exposed.

In fact neither introspection nor the results of picture recognition studies tells us how much information regarding any particular visual pattern has been stored. When people demonstrate the ability to recognize something, they may be demonstrating only that they can place that thing in an appropriate conceptual category. And the category may be more or less broadly defined, depending on one's purpose—as when an object is recognized as an automobile, as opposed to being recognized as a Volkswagen, or as the specific Volkswagen that belongs to John Doe. Similarly, when people show that they can distinguish a picture they have seen before from one they are looking at for the first time, they show only that they have retained enough information about the "old" picture to distinguish it from the new one. Given that one typically cannot say how much information *must be* retained in order to permit such categorizations

and distinctions, one cannot rule out the possibility that they may be made on the basis of a small portion of the information that the patterns contain.

The experiments reported in this paper are addressed to the question of how accurately and completely the visual details of a common object, a United States penny, are represented in people's memories. We chose to study people's knowledge of a common object rather than of laboratory stimuli because we are interested in the nature of the information that normally accrues in memory. As a stimulus, a penny has the advantage of being complex enough to be interesting but simple enough to be analyzed and manipulated. And it is an object that all of our subjects would have seen frequently.

EXPERIMENT I

The purpose of the first experiment was to see how accurately people could reproduce a penny through unaided recall.

Method

The subjects were 20 adult United States citizens. Each was given a set of empty circles, 2 in. in diameter, and asked to draw from memory what is on each side of a U.S. penny. Subjects were asked to include all the pictorial and alphanumeric detail they could, and they were allowed to draw as many versions of each side as they wanted.

For purposes of scoring the drawings, we focused on the eight features listed in Table 1. Each subject's drawing was scored according to: (a) whether each of these eight features was present; (b) whether each was located on the correct side of the coin; and (c) whether it was drawn in the correct position in the circular area. The head was scored as being in the correct position only if it was drawn as an east-facing profile.

Results

In general, performance was remarkably poor. Figure 1 shows some examples of the drawings we obtained. Of the eight critical features, the median number recalled and located correctly was three. Not counting the Lincoln head and the Lincoln Memorial, the median number of recalled and correctly located features was one. Only 4 of our 20 subjects got as

TABLE 1
FEATURES IDENTIFIED FOR SCORING PURPOSES IN EXPERIMENT I

Top side
  Head
  "IN GOD WE TRUST"
  "LIBERTY"
  Date

Bottom side
  Building
  "UNITED STATES OF AMERICA"
  "E PLURIBUS UNUM"
  "ONE CENT"

FIG. 1. Examples of drawings obtained from people who tried to reproduce a penny from memory.
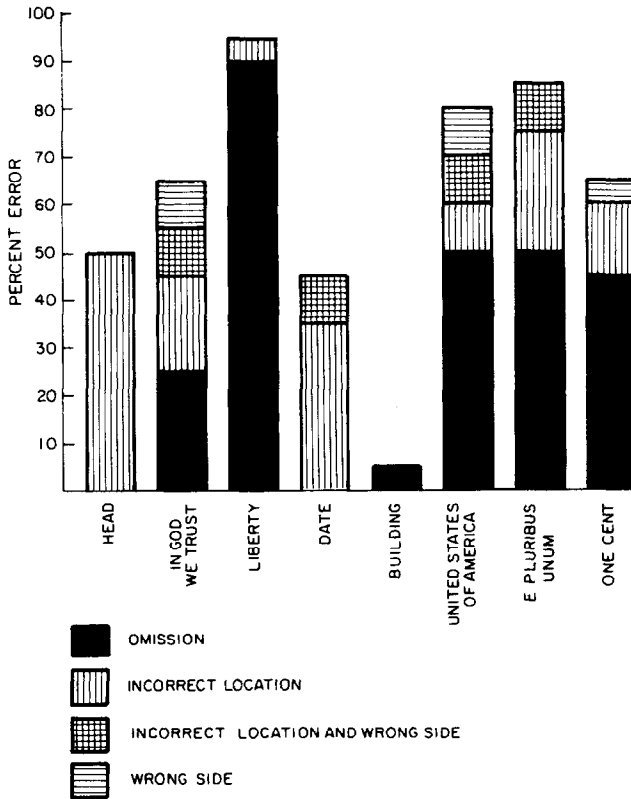

FIG. 2. Types of errors produced when subjects attempted to draw a penny from memory.

many as half of them. Only 1 subject (an active penny collector) accurately recalled and located all eight.

Figure 2 shows an analysis of the errors with respect to each feature. The overall probability that a feature would be either omitted or mislocated was .61. The probability that a feature would be omitted was .33; excluding the Lincoln head and the Lincoln Memorial, this probability was .43. The only features that all our subjects produced were a head and a date. All but one subject also recalled a building as the central figure on the bottom side. The feature most frequently omitted was LIBERTY: only two of our subjects remembered that this is on the coin, and one of them located it on the wrong side. UNITED STATES OF AMERICA, E PLURIBUS UNUM, and ONE CENT were also omitted by about half of our subjects. It is interesting to note that with the exception of Lincoln's head, the Memorial, and ONE CENT, all of these items occur on every current U.S. coin.

Figure 2 also shows that subjects were quite poor at locating those features they did recall. The probability of mislocating a correctly recalled feature was .42. The only feature that was consistently located correctly was the building, which would be difficult to position incorrectly if it were recalled at all. Excluding the building, the probability of mislocating a feature was .50. Exactly half of our subjects faced the Lincoln head in the wrong direction.

Ten subjects exercised the option of drawing more than one version of the coin, although one of them redrew the top side only. Across the 19 cases in which multiple versions of a side of the coin were drawn, the final choice was the most accurate version in six cases, equivalent to the other(s) in eight cases, and worse than at least one of the rejected versions in five cases. We had suggested this option partly because we suspected that subjects would do better if they could draw several versions and then decide which looked best; evidently we were wrong.

Subjects' memories for the coin also appeared uneven in that they often recalled minor details while omitting or confusing more conspicuous ones. For example, every one of the 19 subjects who drew a building on the bottom side of the coin drew it with a colonnade, and 5 of them even drew a tiny figure of Lincoln inside; on the other hand, 7 subjects drew the building with a peaked roof, 1 with a dome, and 2 with chimneys. Eleven subjects finished their drawings of Lincoln at the neck; of those who drew any part of the torso, only 4 extended it to the edge of the coin. Eleven subjects indicated that the coin could or should have a mint mark, but several of them had incorrect ideas about what letters were appropriate, and only 5 of them located the mark under the date. Three subjects indicated that the designer's initials should be on the head of the coin, but only 1 of them correctly specified what or where those initials should be.

There were relatively few intrusion errors: Three subjects thought that

"PENNY" was imprinted on the coin; two thought "ABRAHAM LIN-
COLN" was. Eight subjects drew sheaves or wreaths. Perhaps that
should not be surprising inasmuch as pre-1959 pennies did have wreaths;
but that was over 20 years ago and today it is very difficult to find pre-1959
pennies in circulation. In any case, one of these subjects was the one who
forgot the building: on the tail of the coin he drew a wreath with the words
"ONE CENT" inside, similar to how the old pennies look. Of the others,
four drew the sheaves on the tail of the coin and three drew them on the
top side encircling Lincoln's bust.

EXPERIMENT II

The results of Experiment I indicate that the information that appears
on a U.S. penny is not trivially easy for many of us to recall, or at least to
draw on request. They also suggest that even when we can recall that a
feature is on the penny, we often are unable to locate it correctly. Because
of the high frequency of omission errors, however, the mislocation data
are difficult to interpret. The problem is, in part, statistical: For example,
it is not reasonable to estimate the probability of mislocating LIBERTY
from the data of those two subjects who recalled it at all. But there is also
the possibility that mislocation errors were partially induced by omission
errors: When subjects could not recall all of the features that belonged on
the coin, they might have arranged what they could remember so as to
make their drawings look better—to fill them out or to balance them in
terms of design. The same sort of effort might have motivated intrusion
errors as well. Several subjects volunteered such explanations for their
poor performance. The purpose of Experiment II was to collect some data
on memory for location that would be independent of memory for
content.

Method

The procedure and materials were the same as in Experiment I except that subjects were
given a list of the eight features of interest. The subjects' task was to locate these features
correctly. Twenty different adult U.S. citizens served as subjects.

Results

Again, performance was surprisingly poor. None of our subjects lo-
cated all of the details correctly, and only four got as many as half of
them. The overall probability of mislocating a feature was .68, as com-
pared to .42 in Experiment I. Excluding the building, which again was
correctly placed by everyone, the probability of mislocating an item was
.77, as compared to .50 in Experiment I. In short, the possibility that the
mislocations in Experiment I were artifacts of omission errors was not
supported. To the contrary, the fact that the relative frequency of mislo-
cations was not greater in Experiment I may have been an artifact of the
high frequency of omissions: It appears that memory for location was
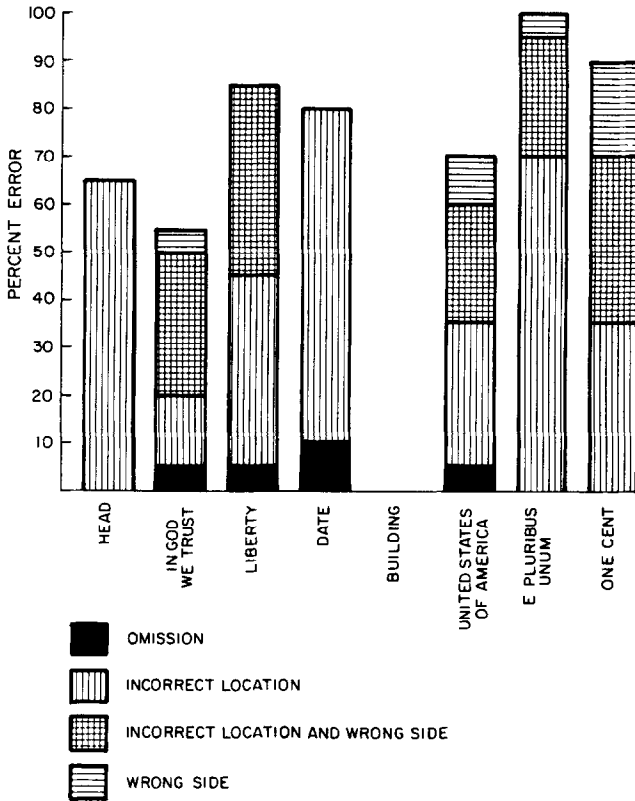better for features that could be recalled than for those that could not.

FIG. 3. Types of errors produced when subjects attempted to draw a penny, given a list of the features of interest.

Figure 3 shows an analysis of errors with respect to features. Note that subjects occasionally failed to draw a feature even though they had the list in front of them during the experiment. We do not know whether these omissions reflect especial uncertainty, or mere carelessness in checking the drawings against the list. The Lincoln head was facing the wrong direction in about 65% of the drawings. With the exception of the date, all of the alphanumeric items were frequently drawn on the wrong side of the coin as well as in the wrong location within the circular area. The elements that were most frequently omitted in Experiment I (LIBERTY, UNITED STATES OF AMERICA, E PLURIBUS UNUM, and ONE CENT) were all incorrectly located by a large majority of the subjects. The date was shown on the correct side of the penny by all but two subjects, who omitted it completely; however, only four subjects located it correctly on that side.

In this experiment only six subjects exercised the option of drawing

more than one version of the coin, and, as in Experiment I, they seemed to gain no advantage by doing so. In terms of our scoring system, only two of these subjects ultimately selected a drawing that was more accurate than any of their others.

Again, there was considerable variation in the details of subjects' drawings. As examples, in place of the Lincoln Memorial, one subject drew what we take to be a picture of the Washington Monument while another drew a side view of Lincoln sitting in a chair.

EXPERIMENT III

The results of Experiments I and II indicate that people cannot accurately recall either the features that appear on a penny or how those features are arranged. We reasoned that these data might not reflect people's lack of knowledge of pennies so much as the inappropriateness of recall tasks for purposes of assessing that knowledge. Perhaps performance would be more impressive on a recognition task. Item recognition is often taken to be a more sensitive test of memory than item production (Anisfield & Knapp, 1968; Kintsch, 1970a, 1970b; Underwood, 1972). Moreover, recognition tasks would seem to be more closely related to what we normally do with pennies. In view of these considerations, Experiments III, IV, and V were done using recognition tasks. Experiment III was designed to assess awareness of the features that are on a penny, independently of awareness of their location or appearance.

Method

Twenty new subjects (adult U.S. citizens) were given a list of 20 features. Their task was to indicate with respect to each feature (a) whether it is on a penny, and (b) their degree of confidence (on a 3-point scale) in their answer. Two answer forms were used, each with 10 subjects. The two forms, which are shown in Table 2, differed only with respect to the "distractor" items.

Results

Subjects used the highest, intermediate, and lowest confidence levels on about 45, 31, and 24% of the test items, respectively. We take this as evidence that the task was not perceived as trivially easy.

The overall probability of a correct response in this task was .85. The relationship between confidence and correctness is shown in Fig. 4. In general, the higher the subject's confidence in an answer, the more likely was the answer to be correct. The probability that a response would be correct was somewhat higher for negative than for positive responses at all confidence levels, but this could be an artifact of the greater number of negative than of positive items on the answer sheet. Because of this asymmetry, random negative guesses would have been more likely to be correct than random positive guesses.

Figure 5 shows the percentages of correct (positive) and incorrect (negative) responses at each confidence level for those features that are in

TABLE 2

THE LISTS OF FEATURES THAT WERE GIVEN TO SUBJECTS IN EXPERIMENT III

1. The word JUSTICE
2. The words UNITED STATES OF AMERICA
3. The words LEGAL TENDER
4. The word VERITAS
5. The words ONE CENT

6. The date (year) of mint
7. The presidential seal
8. The word COIN
9. The words WASHINGTON, D.C.
10. The left side of Lincoln's face

11. The right side of Lincoln's face
12. The White House
13. An eagle with spread wings
14. The Lincoln memorial
15. The words IN GOD WE TRUST

16. The word LIBERTY
17. Sheaves of wheat
18. The Roman numeral I
19. The words E PLURIBUS UNUM
20. The words MINTED IN USA

1. The words ONE PENNY
2. The words UNITED STATES OF AMERICA
3. The words ONE NATION UNDER GOD
4. The right side of Washington's face
5. The words ONE CENT

6. The date (year) of mint
7. The great seal
8. The words LINCOLN MEMORIAL
9. The number 1 centered
10. The full face of Lincoln

11. The right side of Lincoln's face
12. A laurel wreath
13. The words MADE IN TAIWAN
14. The Lincoln memorial
15. The words IN GOD WE TRUST

16. The word LIBERTY
17. The words ANNO DOMINI
18. The word COPPER
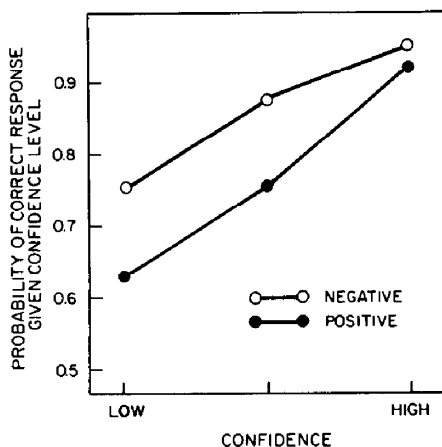19. The words E PLURIBUS UNUM
20. The Statue of Liberty's torch

FIG. 4. The relationship between degree of confidence expressed in a response and the probability that the response was correct.
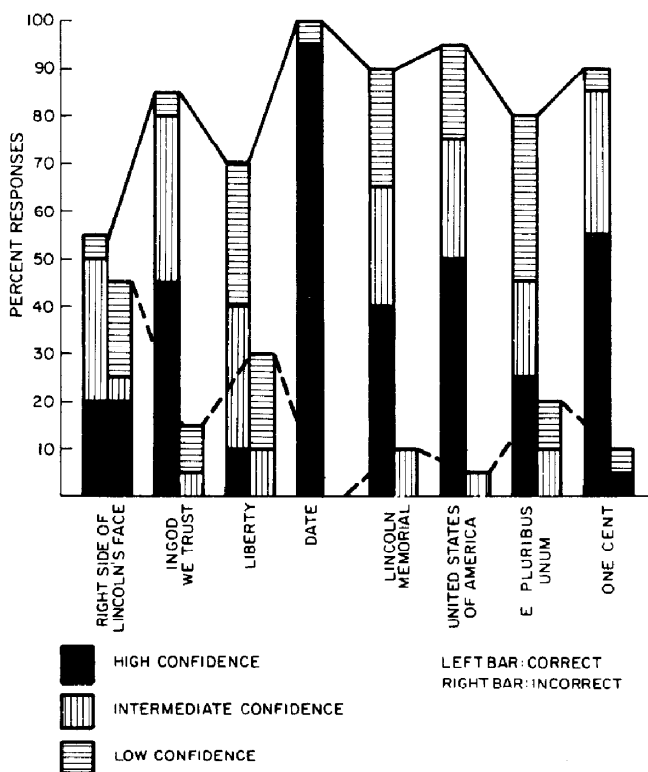
FIG. 5. The percentage of correct (positive) and incorrect (negative) responses, and associated confidence levels, for those features that are on the penny.

fact on the penny. The bars representing correct responses (left of each pair) are connected, as are those representing incorrect responses (right of each pair). More often than not, subjects tended to believe that these eight features were on a penny, but the response distribution was far from bimodal. The only feature that subjects selected with *both* consistent accuracy and high confidence was the date. Although several other features were selected by at least 80% of the subjects, the degree of confidence in the presence of these items was not uniformly high. Again, LIBERTY proved to be difficult; only 2 of the 20 subjects were certain that it belonged on the coin. The poor showing with respect to the "right side of Lincoln's face" must be weighed in light of the fact that of the 9 subjects who rejected this item, 6 opted for the "left side of Lincoln's face," 1 for his full face, and 1 for the right side of Washington's face.

The distractor features that were judged to be on the penny by at least 2 subjects were the left side of Lincoln's face (6), a laurel wreath (6), sheaves of wheat (4), the words LINCOLN MEMORIAL (3), the number 1 centered (2), the great seal (2), the Roman numeral I (2), and the words WASHINGTON, D.C. (2). No one voted for MADE IN TAIWAN.

On the whole, the results from Experiment III seem to present a slightly more positive assessment of memory for visual features than did those of Experiments I and II. At least with the particular set of distractor features that was used, subjects were able to distinguish between bona fide features and distractors with fair accuracy. However, this performance measure may be somewhat misleading. It may reflect not only what subjects remember about a penny, but what they can infer. Even a subject who had never seen a penny might accept some of the candidate features on the grounds that they *ought* to be on a U.S. penny (e.g., UNITED STATES OF AMERICA, ONE CENT, a date) and reject others on the grounds that they ought not to be there (e.g., MADE IN TAIWAN). The possibility that our subjects may have done some judicious guessing gets some support from the fact that they often did not report high confidence in their answers even when they were correct.

EXPERIMENT IV

On the basis of Experiments I, II, and III, one might conclude that our knowledge of the way pennies look is in general quite vague and incomplete. Yet, given our familiarity with pennies, this conclusion seems incredible. An alternate explanation is that we generally do have in memory a relatively complete and accurate representation of a penny, but that this representation is holistic and unanalyzable. Under this hypothesis people might be expected to be inept at reproducing or recognizing a penny feature by feature. However, they should be good at judging whether or not a facsimile is accurate.

Experiment IV was designed to assess this hypothesis. Each subject was given a drawing of the head of a penny. The task was to decide whether or not the drawing was accurate and, if not, to specify what was wrong with it. If the holistic-representation hypothesis is correct, subjects should be good at determining whether a drawing is accurate, but not necessarily so good at specifying what is wrong with it if it is not accurate.

Method

The stimuli were 15 different drawings of the head of a U.S. penny. These are shown in Fig. 6. One of the versions (A) was accurate; the others were inaccurate in that at least one feature was omitted, mislocated, or added. These inaccuracies are specified in the second column of Table 3. The subjects were 127 U.S. citizens in a Psychology I lecture at Brown University. Each subject was given one of the drawings and asked to decide whether it was an accurate reproduction of a penny, and, if not, to describe what was wrong with it. Each drawing was evaluated by 8 or 9 subjects.

Results

The results are summarized in Table 3. The third column gives the number of subjects who examined each version, and the fourth gives the number of those who accepted that version as correct. The first thing to note is that our predictions were off again. Only four of the eight subjects who saw the accurate version, accepted it as such. Moreover, the accurate drawing was not a clear favorite. Versions *G* and *I* were respectively accepted by four and six of the nine subjects who saw them, and five

FIG. 6. The fifteen drawings of the top side of a penny that were used in Experiments IV and V. A brief characterization of each drawing is given in Table 3.

NICKERSON AND ADAMS

others were accepted by at least one subject. The incorrect reproductions that were judged to be correct seem to have little in common: for version *D* a feature was missing; for *G* a feature was substituted; for *I* an extra feature was added; for *J* and *K* the positions of two of the features were switched; for *M*, the bust was reversed; and *N* was thoroughly mixed up. On the basis of these data, then, we can point to no particular configural or featural properties that were controlling subjects' responses.

The fifth column in Table 3 gives the number of subjects who correctly indicated which features were in error for each drawing. The number who identified only these features as incorrect and specified exactly what was wrong with them is given in parentheses; the balance includes subjects who incompletely or incorrectly specified what was wrong with the erroneous feature(s) as well as those who cited other, correct features as erroneous. Referring to version *J* as an example, two subjects specified

TABLE 3

CHARACTERIZATIONS OF THE DRAWINGS SHOWN IN FIG. 6
AND RESULTS FROM EXPERIMENTS IV AND V

Drawing	Characterization	Experiment IV			Experiment V			
		No. of subjects	No. who thought drawing accurate	No. who identified error(s)	Response category			
					1	2	3	4
A	Correct	8	4	—	15	12	4	5
B	1 Omission	9	0	6(2)	0	0	6	30
C	1 Omission	9	0	9(1)	0	1	4	31
D	1 Omission	8	2	3(1)	1	3	6	26
E	1 Mislocation	9	0	8(0)	0	12	9	15
F	1 Mislocation	8	0	5(0)	0	5	17	14
G	1 Substitution	9	4	1(0)	4	10	10	12
H	1 Substitution	8	0	2(0)	2	6	8	20
I	1 Addition	9	6	2(1)	7	5	5	19
J	2 Features interchanged	8	2	4(2)	2	18	5	11
K	2 Features interchanged	8	3	3(1)	0	5	13	18
L	Mirror image	9	0	4(3)	1	8	4	23
M	Reversed face	8	3	3(1)	4	9	5	17
N	Mirror with 2 features interchanged	9	1	1(1)	0	3	5	28
O	Mirror with 1 omission, 1 mislocation, and 1 addition	8	0	0(0)	0	3	4	29

only that the positions of LIBERTY and the date had been switched, one noted the switch and added that the words ONE CENT were missing, and one specified that the date belonged on the right but merely that LIBERTY belonged someplace else. Thus, the only criterion for this response category was that the subject indicate that *something* was wrong with each of the items that were indeed wrong. Despite the leniency of this criterion only version *C*, with a missing date, was correctly diagnosed by all of its viewers. Version *E* was a close second, with eight of its nine viewers noting that the date was in the wrong place. Subjects' apparent sensitivity to the date does not seem to be an artifact of their response criteria: Of the 75 subjects who saw drawings in which the date was correctly located, only three suggested that it was not.

Again one is tempted to conclude that the average U.S. citizen knows relatively little about the details of a penny, with the possible exception of the date. But there are hints in these data that this view is too simplistic. As described above, almost everyone noticed that the date was wrong when it was the only feature that had been altered or omitted (versions *C* and *E*). However, only 38% of the subjects noted that the date was amiss when it was one of several erroneously portrayed features (versions *J*, *L*, *N*, and *O*). Further, subjects who noted something wrong with the date in versions *C* and *E*, went on to cite incorrectly an average of 1.35 additional problems with the reproduction (e.g., "LIBERTY belongs on the other side"; "IN GOD WE TRUST isn't on a penny"). By contrast, subjects who correctly named the distorted feature(s) of other versions cited an average of only 0.44 other problems. Thus, it seems that subjects' ability to detect a problem with the date depended on whether the rest of the features were correctly configured, and, conversely, that their ability to evaluate the configuration of the other features depended on whether the date was correctly arrayed. This in turn suggests that their responses were shaped, at least partially, by memory for the face of the coin as a whole.

EXPERIMENT V

Rather than concluding that we know so little about the appearance of an object that is so very familiar, we again considered the possibility that our tasks had been somehow inappropriate for tapping that knowledge. We decided to try one more method: each subject was given all 15 of the drawings in Fig. 6 and asked to select the most plausible from among them. We were sure this task would be quite easy. The subjects would have all 15 versions before them. If the correct version did not just pop out at them, they could compare and contrast the alternatives in any way they pleased.

Method

Each of 36 female students from Lesley College (all U.S. citizens) was given the 15

drawings from Experiment IV, each printed on a separate card. The subjects were told that one of the drawings was correct, whereas each of the others had one or more things wrong with it. The subject's task was to sort the drawings into the following four categories: (1) the one drawing she thought most likely to be correct; (2) drawings she could easily believe to be correct if the one she had chosen as correct proved not to be; (3) drawings that might possibly be correct; and (4) drawings that she felt sure were incorrect. Suitable labels were provided to facilitate the sorting. Subjects were told that they must assign exactly one drawing to the first category, but that they could have as many or as few drawings in each of the other categories as they wished and that it was not necessary to use all categories. They were given as much time as they wanted and were free to move drawings from one category to another until satisfied with their selections.

Results

The last four columns of Table 3 show the distribution of category placements for each of the 15 drawings. Although the correct drawing was more likely to be judged correct than were any of the counterfeits, it was not recognized as the obvious choice by all, or even by a majority, of our subjects. Somewhat less than half (15 of the 36) of our subjects placed it in Category 1. As in Experiment IV, drawing *I* proved to be relatively plausible, and was selected as the most likely one by 7 subjects. Drawings *G* and *M* both got 4 votes, and *D, H, J* and *L* got at least 1.

A second general observation that may be made from Table 3 is that many of the drawings were considered as possibilities by many of the subjects. In fact, excluding the Category 1 assignments, about one-quarter of the drawings, on the average, were judged as easily believed to be correct, one-quarter were judged conceivably correct, and one-half were judged as certainly incorrect.

Examination of the response distributions shown in Table 3 points out one of the dangers involved in making inferences about the contents of memory on the basis of forced-choice recognition tasks. If our subjects had been asked only to select the one drawing they considered most likely to be correct, we might have concluded that recognition memory was rather good, inasmuch as the correct alternative would have been chosen at least twice as frequently as any other. And had the set of distractors been made smaller by exclusion of some of the more plausible alternatives (e.g., versions *G, I, M*) performance would have been much more impressive. As is apparent from the table, however, although subjects were more likely to choose the correct drawing than any other, they were not, as a rule, able to reject all the other possibilities with a high degree of confidence. (Only two subjects classified all but one of the drawings as certainly incorrect, and one of these subjects selected an incorrect drawing—version *I*—as the one most likely to be correct.)

How does the degree of plausibility of a drawing depend upon the relationship between that drawing and the correct one? On the assumption that, at least in a statistical sense, the correct drawing is more plausi-

ble than any of the incorrect ones, we might expect the degree of plausi-
bility of the incorrect drawings to drop off as the degree of their similarity
to the correct drawing decreased. Unfortunately, we have no measure of
between-drawing similarity. However, one thing seems clear in this re-
gard: If similarity were defined as the number of features with respect to
which two drawings differed, the relationship between similarity and
plausibility would not be simple. Two of the least plausible drawings (B
and C) differed from the correct one with respect to only a single feature;
the inscription IN GOD WE TRUST was missing from one and the date
from the other.

DISCUSSION

The results of these experiments suggest that our memory repre-
sentations of the details of a penny's characteristics are very incomplete
and imprecise. Our subjects were not able to draw a penny from memory;
indeed, their attempts to do so were, for the most part, grossly inaccurate.
Nor were they able to position features correctly, even when told what
the features are. They were somewhat better able to indicate which of
several listed features are on a penny; however, even in this case, perfor-
mance was far from perfect, and confidence was not uniformly high. They
were unable to specify what was wrong with erroneous facsimiles of a
penny, and two of those facsimiles were accepted as bona fide repre-
sentations as frequently as was the correct drawing. In a forced-choice
situation, less than half of our subjects selected the correct representation
from among a set of incorrect drawings, and almost all of them found
several of the incorrect drawings to be plausible possibilities. Even such a
prominent feature as the orientation of the Lincoln head seemed not to be
encoded well at all.

These results violate our intuitions regarding what we know about the
way things look. Most people, we suspect, would be willing to say that
they know what a penny looks like or at least that they would have no
trouble recognizing one when they saw it. A typical reaction of our sub-
jects after participating in this study was one of surprise, and sometimes
embarrassment, at how difficult their tasks, which initially sounded so
simple, turned out to be. Certainly, all of our subjects had seen pennies
many thousands of times during their lives; some had collected them as a
hobby. And we had, after all, selected a penny as our stimulus because we
thought it would be at least as familiar to most people as any other object
we might have used. The results may also seem surprising in view of the
findings of several other studies of visual memory. How are they to be
reconciled, for example, with the fact that people can distinguish with a
high degree of accuracy between complex pictures they have seen briefly
and those they have not, even after having seen a large number of pic-

tures? Our discussion of these results, and our attempt to reconcile them with studies of visual memory that have yielded more impressive findings, will draw upon the notions of cue redundancy, meaningfulness, interference, and inference.

As was noted in the introductory passage, it is not clear what sorts of information regarding pictures must be retained in order to permit the kind of performance reported in such studies as those of Nickerson (1965, 1968), Shepard (1967), and Standing et al. (1970). The pictures that were used in those studies were complex and diverse. On the average, they probably differed from each other with respect to a very large number of details, and it may be that the distinction between "old" and "new" stimuli could be made on the basis of any of a number of small subsets of those details. Similar suggestions have been made by Goldstein and Chance (1970) and by Green and Purohit (1976).

To the extent that this notion of a multiplicity of cues on which distinctions might be based is taken as at least a partial explanation of recognition-memory performance with complex pictures, it also helps to explain the poorer performance of our subjects on our recognition tasks. The incorrect drawings of pennies that were used in these tasks did not always differ from the correct drawing with respect to a large number of features. Indeed, in many instances the difference involved only a single feature. It cannot be said of these stimuli, therefore, as it can of those in the cited studies, that the necessary distinctions could be made on the basis of any of a large variety of distinguishing cues.

While the idea of cue redundancy does help, we believe, to account for the ability of people to distinguish between pictures they have seen before and those they have not, it cannot be the whole story. Meaningfulness must also be implicated in some way. Recognition performance is much poorer with relatively abstract complex visual patterns, such as snowflakes and inkblots, than with random photographs of real-life scenes (Goldstein & Chance, 1970). Moreover, support for the idea that it is not their abundance of details alone that makes pictures memorable comes from an experiment in which recognition memory was tested for (a) photographs, (b) one-sentence verbal descriptions of the photographs, (c) line drawings of the main themes of the photographs, and (d) those same line drawings embellished with details not essential to the main themes (Nelson, Metzler, & Reed, 1974). The unembellished line drawings were recognized as well as the photographs and embellished line drawings, both immediately and after 7 days.

Recognition of the importance of meaningfulness also helps to reconcile our results with those of picture-memory experiments. While a penny is certainly a meaningful object, the particular details that appear on it, and the spatial relationships among those details, are relatively arbitrary. The

visual components of a penny do not play the same role in determining the meaning of the whole, as do the components of many real-life scenes.

The importance of meaningfulness is illustrated by our subjects' poor memory for orientation. The conclusion that people tend to have little, if any, remembrance of the direction in which the Lincoln head faces is supported by the results of all these experiments. Our explanation of why people do not remember the orientation of the profile on a coin is because it has no significance: One orientation will do quite as well as the other, and neither is incongruous in the context of the other components of the coin.

There is other evidence that memory for orientation is often poor. For example, Bartlett (1932) noted that subjects were unable to remember the orientation of faces on pictures shortly after having seen them. Other investigators have found subjects in picture-recognition experiments to be about as likely to recognize the mirror image of a picture as the original picture itself (Dallet, Wilcox, & D'Andrea, 1968; Standing et al., 1970). Standing et al. also tested subjects' ability to discern whether or not a picture had been reversed. Eighty-six percent accuracy on this task following a 30-min retention interval fell to 71% after 24 hr; in contrast, after 24 hr recognition accuracy, ignoring orientation, was at 94%. Finally, Blount, Holmes, Rodger, and Coltheart (1975) found that the ability of subjects to discriminate original from mirror-image views of art masterpieces that they had seen before was not greatly above chance (62%).

There is also evidence that orientation is more likely to be remembered if it is meaningful than if it is not. Kraft and Jenkins (1977), for example, have shown that how well a person remembers the orientation of the elements of a visual scene may depend on whether orientation is significant or incidental in the context in which the elements occur. Thus, if a sequence of pictures represents a meaningful sequence of events such as a story, and, in particular, one in which the meaningfulness of the story would not be preserved if the orientation of the pictures were changed, then orientation information may be retained with a relatively high degree of accuracy. If the pictures of the sequence are independent of one another, however, such information tends not to be retained.

In addition to cue redundancy and meaningfulness, a third factor that relates to the performance of our subjects is interference. There was some evidence in our results that some subjects may have confused features of current pennies with those of pennies that are no longer in circulation. There is also the possibility of interference from memory for features on other coins. For example, subjects who drew a dome on the Lincoln Memorial may have been experiencing interference from their memories of the back of a nickel, which has a relief of Monticello. With respect to the orientation of the Lincoln head, it is worth noting that on all other

current U.S. coins that show busts, the head faces in the other direction. Indeed, there is a preponderance of left over right cheeks in art work in general (McManus & Humphrey, 1973). We are inclined to attribute the confusion over the orientation of Lincoln's head to its lack of significance, as indicated above. However, for some of our subjects, this confusion may be less indicative of poor memory for this aspect of a penny than of interference from memories of so many other profiles.

So far, we have focused on reconciling our results with those of some other studies of visual memory. We have attributed the differences between our results and those of several picture-memory experiments in part to differences in the multiplicity of distinctive cues on which performance could depend and in the degree of meaningfulness of stimulus features and the relationships among them. We have also noted the possibility of interference between memory representations of pennies and those of other visual patterns, especially other U.S. coins. These considerations seem to fall short, however, of explaining why we are so poor at specifying, or even recognizing, what a penny looks like. Why are our memory representations for so familiar an object not more complete and precise?

One plausible explanation is that there is no need for them to be any better. Perhaps what we mean when we say that we know what a penny looks like is that we can distinguish a penny from other things from which we normally have to distinguish it, for example, from other coins. This does not require that we know what a penny looks like in any detail. The features that are salient for distinguishing a penny from other U.S. coins are probably its color and size. And even when one has occasion to distinguish a penny from a foreign coin of similar color and size, a gross comparison of their features will generally suffice. (In view of our subjects' relatively good memory for the date, it is noteworthy that of the features considered in this study, it is the only one that many of us find valuable for distinguishing among pennies.) What is interesting about this explanation is that it suggests that many of the numerous things we all can "recognize," we may recognize on the basis of memory representations that are as incomplete and imprecise as our representations of pennies appear to be. Skeptics are invited to try to draw from memory a telephone dial or their watch face or any other thing at which they frequently look.

We should note that our subjects' underlying memory representations may have been even more vague than our results suggest. The fact that a subject drew a particular feature in the first of our experiments does not prove that he or she relied on stored information about pennies in particular to do so. All current U.S. coins have a head on one side. Moreover, they all contain a date and the words LIBERTY, E PLURIBUS UNUM and UNITED STATES OF AMERICA. Even if one

were not aware of this fact, one might expect any coin to display its denomination, the name of the country of coinage, and the year of mint. Remembering, or being able to guess, that the building on the back side of the penny is the Lincoln Memorial, coupled with a memory representation—from some source other than a penny—of what that looks like, could provide a basis for an accurate drawing. More generally, many correct responses may have been derived from memories for different but related information. Inference may be seen as the productive counterpart of interference. These considerations illustrate a methodological difficulty that characterizes much long-term memory research: namely, the difficulty (perhaps impossibility) of distinguishing between what is remembered and what is inferred.

There is, finally, one possible explanation of our results that puts them in a quite different light. Perhaps it is not that we only know about the grosser or more salient aspects of our visual worlds, but that that is all we are conscious of knowing. Haber and Erdelyi (Erdelyi & Becker, 1974; Haber, 1970; Haber & Erdelyi, 1969) have reported some provocative indications that visual memories may be quite elaborate but stubbornly inaccessible for purposes of recall or reconstruction. There is also the older literature on introspection and imageless thought. In summarizing his review of this literature, Woodworth quotes Book (1910): "conscious attitude seems to represent a stage in a process of development which begins with vivid, imaginal thought, and slowly and gradually passes downward to a stage of automatic or instinctive control" (Woodworth, 1938, p. 790). As an everyday illustration that we may know at some level more than we are aware of knowing: People often note when a friend wears new clothes, although they probably could not begin to describe their friend's wardrobe.

It may be adaptive for the details of our visual experiences to be inaccessible. One is reminded of Luria's mnemonist who had so much trouble recognizing people's faces because, as he put it, they are "constantly changing" (Luria, 1968, p. 64). If we do indeed have such deep and elaborate knowledge, it may play a critical role in our abilities to navigate about our worlds. On the other hand, it may be that when we understand better the process of navigation, we may find that it requires less elaborate information about the world than we would have thought. In any case, in many situations it matters little how much a person knows unless that knowledge can somehow be made public. The results from these experiments should at least give us pause about the accuracy of testimonies on topics that we know like the "backs of our hands."

CONCLUDING COMMENT

On balance, the results from these experiments demonstrate that fre-

quent exposure to an object and the ability to "recognize" that object for practical purposes do not guarantee that the object is represented accurately in memory in any great detail. To the contrary, they raise the question of whether visual long-term memory is much less rich and elaborate than has often been supposed.

The results also lead us to the following conjecture: Typically, the details of visual stimuli are not retained in memory—or at least they are not available from memory—unless there is some functional reason for them to be. In other words, what one is most likely to remember about the visual properties of objects is what one needs to remember in order to distinguish those objects in everyday life. In general, investigators of human memory have not focused on the question of sufficiency. As one aspect of the study of what is stored in memory, it might be useful to give more thought to the question of what information *must* be retained in order to permit one to identify common objects or to distinguish them from each other. It may turn out that because of the multiplicity of features with respect to which most objects of interest differ from each other, the constraining effects of the contexts in which objects are typically encountered, and the role of inferential processes, recognition may make much smaller demands on memory than has commonly been believed.

REFERENCES

Anisfeld, M., & Knapp, M. Association, synonymity, and directionality in false recognition. *Journal of Experimental Psychology*, 1968, 77, 171–179.

Bartlett, F. C. *Remembering*. London: Cambridge Univ. Press, 1932.

Blount, P., Holmes, J., Rodger, J., & Coltheart, M. On the ability to discriminate original from mirror-image reproductions of works of art. *Perception*, 1975, 4, 385–389.

Dallett, K., Wilcox, S. G., & D'Andrea, L. Picture memory experiments. *Journal of Experimental Psychology*, 1968, 76, 312–320.

Erdelyi, M. H., & Becker, J. Hypermnesia for pictures. Incremental memory for pictures but not words in multiple recall trials. *Cognitive Psychology*, 1974, 6, 159–171.

Goldstein, A. G., & Chance, J. E. Visual recognition memory for complex configurations. *Perception and Psychophysics*, 1970, 9, 237–241.

Green, D. M., & Purohit, A. K. Visual recognition memory for large and small binary pictures. *Journal of Experimental Psychology: Human Learning and Memory*, 1976, 2, 32–37.

Haber, R. N. How we remember what we see. *Scientific American*, 1970, 222, 104–112.

Haber, R. N., & Erdelyi, M. H. Emergence and recovery of initially unavailable perceptual material. *Journal of Verbal Learning and Verbal Behavior*, 1967, 6, 618–628.

Kintsch, W. *Learning, memory, and conceptual processes*. New York: Wiley, 1970(a).

Kintsch, W. Models for free recall and recognition. In D. A. Norman (Ed.), *Models of human memory*. New York: Academic Press, 1970(b).

Kraft, R. N., & Jenkins, J. J. Memory for lateral orientation of slides in picture stories. *Memory & Cognition*, 1977, 5, 397–403.

Luria, A. R. *The mind of a mnemonist*. New York: Basic Books, 1968.

McManus, I. C., & Humphrey, N. K. Turning the left cheek. *Nature (London)*, 1973, 243, 271–272.

Nelson, T. O., Metzler, J., & Reed, D. A. Role of details in the long-term recognition of pictures and verbal descriptions. *Journal of Experimental Psychology*, 1974, 102, 184–186.

Nickerson, R. S. Short-term memory for complex meaningful visual configurations: A demonstration of capacity. *Canadian Journal of Psychology*, 1965, 19, 155–160.

Nickerson, R. S. A note on long-term recognition memory for pictorial material. *Psychonomic Science*, 1968, 11, 58.

Shepard, R. N. Recognition memory for words, sentences, and pictures. *Journal of Verbal Learning and Learning Behavior*, 1967, 6, 156–163.

Standing, L. Learning 10,000 pictures. *Quarterly Journal of Experimental Psychology*, 1973, 25, 207–222.

Standing, L., Conezio, J., & Haber, R. N. Perception and memory for pictures: Single-trial learning of 2500 visual stimuli. *Psychonomic Science*, 1970, 19, 73–74.

Underwood, B. J. Are we overloading memory? In A. W. Melton & E. Martin (Eds.), *Coding processes in human memory*. Washington, DC: Winston, 1972.

Woodworth, R. S. *Experimental psychology*. New York: Holt, 1938.