Misremembering a common object: When left is not right

GREGORY V. JONES

University of Warwick, Coventry, England

Three experiments were carried out to investigate people's memory for British coins. Two principal issues were studied. First, it has previously been shown that memory for U.S. pennies and other coins is surprisingly imperfect. How do other countries compare? It turned out that recall of the design of British pennies was, if anything, worse even than that of U.S. pennies. The situation was no better for a larger coin with an unusual shape. It is suggested that individual features are poorly remembered if they have low levels of meaningfulness, redundancy, identifiability, and discriminativeness. Second, in addition to this generally weak level of remembering, an instance of systematic *misremembering* was consistently observed. The Queen's portrait always faces to the right on British coins. Yet in all three experiments, the proportion of participants who recalled that the portrait faces to the right was so low (overall, 19%) that it was significantly less than even the 50% baseline to be expected from people in a state of complete ignorance. It follows that the participants were not in a state of complete ignorance. Rather, they relied upon extraneous knowledge of either a general or a specific nature (bias and schema hypotheses, respectively), whose importation into this domain was in fact invalid. The resulting belief that coin portraits face left was not right.

For over a decade now, much interest has been focused on the role of memory processes in the everyday world (e.g., see Gruneberg, Morris, & Sykes, 1978, 1988). An important study in this area is that reported from Cambridge, Massachusetts by Nickerson and Adams in 1979. This research receives extensive description in specialist memory texts (e.g., Baddeley, 1982, pp. 116-117; Cohen, 1989, pp. 70-71), in texts on cognitive psychology (e.g., Bourne, Dominowski, Loftus, & Healy, 1986, pp. 113-114; Reed, 1988, pp. 147-148), and in general texts on psychology as a whole (e.g., Coon, 1986, pp. 244-245; Dworetzky, 1988, p. 241). The original article was also in large part reprinted by Neisser (1982).

What Nickerson and Adams did was to explore people's memory for an object to which it was reasonable to assume they had been exposed on innumerable occasions, by asking them to draw a U.S. penny. What they found was that memory for the cent was surprisingly poor. Nickerson and Adams examined eight particular features of the coin—Lincoln's head, "IN GOD WE TRUST," "LIBERTY," the date, the Lincoln Memorial, "UNITED STATES OF AMERICA," "E PLURIBUS UNUM," and "ONE CENT." They assessed feature recall, using a generous criterion (e.g., Lincoln's head was credited if any head was drawn in any orientation), and found that over all the features of this commonest of stimuli, the average level of recall was as low as 67%. Just one of

the twenty participants correctly recalled and located all eight features. Only two participants recalled the word "LIBERTY" at all. Perhaps one of the most intriguing findings was that although all participants correctly recalled the presence of a head, only half (10 people out of 20) had the head facing correctly to the right—that is, memory for the head's orientation was at precisely chance level.

In additional experiments, Nickerson and Adams found further evidence of poor memory for the common penny. In their second experiment, people were given a list of the eight features, and merely had to locate them correctly in their drawings. Examination of the results shows that, with the exception of Lincoln's head and the Lincoln Memorial, each of the features was correctly located by fewer than half of the people. Furthermore, the orientation of the head was correctly recalled by only 35% of the people (7 out of 20). The remaining three experiments involved recognition measures, which again provided evidence of poor memory performance.

In spite of the prominence of Nickerson and Adams's report, there appears to have been little further investigation of their findings. One exception is provided by Rubin and Kontis (1983), who asked people to draw (in any order they wished) four coins: the U.S. 1¢, 5¢, 10¢, and 25¢ coins. Their results confirmed and extended those of Nickerson and Adams, in showing, for example, that "LIBERTY" was again worst recalled (by 7, 4, 6, and 4 people out of 125, for the 1¢, 5¢, 10¢, and 25¢ coins, respectively). Similarly, the orientation of the head for the 1¢ was correctly recalled as right-facing by only 38% (42 out of 112) of those who directed the head to one side or the other.

Correspondence concerning this article should be addressed to Gregory V. Jones, Department of Psychology, University of Warwick, Coventry CV4 7AL, England.

Suggestive as the preceding findings are, it may be argued that it is desirable to carry out a further study with a foreign coinage. Perhaps the earlier findings are peculiar to U.S. coins. Certainly the utilization of coins from Britain in particular would allow one to investigate issues that cannot be addressed using American ones. Not all British coins are circular, for example, and memory for overall shape may therefore be examined. The distribution of head orientation is also very different for British coins.

Nickerson and Adams pointed out that, at the time they wrote, the cent was exceptional in being the only current U.S. coin in which the head pointed to the right (shortly afterwards—from 1979 to 1981—a second coin with right-facing head, the Susan B. Anthony dollar, was produced). Thus Rubin and Kontis (1983) suggested that the poor recall of head orientation is due to the cent's assimilation to a generic left-facing head schema for U.S. coin portraits (although they also noted that the circulation of the cent exceeded that of all other denominations combined). In contrast, a right-facing head appears on all British coins issued since the last coronation (of Elizabeth II) in 1953. Since decimalization in 1971, the only coins still circulating with a left-facing head have been a few shillings and florins—now valued at 5 and 10 pence, respectively—of the previous monarch, George VI (see the Appendix for a brief description of all British coins in general circulation). Thus we may infer that the general head schema for British coins is likely to be right-facing, and that recall of head orientation for the British penny will be—unlike that for its U.S. cousin—conspicuously accurate.

EXPERIMENT 1

Method

Subjects. The subjects were 27 undergraduates of Warwick University studying first-year psychology.

Procedure. Each subject was given a sheet of paper depicting two circles 51 mm in diameter, and asked to draw from memory what is on each side of the current British penny.

Material. The current British penny is illustrated in the upper part of Figure 1. The present design of the penny was introduced with the decimalization of British money in 1971. Since that date, there have been only two minor alterations made to the penny ("NEW PENNY" was replaced by "ONE PENNY" in 1982; the shape of the Queen's head and the order of the surrounding legend were modified in 1985). Pre-1971 pennies, which were considerably larger (diameter approximately 30 mm instead of approximately 20 mm) and worth $\frac{1}{240}$ th rather than $\frac{1}{100}$ th of a pound were withdrawn at the time of decimalization. Like the U.S. penny, some of the legend of the British penny is Latin in nature: "D.G.REG.F.D." stands for "Dei Gratia Regina Fidei Defensor"—"By the Grace of God, Queen and Defender of the Faith." The illustration on the reverse is that of a portcullis (i.e., a rigid metal grating, spiked at the bottom, which can be lowered to close a gateway in a castle). It was originally a badge of the Tudors, who became monarchs in the 15th century.

Results

The accuracy of the reproductions was assessed with respect to seven major features: the Queen's head, "ELIZABETH II," "D.G.REG.F.D.," the date, the portcullis,

Figure 1. Head and tail of the current British penny (above), with the features likely to be recalled (below).

"1," and "ONE PENNY." The results for each of these are reported next.

Queen's head. All but one of the 27 subjects (i.e., 96% of the total) correctly recalled this feature, and 22 subjects (i.e., 85% of the 26) correctly reproduced a crown on the head. However, only 3 subjects (i.e., 12% of the 26 recalling the head) correctly recalled that the head faces right, with the remaining 23 having the head facing left. Comparison of the data for right-facing and left-facing reproductions in a binomial test indicates that performance was so poor that it was even significantly worse than the chance level of 50% [$z = 3.73$, two-tail $p < .001$].

"ELIZABETH II." Only 6 (i.e., 22%) of the subjects recalled this feature. Of these, 4 (i.e., 67% of the 6 recalling the feature) also reproduced it on the correct side of the coin.

"D.G.REG.F.D." No subject correctly recalled this feature in full. Only 5 subjects (i.e., 19% of the total) produced even partial recall of the feature. The five attempts consisted of "REG D V," "E R FID DEF," "REX," "R," and "D F."

Date. This was recalled by 20 subjects (i.e., 74% of the total). Of these, 12 (i.e., 60% of the 20) reproduced it on the correct side of the coin, with 7 (i.e., 58% of the 12) also correctly positioning it at either the 11 o'clock position used prior to 1985 or the 5 o'clock position used subsequently.

Portcullis. This was correctly recalled by 20 subjects (i.e., 74% of the total), all of whom reproduced it on the correct side of the coin. Of these, 6 subjects (i.e., 30% of the 20) also correctly reproduced at least one or the other of the crown and the chains attached to the portcullis. In addition, 14 of the 20 showed the portcullis as pointed at one end. However, of these, the majority

(8, i.e., 57% of the 14 with a pointed portcullis) showed it upside-down, with only a minority (6, i.e., 43% of the 14) correctly showing the portcullis pointing downwards.

"1". This was correctly recalled by 12 subjects (i.e., 44% of the total). Of these, all but 1 (i.e., 92% of the 12 correctly recalling the feature) reproduced it on the correct side of the coin, and all but 1 of these (i.e., 91% of the 11 recalling it on the correct side) also correctly reproduced it at the bottom of the side.

"ONE PENNY". This (or "NEW PENNY") was correctly recalled by 14 subjects (i.e., 52% of the total). Of these, 11 (i.e., 79% of the 14) also reproduced it on the correct side of the coin, with 6 (55% of the 11) in an incorrect location (5 at the bottom and 1 on the left) and 5 (45% of the 11) correctly at the top of the side. In addition, 4 subjects (i.e., 15% of the total 27) reproduced "ONE PENCE" instead of "ONE PENNY," all 4 on the correct side and with 2 at the bottom and 2 at the top. "Pence" (along with "pennies") is historically a plural of "penny" in Britain, but it is now becoming common as a singular also.

Overall. The average level of correct feature recall (ignoring location and orientation) was 3.6 out of 7 (i.e., 51% correct), with a range over individuals from 1 (i.e., 14% correct) to 5 (i.e., 71% correct). If recall of the head is neglected, then the average level of correct feature recall falls to 2.7 out of 6 (i.e., 43% correct), with a range over individuals from 0 to 4 (i.e., 57% correct). Underneath a depiction of the actual British penny, Figure 1 illustrates in the lower part what is likely to be recalled of the penny. In this illustration, a feature is included if recalled by the majority of subjects; if thus included, it is shown in its most frequent location and orientation.

Discussion

The average level of recall in this experiment (51%: 3.6 features correct out of 7) was numerically lower even than that found in Nickerson and Adams's recall experiment (67%: 5.4 features out of 8). Quantitative comparison of the two proportions is probably not appropriate in view of possible differences in the sampling for the two studies (e.g., all those tested here were undergraduates, whereas the educational status of the participants in the earlier experiment was not specified). Qualitatively, however, the experiment does provide strong confirmation that the phenomenon of very poor recall of the ubiquitous penny is not unique to the U.S. coinage; indeed it appears, if anything, to be even more pronounced for British coins.

The results are consistent in general terms with those of an unpublished experiment by Morris (see Smyth, Morris, Levy, & Ellis, 1987, pp. 209-210). This resembled the final recognition experiment reported by Nickerson and Adams, except that it examined recognition of the obverse of what was said to be a British 10-pence coin (the design and shape of the obverse is the same for all British coins except the 20- and 50-pence coins). It was reported that performance was only a little above chance (15% success, with 12 candidate drawings) and thus con-

siderably lower even than it was for U.S. pennies in Nickerson and Adams's study (42% success, with 15 candidate drawings).¹

In spite of the low general level of performance, the extremely poor recall of head orientation in the present experiment (12%, as opposed to 50% in the comparable experiment of Nickerson and Adams) was entirely unexpected. As explained earlier, it was assumed that the general head schema for British coins (unlike that for U.S. coins) would be right-facing and would therefore lead to a high level of correct recall of head orientation. Even with the very low level of overall performance in Morris's experiment, the proportion of right-facing alternatives selected was close to chance (52%), rather than systematically below chance (Morris, 1988). In view of this, a further experiment was carried out in order to establish the reliability of the present finding. This experiment followed a method similar to that of Nickerson and Adams's second experiment, in that people were provided with a verbal list of a penny's correct features and therefore merely had to configure these appropriately.

The new experiment also allowed further study of the surprising finding that most of the people who recalled the portcullis drew it upside-down. One possibility is that these people had interpreted their remembered gridiron with projections as representing a drawbridge rather than a portcullis. The presence of two chains might encourage this interpretation, since these are externally evident with an open drawbridge but not with a portcullis. If the gridiron is interpreted as a drawbridge, then it could be inferred falsely that the hinged base must be flat and the unattached top is pointed. If this hypothesis is correct, it would be expected that when people are provided with the explicit label "portcullis" they are no longer likely to draw it upside-down.

EXPERIMENT 2

Method

Subjects. The 20 new subjects were studying second-year psychology at Warwick University.

Procedure and Material. These were the same as in Experiment 1, with one addition. On each response sheet was typed a list of the seven critical features of a penny (though the location and orientation of each feature were not specified).

Results

Queen's head. A crown was correctly shown on the head by all but 1 subject (i.e., 95% of the 20). Only 4 subjects (i.e., 20% of the 20) correctly recalled that the head faces right. Of the remainder, 14 (i.e., 70% of the 20) had the head facing left and 2 (i.e., 10% of the 20) had the head positioned symmetrically. Comparison of the data for right-facing and left-facing reproductions in a binomial test indicates that performance was significantly worse than chance (two-tail $p < .05$).

"ELIZABETH II", "D.G.REG.F.D.", and date. These were shown on the correct side by 19 subjects (i.e., 95% of the 20), 12 subjects (i.e., 60% of the 20), and

9 subjects (i.e., 45% of the 20), respectively. Their reproduced locations around the Queen's head were not examined since the true positions had been modified relatively recently, in 1985.

Portcullis. This was shown on the correct side by all but 1 subject (i.e., 95% of the 20). In addition, 6 of these (i.e., 32% of the 19) also correctly reproduced at least one or other of the crown and chains attached to the portcullis. Further, 11 of the 19 showed the portcullis as pointed at one end. Of these, 2 (i.e., 18% of the 11 with a pointed portcullis) showed it upside-down, with 9 (i.e., 82% of the 11) correctly showing it pointing downwards. The proportion of subjects showing the portcullis upside-down was numerically considerably smaller than that in Experiment 1 (viz, 57%), though this difference did not reach significance according to Fisher's exact probability test.

"1" and "ONE PENNY". These were shown on the correct side by 11 subjects (i.e., 55% of the 20) and 16 subjects (i.e., 80% of the 20), respectively. However, their correct locations (viz, positioned at the bottom and at the top, respectively) were also correctly reproduced by only 5 subjects (i.e., 45% of the 11) and 7 subjects (i.e., 44% of the 16), respectively.

Discussion

Even when subjects were provided with the major features of a penny, recall of its remaining aspects was not very good. The average level of allocation of "1" and of "ONE PENNY" to the correct side, for example, was only 68%, while the average level of correct recall of location within the side (following allocation to the correct side) was only 45%. In addition, the results replicated the most surprising finding of Experiment 1, in that the number of people correctly reproducing the orientation of the Queen's head was again significantly less than that expected by chance. On the other hand, the results concerning the orientation of the portcullis were not very clear-cut. Provision of an explicit verbal label for this feature had been expected to decrease the incidence of upside-down responses, but though the proportion of these was indeed numerically smaller in this experiment, this decrease did not reach significance.

One possible factor relevant to the poor recall found for both U.S. and British pennies is their relatively small size (diameters approximately 19 and 20 mm, respectively). Although Rubin and Kontis (1983) found poor recall for the 5¢, 10¢, and 25¢ coins also, it still seems worthwhile to investigate recall of the largest generally current British coin, the 50-pence coin. This coin is of particular interest because unlike all other British coins except one (the 20-pence coin), it is not circular but instead is a curvilinear heptagon with a maximum width of approximately 30 mm. It is possible that this distinctiveness makes the coin a relatively highly memorable one.

EXPERIMENT 3

Method

Subjects. The 35 new subjects were studying first-year psychology at Warwick University.

Procedure. The subjects were asked to draw on a blank sheet from memory the two sides of the current British 50-pence coin.

Material. The current British 50-pence coin is illustrated in the upper part of Figure 2. It was introduced for the first time in 1969. Since that date, there have been two minor alterations similar to those made for the penny ("NEW PENCE" was replaced by "FIFTY PENCE" in 1982; the shape of the Queen's head and the order of the surrounding legend was modified in 1985). In addition, a 50-pence coin was issued to commemorate accession to the European Economic Community (EEC) in 1973. In this coin, the date (i.e., "1973") was moved to the reverse of the coin and placed in the center along with "50" and "PENCE," with Britannia replaced by nine clasped hands forming a circle (to symbolize the enlarged EEC of nine members).

Results

The accuracy of the reproductions was assessed with respect to eight critical features: the Queen's head, "ELIZABETH II," "D.G.REG.F.D.," the date, Britannia, "50," "FIFTY PENCE," and the shape. The first four features were identical with those in Experiments 1 and 2; Britannia corresponded to the portcullis; the next two features differed only in numerical value; and finally, shape was a new feature with no previous equivalent.

Queen's head. All but 2 of the subjects (i.e., 94% of the 35) correctly recalled this feature, and 29 subjects (i.e., 88% of the 33) correctly reproduced a crown on the head. However, only 7 (i.e., 21% of the 33 recalling the head) correctly recalled that the head faces right. Of the remainder, 22 (i.e., 67% of the 33) had the head fac-

Figure 2. Head and tail of the current British 50-pence coin (above), with the features likely to be recalled (below).

ing left, and 4 (i.e., 12% of 33) had the head positioned symmetrically. Comparison of the data for right-facing and left-facing reproductions in a binomial test indicates that performance was significantly worse than chance ($z = 2.60$, two-tail $p < .01$).

"ELIZABETH II". Only 4 of the subjects (i.e., 11% of the 35) correctly recalled this feature. All of these reproduced it on the correct side of the coin.

"D.G.REG.F.D". No subject correctly reproduced this feature in full. Only 4 subjects (i.e., 11% of the 35) produced even partial recall of the feature. The four attempts consisted of "REGINA," "RG," "FID EST DEF," and "DEF FID."

Date. This was recalled by 19 of the subjects (i.e., 54% of the 35). Of these, 13 (i.e., 68% of the 19) reproduced it on the head side of the coin, 7 (i.e., 54% of the 13) showing it in correct 11 o'clock or 5 o'clock positions.

Britannia. Either Britannia or the clasped hands design was recalled by only 14 of the subjects (i.e., 40% of the 35). Of these, Britannia was recalled by 6 subjects (i.e., 43% of the 14), 5 of whom (i.e., 83% of the 6) also reproduced it correctly on the reverse side of the coin (the 6th subject did not reproduce the head, and hence the reverse side was not identifiable). Britannia was correctly recalled as facing to the right by only 1 of these subjects (i.e., 17% of the 6). Of the remainder, Britannia incorrectly faced to the left for 4 of the subjects (i.e., 67% of the 6) and was positioned symmetrically for 1 of the subjects (i.e., 17% of the 6). At least one of three major subsidiary features of Britannia—the trident, shield, and helmet—was reproduced by 5 subjects (i.e., 83% of the 6); 2 of the subjects reproduced all three of these subsidiary features. A complete lion was reproduced instead of Britannia by 6 of the subjects (i.e., 17% of the 35); a complete lion appears on the reverse of the current 10-pence coin.

The clasped hands design of 1973 was reproduced by 8 of the subjects (i.e., 57% of the 14 with correct designs). The correct number of hands in this design, 9, was reproduced by 2 subjects (i.e., 25% of the 8), while 4, 5, 7, 8, and 11 hands were shown by 1, 1, 2, 1, and 1 subjects, respectively (mean = 7.5 hands). Although "1973" appeared on the reverse of the clasped hands coins, only 1 of the 4 members of this group who reproduced a date did so on the correct side, and none correctly reproduced "1973" (the dates reproduced ranged chronologically from "1982" to "1989").

"50". This was correctly recalled by 22 subjects (i.e., 63% of the 35), 16 of these (i.e., 73% of the 22) reproducing it on the correct side of the coin, and 11 (i.e., 69% of the 16) reproducing it at the bottom of this side.

"FIFTY PENCE". This (or "NEW PENCE" or "PENCE") was correctly recalled by 13 of the subjects (i.e., 37% of the 35), 8 of these (i.e., 62% of the 13) reproducing it on the correct side of the coin.

Shape. Only 17 of the subjects (i.e., 49% of the 35) correctly recalled the seven-sided shape. The complete

Figure 3. Frequencies of recall of different numbers of sides for the current British 50-pence coin; the correct number is seven.

distribution of responses is shown in Figure 3. The mean number of sides estimated by subjects was 6.8.

Overall. The average level of correct feature recall (ignoring location and orientation) was 3.4 out of 8 (i.e., 43% correct), with a range over individuals from 0 to 6 (i.e., 75% correct). If recall of the head is neglected, then the average level of correct feature recall becomes 2.5 out of 7 (i.e., 36% correct), with a range over individuals from 0 to 5 (i.e., 71% correct). Underneath a depiction of the actual British 50-pence coin, the lower part of Figure 2 illustrates what is likely to be recalled of it. As in the lower part of Figure 1, a feature is included if recalled by the majority of subjects; if thus included, it is shown in its most frequent location and orientation. (Similarly, the most frequent shape is also shown.)

Discussion

The results of this experiment agreed well with those of Experiment 1. They showed that even the relatively large size and distinctive shape of the 50-pence coin fail to preserve it from poor levels of recall with, for example, fewer than half of the people recalling that the coin has seven sides. The average level of major feature recall for the 50-pence coin was, at 43%, similar to that found in Experiment 1 for the penny, at 51%. The highest individual level of recall was, at 75%, again comparable to that in Experiment 1, at 71%.

GENERAL DISCUSSION

The results reported here have two principal implications. First, they show that people's ability to recall the design of British coinage is surprisingly poor, given the length and frequency of their exposure to it, and indeed (to the extent that comparisons are meaningful) worse even than people's recall of U.S. designs. On the average, participants recalled 51% of a British penny's seven major

features and 43% of a 50-pence's eight major features, as compared to the recall of 67% of a U.S. penny's eight major features reported by Nickerson and Adams (1979).

Second, in one respect the poverty of recall was strikingly more pronounced even than that found in general. The subjects in all three experiments here overwhelmingly recalled the head incorrectly as facing to the left. It was not merely that there was no evidence of the orientation of a coin's head being recallable, but rather the evidence was that performance was significantly below even the baseline of correct responses expected to arise by chance. The ratios of correct, right-facing reproductions to left-facing reproductions were 3:23 (i.e., 12% correct), 4:14 (i.e., 22% correct), and 7:22 (i.e., 24% correct) in Experiments 1, 2, and 3, respectively—overall, 19% correct. These two major sets of findings will be discussed in turn.

Generally Poor Recall

Why is it that remembering of the features of coins is in general so poor, even though we have been exposed to them on a very large number of occasions? Problems of at least four different types may be postulated to be responsible. Poor recall appears to be caused by low levels of *meaningfulness*, *redundancy*, *identifiability*, and *discriminativeness*.

A good example of each of the four types of problem is provided by the abbreviated Latin legend on the coins studied here (viz., "D.G.REG.F.D."). For many people, the meaningfulness of this is low, because they do not know what the abbreviation is short for, and even if they did know, they would still have difficulty in understanding the Latin. The redundancy is low, because there are not many other situations in which a person is likely to come across these abbreviations. The identifiability is low, because the lettering is quite hard to read (particularly for a penny) unless deliberately inspected in a good light. The discriminativeness is low, because the same legend appears on each of the differently valued coins, and hence the legend is of no assistance in their differentiation. It is perhaps therefore to be expected that in the two experiments in which features were not listed by the experimenter (i.e., Experiments 1 and 3), not a single person came close to reproducing this legend completely.

Conversely, the Queen's head is high in meaningfulness (it evokes much related knowledge), high in redundancy (it appears also on bank notes, for example), and high in identifiability (it is relatively large and unmistakable). Although it again is low on discriminativeness, it is nevertheless to be expected that the Queen's head should be much better recalled than the legend, as observed. This approach could in principle be pursued for each of a coin's features. For example, the moderate recall of the penny's portcullis seems consistent with a moderate meaningfulness, low redundancy, moderate identifiability, and high discriminativeness. At present, we lack normative data on the levels of these four variables. We may, however,

briefly consider each of them from a theoretical point of view.

Meaningfulness. The role of meaningfulness can be interpreted in a number of ways. For example, it could be argued that certain types of coin features are more likely than others to be associated with deeper levels of processing (Craik & Lockhart, 1972) and hence to be better preserved in memory. However, there are dangers of circularity in this approach (e.g., Baddeley, 1978).

An alternative approach is to attempt to measure directly how closely other knowledge is related to the information under consideration—how easy it is to activate that information's mental predicates within a semantic network. This can be done either by asking people to make appropriate magnitude estimations, yielding what I have termed predicability (or, synonymously, ease of predication) scores (Jones, 1985), or else by measuring the time people take to actually output related knowledge, yielding what I have termed predication times (Jones, 1988). Latin abbreviations would be expected to produce low predicability scores (and long predication times), whereas the Queen's head would be expected to yield high predicability scores (and short predication times). High predicability is expected to be associated with superior recall, because a high density of connections makes the existence of a successful retrieval path more likely.

Redundancy. The role of redundancy refers to the extent to which extraneous knowledge can be brought to bear successfully on feature recall. If an event's feature is unique to that particular event, then the feature can only be recalled by direct excitation of that specific representation. If the feature derives also from other similar events, on the other hand, then the feature may instead be recalled indirectly by excitation of a more general representation for all these events.

Jones (1978, 1979) described direct and indirect recall as occurring by means of the activation of intrinsic and extrinsic knowledge, respectively, and suggested (1983b, 1984) that their organizational units are the fragment and the schema, respectively. In semantic network terms, a fragment is a set of one-to-one links between pairs of nodes, each node representing an individual feature. A schema, on the other hand, is a set of many-to-one links between nodes representing individual features and a single, central node. For example, one could recall that a British penny has the Queen's head on it either because one has a fragment specifically representing that particular pairing in memory, or else because one possesses a British coin schema that represents the information both that a penny is a coin and that a coin has the Queen's head on it. For further discussion of the notion of a coin schema, see Rubin and Kontis (1983).

Identifiability. The role of identifiability is straightforward: A feature will not be recalled well if it has not been identified well in the first place. For example, at the distance at which many people customarily hold coins when handling cash, they are likely to experience dif-

faculty in reading the coins' legends, certainly unless the legend happens to be the right way up and the intensity and direction of illumination are also approximately optimal.

Discriminativeness. The role of discriminativeness can be formalized by the concept of cue validity (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976) or, better, by an extension of this concept. Cue validity refers to the probability with which an object selected as being the possessor of a particular feature (or cue) will be a member of a particular category. For example, the probability that a current British coin is a penny if it depicts a portcullis is one—that is, cue validity is at its maximum. In contrast, the probability that a current British coin is a penny if it has the feature "ELIZABETH II" is only slightly greater than it would be if the coin were selected entirely at random—that is, cue validity is low (the difference from randomness arises only because of the existence in circulation of some coins—none of them pennies—from the previous reign).

The problem with cue validity is that it provides an index only of the extent to which a particular feature entails a particular category, whereas the extent to which a particular category entails a particular feature seems likely to be important as well. Consider, for example, Britannia on the 50-pence coin. Here, cue validity is again one—all coins with Britannia are 50-pence coins, just as all coins with a portcullis are pennies. But whereas all pennies have a portcullis, not all 50-pence coins have a Britannia (some have clasped hands instead). I have proposed previously (Jones, 1983a) that a better index than cue validity of the extent to which a particular category is associated with a particular feature is the product of two conditional probabilities—the probability that a possessor of the feature will be a member of the category (i.e., cue validity) and the probability that a member of the category will possess the feature. This product (which I termed *category-feature collocation*) will be lower for the 50-pence coin's Britannia than for the penny's portcullis. It is to be expected that, other things being equal, category-feature conjunctions with high collocation values will be of greater functional significance than conjunctions with low collocation values, since they allow more reliable inferences to be drawn both in moving from feature to category and in moving from category to feature.

Coin sizes and materials. When using coins in practice, people appear to focus not so much on their designs as on their sizes, materials, and (in Britain) shapes. In principle, differences in size are sufficient to discriminate among all British coins. However, some differences in size (e.g., those between 2-, 10-, and 50-pence coins) are relatively small, making correct identification difficult. These problems of identifiability can in each case be resolved by combining approximate size information with information concerning material or shape. Material and shape, in contrast to size (and to some features of the design), are relatively low in discriminativeness (there are just three types of material and just two types of shape)

but high in identifiability. Thus, *in combination* the features of material, size, and shape score highly both on identifiability and discriminativeness—the 2-pence coin is bronze and circular, the 10-pence coin is cupro-nickel and circular, and the 50-pence coin is cupro-nickel and seven-sided. These features score moderately also on the remaining fronts. For the material of a coin, there is an increase in coin denomination in the order bronze, cupro-nickel, and nickel-brass. The latter two metals reflect in appearance silver and (less closely) gold, and they derive some meaningfulness and redundancy from this relation. Similarly, for a given type of material, increasing denomination is signaled by increasing size (except in the case of the 20-pence coin) in a meaningful and redundant manner. Only the shapes of coins (circular or seven-sided) appear to be of limited meaningfulness and to possess no apparent redundancy in regard to their relations to denomination.

Norman (1988) has recently noted examples in which confusion can arise when coins of different denominations have similar sizes and materials. It is perhaps worth noting in this context that relying even on different materials alone to signal different denominations is likely to be dangerous. New designs of British coins were issued to celebrate Queen Victoria's golden jubilee as monarch in 1887. The sixpence had to be quickly withdrawn when it was found to be easily mistaken for the similarly sized half-sovereign if illegally gilded. Both had the same head on the obverse and similar shield designs on the reverse, while neither coin bore any denomination. The revised sixpence issued later in the same year had its shield replaced by the words "SIX PENCE." More recently, 5-pence coins have apparently been passed off in place of the £1 coin (introduced in 1983). The £1 coin has approximately the same diameter as the 5-pence coin, but it has approximately twice the thickness and a brass rather than a silver color. Forgers have simulated the £1 coin from pairs of 5-pence coins by painting and sticking them together with their head sides outermost. Norman (1988) indeed has made the claim that (even for unadulterated coins) "long-term residents of Britain still complain that they confuse the one-pound coin with the five-pence coin" (p. 222).

Norman (1988) postulated that in the British five pence/one pound case and also in similar recent French and U.S. cases (half-franc/ten franc and quarter/Susan B. Anthony dollar, respectively) "the confusions probably occurred because the users of coins formed representations in their memory systems that were sufficiently precise only to distinguish among the coins that they actually had to use" (p. 59). Norman appears to be suggesting that in general only those features possessing high discriminativeness are represented in memory. However, the results of the present experiments demonstrate that this is not correct. Even though it does not allow any discrimination among British coins, the Queen's head was in fact remembered very well. Low discriminativeness was in this instance counteracted by high levels of meaningfulness, redundancy, and

identifiability. Norman's examples seem to serve, rather, to illustrate the distinction between the relatively wide range of information that may be represented in memory and the narrower range utilized in particular actions. What is represented in memory may include aspects of a coin's design as well as its size and material, even if the pattern of confusions in coin use indicates that sometimes only size and material are focused on when one carries out a task such as counting money.

Systematic Misremembering of Head Orientation

Why were the people in the experiments reported here so systematically erroneous in believing that the head points to the left on their pennies and 50-pence coins? All coins issued for general circulation in Britain for approximately the last 35 years have had a right-facing head of Elizabeth II, and for nearly 20 years (i.e., the greater part of the life of most of the participants in these experiments) the only previously issued coins with left-facing heads still circulating have been some 5- and 10-pence coins of George VI. Two possibilities will be considered here—that there is a general leftward bias in portraiture, or that there is a specific problem with the schema for the coin head.

Leftward bias. One possibility is that there is a general bias to portray heads as facing left. There is some support for this in the fact that right-facing portraits appear to be less common than left-facing ones in Western European art (McManus & Humphrey, 1973). Furthermore, this leftward bias is more pronounced for portraits of women than it is for men. In their sample of 1,474 painted portraits, McManus and Humphrey found a significantly larger proportion of left-facing portraits for women (68% left-facing) than for men (56%).

What is the origin of the general leftward bias in portraiture? McManus and Humphrey (1973) considered a number of hypotheses, such as that a right-handed artist finds it easier to draw left-facing profiles (analogous to writing from left to right), or that sitters are matching the artist's own left-facing appearance (the artist normally holding the palette in the left hand in line with the sitter, and turning to the easel on the right). However, these possibilities were rejected because they did not explain why the bias is greater for female portraits. Subsequently, Humphrey and McManus (1973) proposed that the more socially distant the artist perceives sitters to be, the more likely they are to be painted as left-facing. In support, they showed that in 335 portraits by Rembrandt, two possible forms of social distancing in sitters—the sitter's being either female (versus male) or nonkin (versus kin)—both separately increased the likelihood of left-facing portraits. In a similar study of 295 portraits by Goya, Gordon (1974) found less clear results, with the overall increase in left-facing portraits for nonkin sitters not reaching significance. At present, therefore, there appears to be some evidence that there is a general leftward bias in portraiture and also a possibility (though Humphrey and McManus did not draw this inference explicitly) that this is due to most sitters' having been perceived as socially distant by their artists (Humphrey and McManus also did not expli-

cate why social distance should be associated with facing left rather than facing right).

Single schema for heads. There is an alternative explanation for the misremembering of head orientation in the present experiments, which is more specific in scope than the general leftward bias hypothesis. This alternative hypothesis asserts that British people have a schema for heads that encompasses not only coins but also postage stamps. All British postage stamps, like all British coins, bear a portrait of the monarch. Unlike the portrait on British coins, which alternates from left to right in successive reigns, the portrait on British stamps always faces to the left. It is thus possible that the basis for recall of head orientation is a single schema that represents the heads on both coins and stamps, but whose development is dominated by experience with stamps rather than coins. This asymmetry in development is quite plausible, since the design of a stamp generally has to be inspected to identify its denomination, whereas, as noted previously, the denomination of a coin can be inferred from its size, material, and shape without inspecting its design.

A straightforward way of testing between the general bias hypothesis and the single-schema hypothesis would be to repeat experiments similar to those reported here in a country such as Australia or Canada. Both Australia and Canada still have the (right-facing) Queen's head on the obverse of their coins, and according to the general leftward bias hypothesis their population would be expected to experience misremembering of head orientation similar to that found in Britain. Australia and Canada differ from Britain, however, in nowadays only rarely having the Queen's head on their postage stamps. Thus, if the existence of a single schema for heads on both coins and stamps is responsible for the leftward misremembering of head orientation in the present experiments, we can make the differential prediction that such misremembering should not be observed in either Australia or Canada.

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NOTE

1. In the illustration of the stimuli for this experiment that appears as Figure 10.1 (p. 210) of Smyth et al. (1987), none of the recognition alternatives are in fact correct—they all portray the pre-1968 head design (reversed for half of the alternatives) combined with variations of the post-1968 legend. However, the stimuli used in the actual experiment did have the appropriate decimal head design (P. E. Morris, personal communication, June 1, 1989).

APPENDIX

One consequence of studying everyday cognition is that the environmental materials that are encountered are likely to vary in a less systematic manner than conventional experimental stimuli. A brief description of all British coins in general circulation is therefore perhaps useful. Current values comprise 1, 2, 5, 10, 20, 50 pence and £1, and were introduced at or after decimalization (this occurred officially on February 15, 1971, though some decimalization designs had been introduced beginning in 1968).

All denominations except the 20-pence coin have the same design on the obverse, of the Queen's head with surrounding legend and date; the head was redrawn and the ordering of the surround changed in 1985. The 20-pence coin has a different layout of the legend, with the date on the reverse. All denominations carry the value and a different motif on the reverse. Values were originally denominated in "new" pence, but the word "new" was dropped from 1982. The motifs include the portcullis, plumes, a thistle, a lion, a rose, and Britannia (or linked hands—see Experiment 3) for the 1-, 2-, 5-, 10-, 20-, and 50-pence coins, respectively, and a coat of arms, an oak, a thistle, a leek, or flax for the £1 coin. The 1- and 2-pence coins are bronze; the 5-, 10-, 20-, and 50-pence coins are cupro-nickel; and the £1 coin is nickel-brass. The 20- and 50-pence coins have seven sides, and the remainder are circular. The 1-, 2-, 20-, and 50-pence coins have plain edges; the 5- and 10-pence coins have milled edges; and the edge of the £1 coin has an incised inscription.

Finally, the postdecimalization 5- and 10-pence coins were equated in value, and also in physical size, to the earlier one and two shillings, respectively (the two shillings—or "florin"—was introduced in 1849 with the value of a tenth of a pound as a first step toward decimalization, though this did not reach fruition for another 122 years). Thus there are still also in circulation shillings and florins of George VI minted from 1947 (when the silver in British coins was replaced by cupro-nickel), and of Elizabeth II minted from 1953. On the obverses of these coins, the monarch's head is surrounded by a legend (the Queen's head differs from those of the two postdecimalization designs). The reverses include the value, date, and either one lion or three lions (shilling), or else a rose (florin).

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