Research Report

INCIDENTAL LEARNING OF REAL-WORLD REGULARITIES

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Abstract—*The large literature on incidental learning relies almost exclusively on laboratory experiments. Whenever researchers have attempted to demonstrate incidental learning of real-world regularities, they have typically failed to show learning. For example, it is well established that people do not learn regularities in everyday objects, such as the left-right orientation of faces on coins, despite a very large exposure to them. In this report, we examine this apparent contradiction. We argue that most studies exploring real-life incidental learning use tests that are not as sensitive to low-confidence information as those traditionally used in laboratory tasks. Using more sensitive measures, we show that it is possible to learn regularities from British and Japanese cultural life as a direct result of exposure to these regularities. Further, confidence measures suggest that although the information may be acquired incidentally, it can be expressed with and without concomitant awareness of that knowledge.*

There has recently been great interest in whether people can learn regularities in their environment without the intention to learn anything (*incidental* learning), and in addition whether such learning can take place in the absence of awareness (*implicit* learning). Although there is much debate over the existence of implicit learning (see Shanks & St. John, 1994), many studies do demonstrate incidental learning, in that participants who are not instructed to learn information nevertheless do so. Given that such learning is possible under laboratory conditions, one might also expect to find it in real-world settings. However, the few attempts to demonstrate real-world incidental learning have been unsuccessful. In a well-known study, Morton (1967) demonstrated that recall of letters on telephone dials (universal at the time of the experiments) was exceptionally poor. This was true even for a group who might be termed experts, in that they were switchboard operators who had a great deal of experience in using the letters on the telephone dial.

Jones (1990) demonstrated that memory for the orientation of the head of Queen Elizabeth II on British coins was remarkably poor, finding that only 19% of people tested drew the head correctly facing to the right. The convention in British coinage is that each monarch faces in a consistent direction, though the direction alternates between monarchs. So, every British coin minted since 1953 has shown Queen Elizabeth's head consistently facing rightward. Jones and Martin (1992) demonstrated that this poor performance is not a consequence of response mode, as verbal responses were no more accurate than drawing. To give a final example, Martin and Jones (1997) asked subjects to draw the crescent of the moon as it should appear at the beginning or end of each month. In three separate experiments, they found no evidence that participants could perform this task accurately.

These results seem to be at odds with some aspects of the incidental-learning literature. In many demonstrations of incidental learning, it appears that structural information is learned from simple exposure to a set of examples. For example, in the many studies of artificial grammar learning (e.g., Reber, 1989) and rule abstraction (e.g., McGeorge & Burton, 1990), it appears that quite complex information is learned without the intention to do so. One might suppose that an implicit-learning mechanism that could account for the laboratory results would also learn the contingencies in the real-world examples just listed, given their highly structured (e.g., regular) nature. Of course, failure to observe learning in these cases does not rule out the possibility of incidental learning of less abstract information, as, for example, in motor tasks (Willingham & Goedert-Eschmann, 1999). However, for abstraction of rules such as "the Queen's head faces right," there seems to be a mismatch between laboratory and real-world results.

It is possible that the absence of evidence for real-world incidental learning is due to a lack of sensitivity of the tests used in these tasks. This has become a very important issue in the field of implicit learning (e.g., Shanks & St. John, 1994). However, it is rarely discussed in studies reporting failure to observe learning of real-world contingencies. One notable difference between studies of the two kinds of learning is that studies of implicit learning typically use forced-choice or recognition tests, whereas studies of incidental real-world learning normally require subjects to recall the regularities. In the experiment reported here, we used a forced-choice procedure, in an attempt to increase the sensitivity of the test.

We tested learning for nonsalient regularities using five items from two different cultures. The two British items were coins and stamps: Both bear the monarch's head facing in a consistent direction (rightward for coins and leftward for stamps) and are encountered on a daily basis by most of the population of the United Kingdom. The three Japanese items were Kirin beer labels, the Japanese Football Association (JFA) logo, and the cartoon character Hello Kitty. The Kirin label shows a kirin (dragon) that faces left. Similarly, the JFA logo contains a crow, which faces right. Finally, the popular character Hello Kitty always wears a bow in her hair above her left ear. These images are commonly encountered by most of the Japanese population. Using these stimuli across cultures allowed us to test regularity learning while controlling for stimulus characteristics that might lead to an orientation being preferred for simple aesthetic reasons. Participants from one culture would not have encountered the stimuli prevalent in the other, and so formed a control group for those stimuli. Extrapolating from laboratory studies of invariance learning, we expected that participants would show incidental learning of real-world regularity (i.e., only regularities from their own culture) when tested on a two-alternative, forced-choice test.

METHOD

Participants

Forty-eight undergraduate students were recruited from Doshisha University, Japan, and 48 undergraduate subjects were recruited from University College London. All were volunteers.

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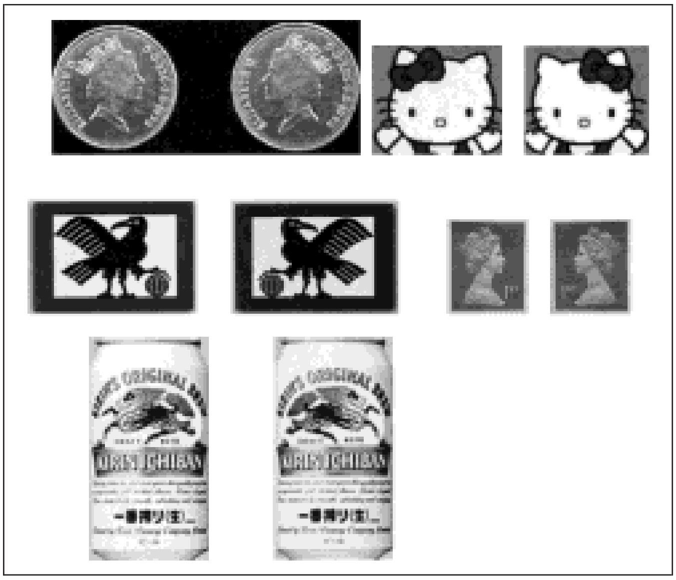

Fig. 1. British and Japanese stimuli used in the experiment.

Materials

The British objects were a first-class stamp and a 10-pence coin. Both show a portrait of Queen Elizabeth II facing in a consistent direction (left for stamps, right for coins). The Japanese objects were a Kirin beer can (the kirin faces to the left), a Hello Kitty picture (bow always on left ear), and the JFA logo (the crow's head faces to the right). These are three very common images in Japan, and the JFA logo was more prevalent than usual in the media at the time of testing because Japan had recently qualified for the World Cup finals. Digital images of these designs were manipulated using graphics software to produce items with both normal and opposite orientations (see Fig. 1).

Procedure

All participants were tested individually in a quiet room. Correct and incorrect versions of each object, printed on laminated paper, were shown simultaneously, and position was randomized. Participants were told that only one of each pair of stimulus pictures was correct and were asked to choose the correct version. If participants were unsure about how to choose the correct item in a pair from the other culture, they were told to choose whichever picture looked more correct and to guess if they were still unsure. No further instruction was given. After each choice, participants were asked to rate their confidence in their decision on a 5-point scale, from *not at all confident* to *very confident*. On completion of the recognition test, participants were asked to answer various questions about their familiarity with the items. We did this to ensure that no subject had spent time recently in the alternative culture.

RESULTS

Recognition Accuracy

The number of people choosing the correct image over the incorrect image in the British and Japanese groups is shown in Figure 2. The British group displayed significant (i.e., better than chance) knowledge of the coin and stamp ($z = 2.17$ and 1.88, respectively, one-tailed, ps < .05), but not of the Kirin label, Hello Kitty, or the JFA logo ($z = 1.59$, 1.30, and 0.14, respectively). In contrast, the Japanese group displayed significant knowledge about the Kirin label, Hello Kitty, and the JFA logo ($z = 5.64$, 3.61, and 3.03, respectively, all ps < .05), but were at chance for the coin and stamp ($z = 0.14$ and 0.43, respectively). Comparing the British and Japanese groups directly in a chi-square test showed that they were significantly different from each other for every item: coin, $\chi^2(1, N = 96) = 2.74$; stamp, $\chi^2(1, N = 96) = 3.41$; Kirin, $\chi^2(1, N = 96) = 30.8$; Hello Kitty, $\chi^2(1, N = 96) = 3.10$; and JFA logo, $\chi^2(1, N = 96) = 6.27$, all ps < .05.

Confidence

Table 1 shows that, in general, the items that each group knew were also the items that they were most confident about. Comparing total confidence scores in a 2 (group) × 5 (item) analysis of variance ($MSE = 0.91$) showed that the Japanese were significantly more confident about Kirin and Hello Kitty than about the coin or stamp. Similarly, the British were significantly more confident about responses to the coin or stamp than about responses to any of the Japanese items (all ps < .05). The only exception to this trend for greater confidence in one's own cultural items was for the Japanese group's confidence regarding the JFA logo. The Japanese were no more confident than the British about the logo, $F(1, 470) = 1.68$, and no more confident for the logo than for the unfamiliar items, $F(1, 367) < 1.5$ in both cases. Examining confidence scores for correct and incorrect items separately showed that there was no overall trend for higher confidence ratings for items that were correctly, rather than incorrectly, chosen. In many cases, the mean confidence rating was higher for incorrect responses.

DISCUSSION

Contrary to previous reports in the literature (e.g., Martin & Jones, 1997; Morton, 1967), this study found incidental learning of regularity in real-world stimuli. The difference between this study and those reported previously is that this study used a more sensitive judgment, two-alternative forced choice.

This finding is in line with previous laboratory studies (e.g., Bright & Burton, 1994; McGeorge & Burton, 1990) in which incidental learning of invariant properties was found. However, unlike laboratory tasks, learning of real-life regularities does not take place in a single block of exposure. Instead, the regularities are seen over an extended period, and attention is not directed to the stimuli by means of an orienting task. Although we have demonstrated that real-world regularities can also be learned, it is, of course, possible that the mechanisms underlying performance in the real world and performance on laboratory tasks are different in nature.

It seems clear that learning in this study can be described as incidental, but what of the stronger claim that it may have been implicit? It is notoriously difficult to define the term implicit learning (cf. Frensch, 1998). Some published definitions of implicit learning could also refer to incidental learning, for example:

> Implicit learning is thought to be an alternative mode of learning that is automatic, nonconscious, and more powerful than explicit thinking for discov-

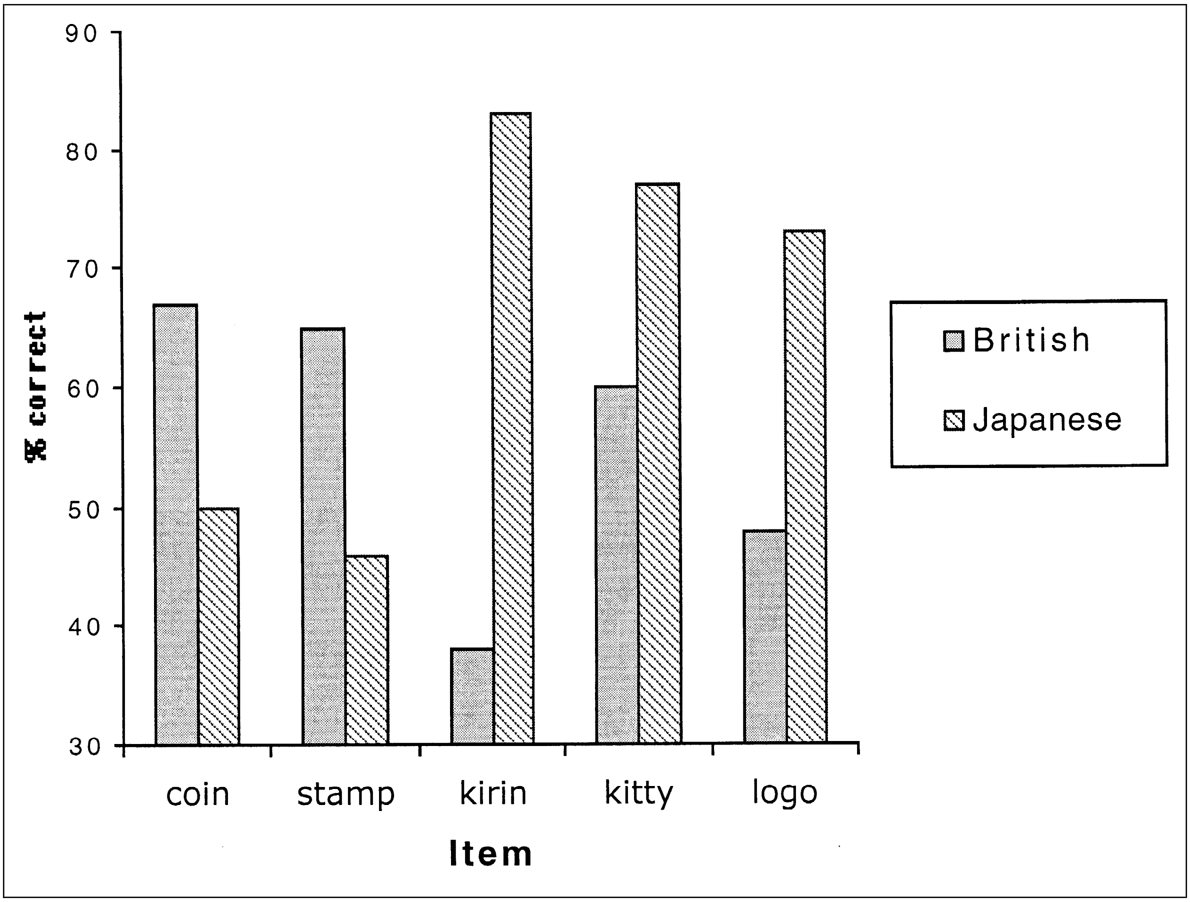

Fig. 2. Percentage of participants choosing the correct orientation of each stimulus.

ering nonsalient covariance between task variables. (Mathews et al., 1989, p. 1083)

[Implicit learning] is characterised as a situation-neutral induction process whereby complex information about any stimulus environment may be acquired largely independently of the subjects' awareness. (Reber, 1993, p. 12)

A person learns about the structure of a fairly complex stimulus environment, without necessarily intending to do so, and in such a way that the resulting knowledge is difficult to express. (Berry & Dienes, 1993, p. 2)

For the purposes of this study, we define implicit knowledge as knowledge that is acquired incidentally and also utilized without the person's conscious awareness of having that knowledge. The confidence measures used in this study may provide an indication as to whether the incidentally acquired information might also be implicit

Table 1. *Mean confidence ratings for each item by the British and Japanese groups*

	Item				
Responses	Coin	Stamp	Kirin	Kitty	Logo
			British group		
Total	3.89 (1.12)	3.98 (1.18)	3.04 (0.99)	2.78 (1.14)	2.93 (0.99)
Correct	4.06 (1.13)	3.84 (1.27)	2.95 (0.91)	3.09 (1.13)	2.83 (0.94)
Incorrect	3.56 (1.09)	4.24 (0.97)	3.10 (1.03)	2.32 (1.00)	3.02 (1.05)
			Japanese group		
Total	2.88 (1.12)	2.60 (1.14)	4.67 (0.48)	3.69 (1.11)	2.65 (1.12)
Correct	2.96 (1.23)	2.59 (0.85)	4.68 (0.47)	3.84 (1.14)	2.74 (1.15)
Incorrect	2.79 (1.02)	2.73 (1.28)	4.50 (0.58)	3.18 (0.87)	2.38 (1.04)

Note. Standard deviations are in parentheses. Confidence ratings were on a scale from 1 (*lowest confidence*) to 5 (*highest confidence*).

according to this definition. Dienes and Berry (1997) suggested that if confidence is unrelated to accuracy, then this lack of a relationship may provide a useful index for categorizing knowledge as implicit. The Japanese participants in this study were very confident in their responses about the Kirin label, and to a certain extent confident about Hello Kitty. This suggests that knowledge of the orientation of these items was explicit. Confidence for the incorrect Kirin responses was high as well, although with only four such responses, the reliability of this finding is questionable. In contrast to the high confidence for these stimuli, confidence was low for the JFA logo despite above-chance performance on this item. In fact, confidence on this item was no higher than for unfamiliar stimuli (for which the Japanese group performed at chance on the two-alternative, forced-choice test). This suggests that information about the orientation of the logo may have been held implicitly.

Additional support for this conclusion is provided by the low-confidence responses (scores of 1 or 2 on the confidence scale) to the logo by the Japanese group. Of 20 such responses, 15 were correct. This ratio is significant in a sign test and gives added support to the idea that knowledge of the logo's orientation was implicit, in that the participants seemed to be lacking in metaknowledge for this particular response. For the low-confidence unfamiliar items, the Japanese group performed at chance in choosing the correct coin and stamp (9 out of 18 and 8 out of 19, respectively). It thus seems that information acquired incidentally may or may not be accessible to consciousness. The factors that determine implicit learning over and above incidental learning remain to be identified.

It would be interesting to compare two-alternative, forced-choice responses with more explicit recall measures (although Jones, 1990, has already demonstrated very poor recall of head orientation on coins using a drawing task). One might assume that tests with differential sensitivity might demonstrate an "awareness gradient" for different types of information. Hence, one might imagine that the Kirin label would be recalled in studies using very coarse measures such as drawing, whereas demonstrating incidental learning of the JFA logo would require two-alternative, forced-choice conditions. Identifying a stimulus-specific hierarchy for learning with and without awareness will be an important step in determining the parameters under which real-life implicit learning can and does operate.

There has been a general belief that incidental and implicit learning have some relevance for applied problems, particularly in education and training (see, e.g., Berry & Dienes, 1993). However, to date, there have been no reports of applicable incidental- or implicit-learning studies that may pertain to contingency learning in the real world. By describing situations in which one can measure real-world incidental learning, this study represents a first step toward applying the theoretical developments to everyday concerns.

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