Cross Cultural Differences in Implicit Learning

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Abstract

Previous studies have indicated cross cultural differences in conscious processes such that Easterners have a preference for a more global perspective and Westerners for a more analytical perspective. We investigated whether these biases also apply to implicit learning. In Experiment 1, Japanese and British participants were asked to attend to one of the two aspects of a set of GLOCAL strings, global or local. The results showed that they could learn the AG implicitly only from the attended level in both cultural groups. They also showed that the global superiority in implicit learning was found only for the Japanese. In Experiment 2, these cultural differences were examined without manipulating the participants' attention. The results indicated implicit learning only at the global and not the local level for the Japanese, but equal learning of both levels by the British. We concluded that cultural biases strongly affect the type of unconscious knowledge that people acquire.

Keywords: cultural differences; selective attention; implicit learning; artificial grammar learning; global/local.

Role of Selective Attention in Implicit Learning

When repeatedly exposed to large amounts of information, we can acquire some abstract knowledge, such as rules or covariations between variables, without being aware of it. This phenomenon has been known as *implicit learning*. Since Reber's pioneering work on it (Reber, 1967), implicit learning has been studied using several paradigms, for example, serial reaction time (SRT) task or artificial grammar (AG) learning (for reviews, see Dienes, 2008; Reber, 1989; Shanks, 2005).

Reber (1989) suggested that we can implicitly learn some knowledge with a minimal amount of attention. Several researchers have agreed with the claim (e.g. Perruchet & Vinter, 2002; Whittlesea & Dorken, 1993). Based on this claim, it can be supposed that some attentional selection should occur in implicit learning.

Previous studies on the role of selective attention in implicit learning (e.g. Cock, Berry, & Buchner, 2002; Jiménez & Méndez, 1999; Rowland & Shanks, 2006) have provided supportive evidence to Reber's claim. However, these studies have mainly used the SRT task and few studies have investigated the role of selective attention in AG learning.

Seger (1998) argued that different mechanisms may underlie learning in the SRT task and in AG learning. Specifically, SRT task involves the acquisition of perceptual motor implicit knowledge, whereas AG learning involves acquiring implicit knowledge for the purpose of making judgments. Similarly, Boucher and Dienes (2003) speculated that sequential tasks such as SRT involve error correction mechanisms based on prediction, whereas AG learning may involve an automatic chunking mechanism. Although some researchers suggest that there is a common mechanism in these two tasks (e.g. Perlman and Tzelgov, 2006), the roles of selective attention in implicit learning may differ in SRT and AG learning. This claim needs to be further tested.

The first attempt to investigate the role of selective attention in AG learning was conducted by Tanaka, Kiyokawa, Yamada, Dienes, and Shigemasu (2008). They developed a new method using GLOCAL strings (an example is shown in Figure 1) to manipulate selective attention. GLOCAL strings are chains of compound letters (Navon, 1977). A compound letter represents one large letter (i.e. a global letter) composed of a set of small letters (i.e. local letters). A critical feature of this stimulus is that while a GLOCAL string can be read as one string by using global letters (NVJTVJ in Figure 1), it can also be read as a string using local letters (BYYFLB in Figure 1). Since GLOCAL strings can simultaneously represent two different strings following different AGs, we can examine whether the participants can learn the two AGs—one is attended while the other is unattended—by manipulating their
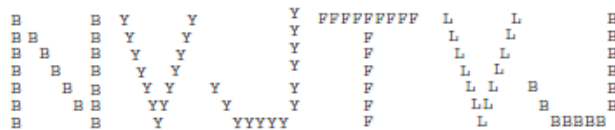
Figure 1. An Example of GLOCAL Strings.

attention. Using the GLOCAL strings, Tanaka et al. revealed that participants could learn an AG only from the attended level of the GLOCAL strings. They concluded that selective attention plays a critical role in AG learning.

Tanaka et al. (2008) also found the global superiority in AG learning. In Experiment 1, the classification accuracy for the attended grammatical strings was higher in the global attention condition than in the local attention condition. In Experiment 2, they examined whether or not the information at the unattended level was encoded by using a Stroop paradigm. They found the global superiority again. These results suggest that there is a global/local asymmetry in implicit learning. This tendency is consistent with the claim for a general preference for processing at the global level (see Navon, 2003, for a review).

Cultural Differences in Attention

Cultural psychology literature has suggested that there are cultural differences in attention between Easterners and Westerners (for reviews, see Nisbett, 2003; Nisbett & Miyamoto, 2005; Nisbett, Peng, Choi, & Norenzayan, 2001). Specifically, Easterners tend to pay attention to a scene globally, whereas Westerners do so locally.

Masuda and Nisbett (2001) examined whether Easterners attend to context more than Westerners do. They presented Japanese and American participants with animated vignettes of underwater scenes (in Study 1) or with photos of an animal in the wild (in Study 2) and asked the participants to report the contents. In a subsequent recognition test, the participants were shown previously seen objects as well as new objects, either in their original setting or in novel settings, and were then asked to judge whether or not they had seen the objects. The results showed that Easterners made more statements about contextual information and relationships than Westerners did. They also found that Easterners recognized previously seen objects more accurately when they saw them in their original settings rather than in the novel settings, whereas this manipulation had relatively little effect on Westerners.

Kitayama, Duffy, Kawamura, and Larsen (2003) developed the framed line test (FLT). In this test, participants were presented with a square frame in which a vertical line was printed. They were then presented with another square frame of a different size and required to draw a line that was the same either in absolute length (absolute task) or in proportional length (relative task). Kitayama et al. (2003) found that the performance of Westerners in the absolute task was better than that in the relative task, whereas for Easterners the pattern was reversed. The results indicated that Westerners are better able to filter out or to suppress contextual frame information, whereas Easterners are better at incorporating contextual information. Ishii and Kitayama (2007) extended the results to non-student participants and to auditory tasks.

Based on these studies, there is a possibility that the global superiority found by Tanaka et al. (2008) is limited to Easterners. In Tanaka et al. (2008), the participants were all Japanese. Because they tended to pay more attention to the information at the global level than that at the local level, they might have had difficulty filtering out the information at the global level when asked to focus on the strings at the local level. As a result, global superiority in AG learning emerged.

Present Study

In the present study, we determined whether or not the global superiority in AG learning found by Tanaka et al. (2008) would be obtained for Western participants. Based on the cross cultural literature, there ought to be cultural differences in attention. Since selective attention plays an important role in AG learning, we hypothesized that the cultural differences in attention would have an effect on AG learning: Easterners could learn AG from the global level more than from the local level, whereas Westerners could not.

We modified the procedures used by Tanaka et al. (2008) in the following ways. The first is the instructions in the learning session. In Tanaka et al. (2008), the participants were asked to write down the strings represented either by global or by local levels during their presentation. This procedure in the learning session might help the participants to learn the attended grammar more than otherwise because they can read the strings that they wrote down on the paper. In the present study, the participants were asked only to look at the strings carefully and sometimes write them down after the GLOCAL string had disappeared.

The second is in the procedure followed in the test session. In the previous study, the participants were not instructed regarding on which AG they should base their judgments. This procedure might cause the degree of each type of AG learning to be underestimated. In the present study, we divided the test into two sessions and the participants were explicitly told to judge the grammaticality based on one of the two AGs in each session. The order of these two test sessions was counterbalanced among participants.

In the third modification, the participants were asked to show the basis of their judgment in each grammaticality judgment trial. Although this point will not be discussed in this paper owing to space constraints, this procedure allows us to examine in more detail whether participants'

grammaticality judgment was based on an implicit or explicit basis.

Experiment 1

This experiment was designed to examine whether or not the global superiority found in Tanaka et al. (2008) could be replicated by Japanese and British participants.

Method

Participants Forty undergraduates from Chubu University and forty-two from the University of Sussex participated in the experiment and received a course credit following the completion of the experimental session. Assignments on types of GLOCAL strings and the order of the tests were counterbalanced. None of the students had previously participated in the same kind of experiment.

Stimuli The same AGs as those in Tanaka et al. (2008) were used. Grammar 1 comprised five letters (J, N, T, V, and X), as did Grammar 2, which used the letters B, F, L, Y, and Z.

Eighteen grammatical strings with a length of three to six letters were constructed from each AG. Two types of GLOCAL strings were constructed from these strings, following the two AGs. One type of GLOCAL string followed Grammar 1 at the global level and Grammar 2 at the local level; this was reversed for the other type of GLOCAL string, so grammar was counterbalanced across levels.

GLOCAL strings were presented as white uppercase letters against a black background. Small letters were used, printed in 12-point MS Gothic font. One large letter was the height of seven small letters. Eight small letters were arranged horizontally to obtain F, J, L, and X; nine to obtain B, N, T, and Y; thirteen to obtain V; and seven to obtain Z. The height of a large letter on the screen was approximately 3.2 cm and the width was approximately 1.8–3.0 cm. The distance between the display and the participants was approximately 60 cm.

Twenty strings following each grammar used in the test phase were composed of five or six letters. These were not GLOCAL but regular letter strings. Half of these were used in the learning phase and will be referred to as 'presented grammatical strings'. The remaining strings were not identical to any of the strings presented in the learning phase and will be referred to as 'novel grammatical strings'. All of these grammatical strings were used to construct nongrammatical strings that violated both of the grammars by placing one or two characters in nonpermissible locations.

Four types of string pairs were constructed for the test phase. The first type—Global_Old—paired a presented grammatical string at the global level of GLOCAL strings in the learning phase with a nongrammatical one based on the AG extracted from the global level of the GLOCAL strings. The second type—Global_New—paired a novel grammatical string at the global level of GLOCAL strings in the learning phase with a nongrammatical one based on the

AG that was extracted from the global level of the GLOCAL strings. Similarly, the third type was termed Local_Old, and the fourth Local_New. Each type comprised 20 pairs. Thus, there were 80 pairs in the test phase. Matching pairs of grammatical and nongrammatical strings in each type were randomized for each participant, subject to the constraint that the two strings should have the same length.

Procedure During the learning phase, 18 GLOCAL strings were presented on the display for 6 seconds. Half of the participants were asked to look at and memorize the GLOCAL strings represented by the large letters. The other half were asked to do so with respect to the strings represented by the small letters. The former was a global attention condition and the latter was a local attention condition. The participants were also required to write down the string represented by the attended level when the message was shown on the display. The message was presented about once in ten trials. Each GLOCAL string was presented six times. A mask stimulus comprising many '+' signs in the area where the GLOCAL strings were intended to be displayed was presented for the 1-second interval between the presentation of GLOCAL strings.

At the beginning of the test phase, the participants were informed that two strings would be presented in the upper and lower regions of the display, each of the two levels of the training strings followed a set of rules, and each string of a pair followed one set of rules. The test phase consisted of two sessions: a test on the global level and one on the local level. Half of the participants were required to press the key associated with the string that they judged to be grammatical, extracted from the global aspects of the GLOCAL strings in the first test session and the local in the second one. The remaining participants were asked to do the same thing, first for the local and then for the global level.

Forty pairs were presented to each participant in a random order in each test session. A pair of strings remained on display until the participants pressed one of the two keys. The presentation of strings from a pair in the upper region was also randomized for each participant, subject to the constraint that one type of pair (i.e. the grammatical string) would be presented equally in each region.

After making judgments, the participants were asked what they based their judgments on and were required to choose one of the following five answers:

1. Random responding or guessing: Your judgment had no basis whatsoever; you could have just flipped a coin to make your judgment.

2. Intuition: You have some confidence in your judgment, but you have no idea why.

3. Familiarity: The sequence seemed familiar or unfamiliar for reasons you could not state.

4. Recollection: You recollected or failed to recollect seeing all or part of the sequence in the training phase.

5. Rules: You based the judgment on a rule or rules you could state if asked.

All of the instructions were presented in Japanese for the participants from Chubu University and in English for those from the University of Sussex. The English instructions were back translated and checked to make sure they had the same meaning as those in Japanese.

Design A $2 \times 2 \times 2$ mixed design was employed. The first factor was global/local. The participants were instructed to attend to the global or local level of the learning phase. This was a between-participants factor. The second factor was attended/unattended. In the test phase, half of the pairs could be judged correctly on the basis of the grammar extracted from the attended level of the GLOCAL strings, whereas the other half could be judged correctly on the basis of the grammar extracted from the unattended level. This was a within-participants factor. In addition, the third factor, presentation, indicated whether or not the grammatical string had been presented before in the learning phase. This was also a within-participants factor.

Results and Discussion

Figure 2 shows the mean classification accuracy for each condition in the test phase. First, the proportion of accurate classifications was subjected to a $2 \times 2 \times 2$ mixed ANOVA with global/local, attended/unattended, and presentation (old or new grammatical string) as factors for each cultural group.

For the Japanese participants, the main effect of the attended/unattended level was significant (F (1, 38) = 231.43, $p < .001$). Accuracy concerning the grammar of the attended level was higher than that of the unattended level. The interaction between the global/local and attended/unattended levels was also significant (F (1, 38) = 11.04, $p < .01$). The results of the simple main effect revealed that accuracy in the global attention condition was higher than that in the local attention condition at the attended level (F (1, 76) = 10.67, $p < .01$), whereas this effect disappeared at the unattended level ($F < 1$).

For the British participants, the main effect of the attended/unattended level was significant (F (1, 40) = 69.03, $p < .001$), indicating that accuracy concerning the grammar of the attended level was higher than that of the unattended level. The interaction between the global/local and attended/unattended levels was not significant (F (1, 40) = 1.43).

In order to examine the possibility that the participants could learn the AG from the unattended level to some degree, we compared the proportions accurately classified with chance (.5) in each condition. With respect to the Japanese participants, accuracy for Unattended_Old and Unattended_New in both the global and local conditions was not higher than chance (ts < 1). With respect to the British participants, on the other hand, accuracy for Unattended_Old in the global condition was significantly higher than chance (t (20) = 2.91 $p < .01$).

We replicated the results of Tanaka et al. (2008) for the Japanese participants. They were able to learn the AG from the global level more than from the local level only when
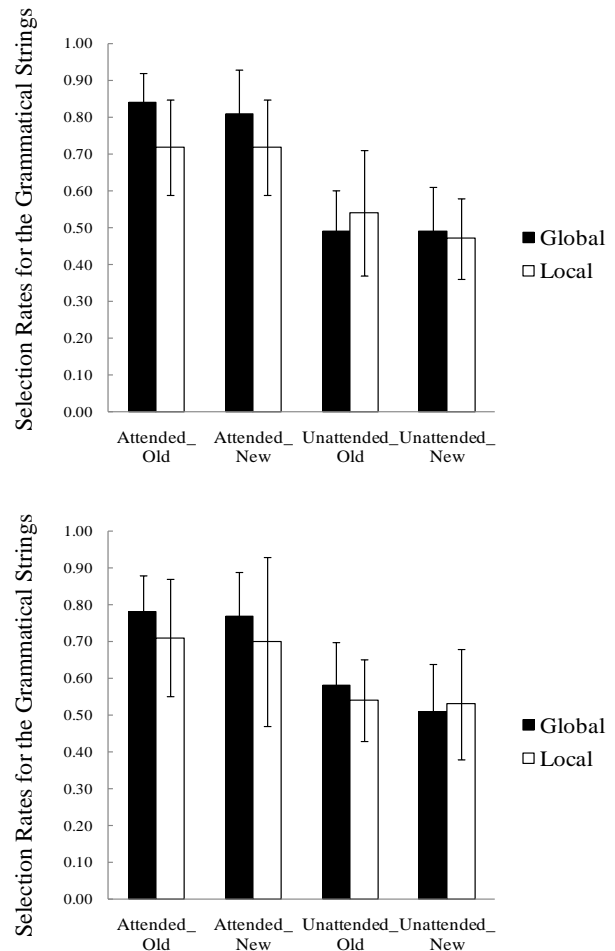

Figure 2. Mean Selection Rates for the Grammatical Strings in the Pairs of Attended_Old, Attended_New, Unattended_Old, and Unattended_New Grammatical Strings with Nongrammatical Strings in Each Attention Condition with Standard Deviations. Top panel: Japan; Bottom panel: UK.

they paid attention to the level itself. Global superiority, however, was not found for the British participants. In addition, the result of a t-test showed that they were able to learn the AG not only from the attended level but also from the unattended level when asked to pay attention to the global level. This might indicate that they have a tendency to process more information from the local level than from the global level.

In sum, the results suggest that there are cultural differences in implicit learning such as AG learning. This may be explained by attentional bias between Easterners and Westerners. In Experiment 2, therefore, we examined whether or not there would be cultural differences in implicit learning without manipulating the participants' attention.

Experiment 2

This experiment was designed to examine whether or not there would be cultural differences in attention and AG learning when the participants were free to manage their attention in the learning session.

Method

Participants Twenty undergraduates from Chubu University and eighteen from the University of Sussex participated in the experiment and received a course credit following the completion of the experimental session. Assignments on types of GLOCAL strings and the order of test were counterbalanced. None of the students had previously participated in the same kind of experiment.

Stimuli The same AGs as those in Experiment 1 were used.

Procedure The same procedures were used as in Experiment 1 except for the following points. First, the participants' attention was not manipulated in the experiment. They were asked to look at the GLOCAL strings not at one level but at both levels. Second, two questions were asked at the end of the experiment. The first question was, 'Which aspect—the bigger letters or the smaller letters—did you pay more attention to in the first session?' The second was, 'By how much more do you think you attended to your favorite aspect, e.g. twice as much, three times as much, etc.?'

Design A $2 \times 2 \times 2$ mixed design was employed. The first factor was cultural group. This was a between-participants factor. The second factor was global/local. This was a within-participants factor. In addition, the third factor was presentation. This was also a within-participants factor.

Results and Discussion

Figure 3 shows the mean classification accuracy for each condition in the test phase. First, the proportion of accurate classifications was subjected to a $2 \times 2 \times 2$ mixed ANOVA with cultural group, global/local, and presentation as factors.

The main effect of the global/local factor was significant (F (1, 36) = 12.13, p < .01). The interactions between cultural group and global/local and between cultural group and presentation were also significant (F (1, 36) = 9.52, p < .01; F (1, 36) = 5.50, p < .05, respectively). The results of the simple main effect revealed that accuracy in the global grammar was higher than that in the local one for the Japanese participants (F (1, 36) = 21.57, p < .0001), whereas this effect disappeared for the British participants (F < 1). The results of the simple main effect showed that accuracy in the new grammatical stimuli was higher than that in the old ones for the British participants (F (1, 36) = 3.75, p = .06), whereas this effect was not found for the Japanese participants (F (1, 36) = 1.91, p > .10).

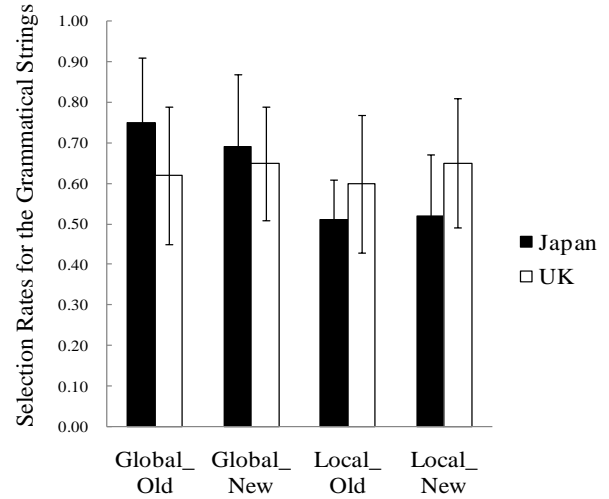In order to examine the possibility that the participants could learn the AG from each level, we compared the

Figure 3. Mean Selection Rates for the Grammatical Strings in the Pairs of Global_Old, Global_New, Local_Old, and Local_New Grammatical Strings with Nongrammatical Strings with Standard Deviations in Each Cultural Group.

Table 1. The ratio of participants who preferred each level in the learning session.

	Japan	UK
Global	90.0	50.0
Local	5.0	44.4
Equal	5.0	5.6

(%)

proportions accurately classified with chance (.5) in each condition. With respect to the Japanese participants, accuracy only for the Global_Old and Global_New strings was significantly higher than chance. With respect to the British participants, on the other hand, accuracy only for all types of strings was significantly higher than chance.

To examine the attentional bias in the learning session, we compared the ratio of the participants who paid more attention to each level between cultural groups. Table 1 shows the ratio of the participants who preferred each level. A *chi-square* test revealed that more participants preferred the global level to the local one in Japan, whereas this pattern was not found (*chi-square* (N = 38) = 8.36, p < .05). The result indicated that there were cultural differences in attention during learning sessions. It also indicated that this attentional bias might cause the cultural difference in AG learning.

General Discussion

In the present study, we examined whether or not there are cultural differences in implicit learning using an AG learning paradigm with GLOCAL strings. In Experiment 1, the global superiority in AG learning was obtained only for the Japanese participants. This indicated that there was a cultural difference in implicit learning between Easterners and Westerners. However, it was common that selective attention played a critical role in AG learning. Although the British participants could memorize the grammatical strings at the unattended level, in both cultural groups, the participants could learn only the AG extracted from the attended level. The results strongly support the necessity for attention in AG learning suggested by Tanaka et al. (2008).

The results of Experiment 2 revealed that the Japanese participants could learn the AG only from the global level, whereas the British participants could learn from both levels. It was also found that there was attentional bias in the learning session: most of the Japanese participants tended to pay more attention to the global level, whereas half of the British participants tended to pay more attention to the local level. Based on the cultural difference in attention, the results of AG learning should be interpreted as showing not that the British participants could simultaneously learn both AGs, but that some learned the AG only from the global level and others only from the local level, corresponding to their attentional preference.

It is necessary to examine whether or not there are also any cultural differences in learning or judging strategy between Easterners and Westerners based on the participants' judgment bases. Previous studies (e.g. Nisbett, 2003; Nisbett et al., 2001) have suggested that Eastern people prefer holistic processing, whereas Western people prefer analytic. It should be examined whether this tendency can be applied to implicit learning situations such as our task setting.

Conclusion

Selective attention plays a critical role in implicit learning in both Eastern and Western cultural groups. However, there are cultural differences in global/local asymmetry. Specifically, Japanese participants learned the AG extracted from the attended global level better than that from the local one, whereas British participants did not. The cultural difference in AG learning seems to be caused by cultural biases in attention between Easterners and Westerners.

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