Proceedings: The 7th International University of Japan Conference on SLR in Japan 1996

Implicit and Explicit Learning in Psychology and SLA

Mark Sawyer
Kwansei Gakuin University

Abstract

This paper examines the concepts of *implicit* and *explicit* learning and knowledge as they have been used in cognitive psychology and in second language research. The treatment of these concepts in psychology focuses on the work of Arthur Reber, his colleagues, and his critics, mostly within the experimental paradigm of miniature artificial grammars. The presentation of the second language research points out some of the mismatches between the theoretical constructs and their empirical application to studies of natural language learning. It concludes by advocating caution in interpreting findings in relation to the theoretical constructs, while seeing promise in the further study of the effects of different task demands on different forms of learning and knowledge.

1 Introduction

The L2 research literature in the last few years have seen a resurrection of Krashen's (e.g., 1981) strong distinction between *acquisition* and *learning*, but in a new form. The dichotomy that is increasingly being used is that between *implicit* and *explicit* learning/knowledge. Implicit learning, like *acquisition* in Krashen's sense, is thought to take place unconsciously, simply through exposure to structured stimuli, such as (comprehensible) input in the case of language acquisition. Explicit learning, similar to Krashen's *learning*, is considered to involve a conscious awareness of structural rules. Implicit knowledge, the product of implicit learning, is assumed to be unverbalizable but demonstrated indirectly in task performance, especially complex task performance. In contrast, explicit knowledge is taken to be verbalizable but not useful in task performance, except on relatively simple tasks. Therefore, it should occupy only a very minor role in the very complex task of language performance. The advantages of using the new set of terms over Krashen's include their more precise definitions, their greater generalizability to learning other than language learning, the respectability they have acquired through their use in the cognitive psychology literature, and the greater potential testability of the distinction between them.

The implicit/explicit distinction has considerable appeal for those who perceive fundamental differences between naturalistic and instructed language learning processes, but recent thinking on the role of consciousness in SLA, such as that of Schmidt (1990 *inter alia*), compels recognition of a more significant role in SLA for conscious processes, such as attention, awareness, and noticing, than would be warranted by their association with explicit learning. One solution to this problem has been proposed by Ellis (1993), in the form of a "weak interface position" between implicit and explicit learning. This position represents the middle ground between two more rigorous, but harder to defend, positions. The "strong interface position," which Ellis attributes to Sharwood Smith and Gregg, holds that explicitly learned declarative knowledge of language rules could in principle be transformed into the implicit knowledge which underlies language performance, *i.e.* language competence. A non-interface position," apparently identical to Krashen's position, maintains that explicit knowledge can never become implicit knowledge. In Ellis' version of the "weak interface position," explicit knowledge cannot become implicit knowledge, but it can be useful in enhancing awareness of particular language features and directing attention, leading in turn to greater comprehension and the implicit internalization of crucial features of the input that learners are ready for.

Since the implicit/explicit distinction is proving to be an increasingly useful one for L2 theoreticians and researchers, and since Ellis' (1993) "weak interface position" seems, on the surface of it, a reasonable hypothesis about how the two varieties of learning might interact, it is very important that sufficient consideration be given to the substance of the concepts implicit and explicit learning and knowledge. To neglect to do so is to risk retarding the progress of SLA as a field through the ill-advised pursuit of ultimately untenable ideas. In order to encourage the proper caution in interpreting claims made about implicit and explicit knowledge in SLA, this paper will first review representative studies from the cognitive psychology literature that have tried to delineate the empirical content of implicit and explicit knowledge, and then examine some recent L2 studies that have attempted to manipulate the concepts.

2 Implicit learning and tacit knowledge

People are often able to make correct judgments without being able to state the criteria upon which the judgments were based. Linguistically naïve native speakers' judgments about the acceptability of sentences in their language serve as a good example; these speakers' consistent acceptance of possible sentences and rejection of ungrammatical sentences demonstrates their knowledge of an underlying grammar, though they often can offer no explanation for their judgments, or they provide explanations that are incorrect and cannot have been the basis for the judgments. In such cases, these language users are said to demonstrate implicit knowledge of the grammar of their language. The question of how such knowledge was acquired is of great theoretical interest, because the apparent complexity of the knowledge implies a very powerful, yet poorly understood learning mechanism. A better understanding of this mechanism would likely have important practical consequences for the optimal facilitation of various types of learning.

In 1967, Arthur Reber first proposed "implicit learning" to account for the acquisition of "intuitive knowledge about the underlying structure of a complex stimulus environment. According to Reber, implicit learning is characterized by two critical features: (a) it is an unconscious process; and (b) it yields abstract knowledge. In other words, the process of implicit learning occurs automatically, without the use of conscious strategies to learn. Moreover, the product of that learning allows the learner to apply the rules underlying the knowledge to new stimuli. The basic strategy of research designed to establish the operation of implicit learning is thus to demonstrate that conscious learning cannot account for the knowledge that has been acquired, and that this knowledge can be generalized to novel stimuli. The slipperiness of the notions *unconscious* and *abstract*, however, makes the interpretation of research on implicit learning far from straightforward.

3 The experimental paradigm for implicit learning research

This section provides a description of the research paradigm most often used to investigate implicit learning. Although Reber (1989:219) claims that the processes involved in implicit learning are general and universal , and that all forms of implicit learning are essentially similar at their deepest levels, he and his colleagues have restricted themselves to a limited number of techniques to study a wide variety of effects. The two techniques that Reber has found optimal for the study of implicit learning are: (1) probability learning; and (2) miniature artificial grammar learning. Because probability learning, as instantiated in tasks such as predicting the sequences of blinking light bulbs, is arguably less relevant to language acquisition than is artificial grammar learning, only studies of the latter will be considered here.

The relevant properties instantiated in the stimulus domains in probability learning and in miniature artificial grammars are *complexity*, *idiosyncratic structure*, and *arbitrariness*. Sufficient complexity in the stimulus domain ensures that subjects cannot figure out consciously its underlying structure; idiosyncratic structure eliminates the possibility of subjects' prior knowledge of the domain through experience; and arbitrariness prevents the transfer by subjects of any previously learned real world principles in their learning of the underlying structure. The difference between the second and third properties is the difference between familiarity with the stimulus domain itself and familiarity with more general principles that might apply to the structure of the stimulus domain. Reber does not claim that implicit learning cannot take place without these conditions, but rather that it can be demonstrated conclusively if and only if these conditions are present.

According to Reber (1989), reliance on a small number of tasks allows the researcher to create a robust data base which can then be used for investigating a large number of issues, without having the complications that are introduced by alternative procedures. Thus, although generalizations about implicit learning under conditions other than those instantiated in these tasks can only be done with much caution, the fact that findings can be closely replicated, and variables can be manipulated across studies in a comparable way, leads to greater confidence in the basic findings and greater interpretability in cross-study variability than would be possible with a wider variety of tasks.

4 Miniature artificial grammars

Miniature artificial grammars (henceforth MAGs), also known as synthetic grammars, Markovian grammars, and finite-state grammars, represent a finite number of states (points) and a narrowly limited number of paths (specified by arrows) connecting them. The paths are labeled with alphabetic letters, and any set of paths that can lead from the initial state to the final state according to the specified arrows is considered to be a well-formed string of the grammar. The grammar is based wholly on left-to-right linear structure. Each letter is dependent on the one to its left, rather than on any sort of logical and/or hierarchical structure. Despite its simple linear structure, a crucial property of a MAG is that even a simple one can generate a large number of well-formed strings; consequently, the regularities underlying the linear structure are not readily learnable through conscious analysis of the exemplars during the period of exposure. This quality is what makes MAGs appropriate for implicit learning experiments. Figure 1 is an example (from Reber, 1967) of a MAG, and Table 1 provides a small subset of the grammatical strings generated by the grammar, as well as a set of ungrammatical strings that the grammar does not generate.

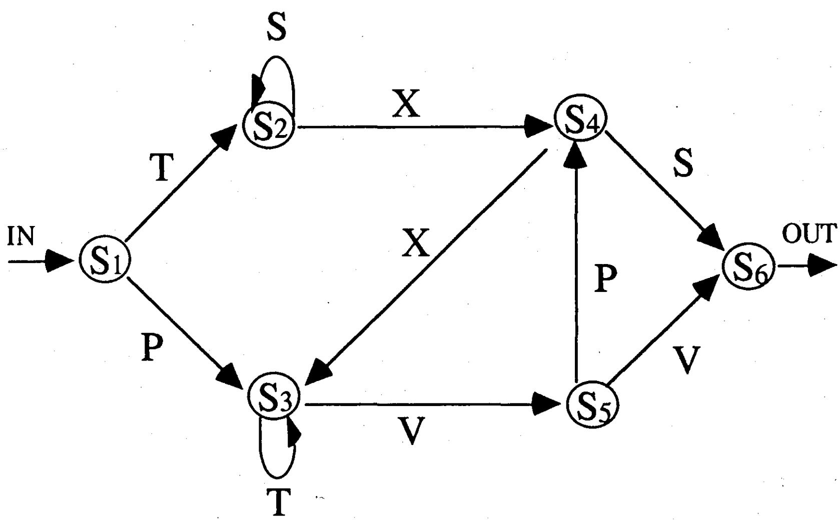

Figure 1. The original miniature artificial grammar (MAG), from Reber, 1965

Table 1. Examples of strings generated and not generated by the MAG

Grammatical		Ungrammatical	
1.	TXS	2.	TXV
3.	TSXS	4.	TTSXS
5.	TSSXXVV	6.	TSSXXVVV
7.	TSXXTVPS	8.	TSXXPTVPS
9.	PVV	10.	PV
11.	PTTVPS	12.	TVV
13.	PTVPXVPS	14.	SXS
15.	PTVPXVPS	16.	PVVS

For a string to be grammatical, the first element must be generated at S_1, the subsequent elements must be generated in an order according to the arrows, and the final element must lead to S_6. All of the eight ungrammatical strings in Table 1 violate one of these three constraints. Notice that since recursion of single elements is possible at S_2 and S_3, and the recursion of a combination of elements is possible at S_4, this finite state grammar can actually generate an infinite number of strings. Thus, although the visual representation of the grammar is very simple, the grammar is certainly complex enough to ensure that it could not be figured out explicitly during the course of an experiment that provides only exemplars of grammatical strings as input.

5 Experimental procedures for MAG research

The basic procedure in MAG learning is to provide a teaching phase, during which subjects implicitly acquire knowledge of the rules of the grammar by being exposed to many strings of letters that the grammar generates (such as TSSXXVV using the MAG above), and then to conduct a testing phase, during which the researcher assesses what the subjects have learned. The typical instruction to the subjects in the teaching phase is to memorize the strings that are presented. The testing phase most commonly consists of asking the subjects to judge the well-formedness of individual strings, after informing the subjects that in fact there are rules underlying the sequences of letters. Thus, again using examples from Table 2, the successful subject will manage to judge that strings like TSSXXVV are generated by the grammar and thus well-formed, whereas strings like VSSXXVV are not generated by the grammar, and are hence ill-formed, or ungrammatical. Assuming the subject cannot report any rules she was using to make the judgments, any better-than-chance performance on this task is considered evidence of implicit learning. Such performance constitutes learning because the knowledge demonstrated by the subject is unrelated to anything that could have been stored in long-term memory, and the learning is considered implicit because the following conditions apply: (1) the structure was too complex to have been "figured out;" (2) the subject cannot report the rules she has based her performance on; and (3) the subject is not aware that learning of the structure has taken place. The evidence that (1) is true is often by way of inference from (2) and (3); however, the danger of inferring the process from the product has been dealt with in a number of MAG studies by providing task instructions for some of the subjects to try to analyze the grammar. Representative results from these studies will now be discussed.

6 The work of Reber and colleagues

The basic theoretical orientation that has underlain 20 years of research by Reber with various associates is that implicit learning and implicit knowledge are integrally linked; that is, a particular process exclusively yields a particular product. Reber thus in principle rejects the possibility that conscious learning can lead to implicit knowledge, or that implicit learning can lead to conscious knowledge. Reber also argues that implicit learning processes are both ontogenetically and phylogenetically prior to explicit learning processes. Pervasive implicit learning is a natural continuation of an evolutionarily earlier adaptive mental capacity; there is no good reason to suppose that it would be lost in human beings. Reber additionally points out the important role for implicit learning among other animal species, and offers human evidence for implicit learning in from a variety of mental disorders (*e.g.*. amnesia, blindsight, alexia) which leave implicit processes relatively unaffected while causing massive changes in explicit processes.

Reber (1969) showed that knowledge derived from MAG memorization was abstract, in that subjects were able to transfer their knowledge of the MAG to a completely new set of letters; when the letters labeling the paths in the grammar were changed in the testing phase, there was almost no decrement in performance in comparison to the original set of letters. Reber (1976) and Reber et al. (1980) demonstrated that the intention to "figure out" the structure underlying the MAG was counterproductive; subjects who simply memorized the strings were more successful in judging well-formedness than those who actively examined the strings with the intention of deducing the rule system. Reber and Allen (1978) found that asking the subjects merely to observe the strings carefully (rather than to memorize them) was sufficient for implicit learning to take place and for the subjects to make reliable well-formedness judgments afterwards. Abrams and Reber (1988) demonstrated a dissociation between explicit and implicit learning processes in psychiatric patients. Compared with normal undergraduate controls on implicit and explicit tasks, the psychiatric patients took longer to complete the implicit task, but their accuracy was equal to the controls. On the explicit task, however, their performance was clearly inferior. The implication is that beyond the demonstration of two different kinds of learning, this experiment has provided evidence that implicit learning is more robust than explicit learning, in that it is less susceptible to impairment.

7 A failure to replicate

Skeptical of Reber's claims that the learning demonstrated in artificial grammar studies was unconscious, and the resulting knowledge abstract, Dulany et al. (1984) replicated Reber et al.'s (1980) study, but found no differences between the subjects who were instructed to search for rules and those who were instructed to memorize. This finding directly contradicted those of the Reber (1976) and Reber et al. (1980), potentially weakening the basis for claiming that MAG learning was unconscious. However, besides the possibility of the result being somehow anomalous, a variety of alternative explanations presented themselves: (1) no unconscious implicit learning discrete from explicit learning had occurred; (2) two types of learning occurred, but explicit learning was just as effective as implicit learning; (3) the rule searching subjects were learning implicitly despite their intentions; or (4) the subjects were not following directions. Dulany et al. preferred the first conclusion, Reber et al. (1985) argued for the third one.

8 Explicit construction of partial grammars?

A second major finding by Dulany et al. (1984) was that subjects developed what the researchers called "correlated grammars": personal, idiosyncratic grammars that were compatible with the actual underlying grammar in their capacity for generating parts of the admissible strings of the grammar. These local, partial grammars were demonstrated in subjects' ability to point out the problematic parts of inadmissible strings. Reber et al. (1985) rejected this conclusion by arguing that the explicit knowledge exhibited by Dulany et al.'s subjects was not developed until after the judgments, as a result of the explicit task requirement to mark the parts of the deviant sentences that 'make them wrong.' Therefore, the explicit knowledge was argued to be not the knowledge that was actually used in making the judgments. In their next study, however, Dulany et al. (1985) were able to demonstrate through computer simulation that "merely guessed justifications for unconsciously controlled judgments" could not possibly have yielded levels of accuracy nearly as high as those obtained in their (1984) study.

Consistent with Dulany et al.'s (1984) findings that subjects performed some conscious analysis on the exemplar strings, Perruchet and Pacteau (1990) concluded from three MAG experiments that subjects primarily encode fragmentary information, which may subsequently be used to develop abstractions if the task warrants it. For their experiments, Perruchet and Pacteau claimed that conscious specific knowledge was enough to account for their subjects' above-chance grammaticality judgments. Reber's (1990) reply attributes their results to insufficient control of the stimulus strings during the training phase, which invited conscious hypothesis testing behavior. However, this does not severely undermine Perruchet and Pacteau's conclusion, and rather underscores the difficulty of establishing the absence of conscious analysis in MAG studies regardless of the instructions.

9 Sorting out implicit processes and implicit products

Perruchet and Pacteau (1991) were concerned with Reber's confounding of two uses of "implicit:" (1) referring to the learning process, when it is synonymous with automatic, involving no intentional control and negligible mental resources; and (2) referring to memorial representations, when it is synonymous with unconscious, and unavailable to conscious thought. Though not denying the existence of either type of implicitness, they asserted that there were many possible relationships between them besides the one that Reber assumed. They suggested that an obvious direction for implicit learning research would be the use of dual-task experiments, which could more unambiguously show if implicit learning in sense (1) above can occur. Dual-task experiments, which would drastically reduce the attentional resources available for conscious analysis of the grammar, could more convincingly establish that any learning taking place must have been unconscious. However, non-learning under such stringent conditions would not establish the non-existence of implicit learning.

Whereas Perruchet and Pacteau (1991) clarified some of the problems with establishing the process of implicit learning, Brody (1989) offered some corresponding suggestions concerning the product: If the researcher does not establish convincingly the existence of implicit knowledge (by showing the absence of explicit knowledge), then any claim of implicit learning is unjustified. Brody pointed out that due to weaknesses in methodology, all of Reber's studies were unconvincing. Specifically, Reber had not been rigorous enough in establishing lack of conscious knowledge; instead, he had just assumed that what was not in subjects' verbal reports was not in consciousness. Brody's ideas for establishing more convincingly that subjects' knowledge of the artificial grammar was unconscious was to: (1) ask subjects to verbalize a second rule if the first one they provide is wrong; and/or (2) ask subjects' to decide on a forced-choice basis between features of a string that define its grammaticality. By probing more thoroughly the contents of subjects' conscious knowledge, researchers would be less vulnerable to the claim the subjects had explicit knowledge sufficient for the task but that the researcher simply did not find it.

10 Similarities between implicit and explicit processing

The results of a 1991 study by Dienes et al. cast further doubt on the operation of implicit learning in MAG tasks. First, their study failed to replicate Reber's (1967) finding that performance deteriorated when subjects looked for rules (explicit mode) rather than simply memorizing the stimuli (implicit mode). Reber had claimed that task instructions inducing to an explicit approach to the task would interfere with implicit learning, leading to worse performance on judgments; however, it should facilitate explicit learning, which would lead to more complete free reports. This was not what occurred in Dienes et al.'s experiment. Not only were well-formedness judgments unaffected between the two conditions, but the implicit/explicit mode had no effect on free report either. Secondly, in a dual-task experiment, they found that a concurrent random number generation task interfered equally with judgments and free reports. Since the dissociation between judgment performance and free report performance is typically taken as evidence of implicit knowledge, this result weakens the claim that there are separate implicit and explicit knowledge bases. Implicit learning, as an unconscious process, should not have been affected by the concurrent random number generation task, unlike explicit learning, which should have been impaired by having attention diverted away from it. Finally, the poor performance on free reports of grammatical knowledge that Dienes et al. obtained, consistent with previous studies, led them to speculate that this result was due to the difficulty of retrieving considerable low-confidence knowledge in a short period of time, along with the fact that artificial grammar learning involves the storing of many more associations than is generally the case in typical concept formation (where free reports are usually more complete). Thus, their study provided further reason to doubt the operation of implicit learning in MAG tasks, and also provided an alternate explanation for poor free report performance, which Reber had earlier used as crucial evidence for implicit knowledge.

11 Memory-based processing, unintentional learning, or abstract analogy?

Four experiments done by Mathews et al. (1989) produced the following relevant findings: (1) implicit processing was sufficient for learning a finite state grammar, but was inadequate for learning a grammar in which covariances were based on a logical rule rather on than simple linearity; (2) subjects were able to verbalize enough of their "implicit" knowledge to yoked subjects that the latter were able to identify well-formed strings on their own; in other words, subjects who had undergone the task of attending exemplar strings of a MAG were able to teach untrained subjects enough about the MAG so that they could make better-than-chance judgments; (3) verbal protocols related to well-formedness judgments varied widely, consistent with the idea that rule-induction rather than memory was involved; and (4) in the grammar based on logical rules, there was a synergistic effect when both implicit and explicit learning processes were used. Though they concluded that two discrete learning processes were involved in complex cognitive tasks, Mathews et. al. suggested reconceptualizing implicit learning as "memory-based processing" to acknowledge the evidence that this process is not completely nonconscious (and also to avoid confusion with the term *implicit memory*, which is used in quite a different way). They also proposed that the more explicit counterpart to memory-based processing should be termed "model-based processing," in that subjects are guided in their behavior by their mental model of the task (cf. Johnson-Laird, 1983).

Questioning the abstract nature of implicit knowledge, Servan-Schreiber and Anderson (1990) made a detailed proposal of their own. They presented evidence that the crucial learning mechanism involved in what they preferred to label *unintentional learning* rather than implicit learning was the *chunking* of small bits of information into larger pieces, and the further chunking of those pieces into still larger pieces. Thus, chunking is a process that organizes the available information in a hierarchical manner, but does not abstract any rules from it. The authors also assumed that chunking is a general learning mechanism that works both consciously and unconsciously. The key finding that supported their position, and also explained the earlier results of Dulany et al. (1984), was that subjects were more sensitive to grammatical violations that break up their chunks than those that leave the chunks intact. Developing these results into a theory of "competitive chunking," Servan-Schreiber and Anderson were able to replicate their results through computer simulation. One problem with their theory, by their own admission, is that it cannot account for transfer of knowledge to a new set of letters instantiated in the same artificial grammar. Since such transfer has been demonstrated by several researchers, it appears that chunking in the sense that Servan-Schreiber and Anderson describe can at best be one of several processes involved in MAG learning.

Brooks and Vokey (1991) also questioned the abstract quality of implicit knowledge. Their experiments centered on the transfer of grammatical knowledge from one artificial grammar to another one with identical principles instantiated in a different set of letters. Replicating Reber's (1969) findings, they found excellent transfer to the "changed letter-set" strings; however, they concluded that their experiments demonstrated that transfer was not due to abstracting the regularities of a large number of training items, but rather to the similarity of specific test strings to specific training stimuli. Thus, they concluded that the process responsible for the transfer effect was abstract (relational) analogy, rather than abstraction of the whole grammar. In other words, rather than applying the rules underlying one grammar to another set of symbols that also conform to the same set of rules, subjects were noticing the similarities between particular two- or three-symbol sequences in the new set and corresponding local patterns which they had picked out of the previous grammar.

12 A preliminary synthesis

Despite the narrowly circumscribed research paradigm, the line of research begun by Reber over 20 years ago has produced no clear-cut conclusions. However, the cumulative results of the studies discussed above do seem to be moving in some specific directions.

In terms of process, it appears that not all learning is conscious; there is sufficient evidence that subjects, asked simply to memorize strings and appearing to do just that, learn more than just a portion of the strings. On the other hand, subjects are very likely to engage in conscious strategies to aid their memorization, which may have an effect on the learning of the underlying structure. Thus, it is very hard to establish that there is learning that is wholly implicit, or that implicit learning is the only kind that is associated with some later performance. Furthermore, the content of implicit learning remains controversial: what is learned may be chunks or some other types of fragment, or it may whole items. This controversy then leads to the one concerning abstractness, specifically the point at which abstraction occurs, the degree to which it occurs, and what else occurs with it. What is clear is that the studies have left open the possibility that learning is going on at several levels at once, and that there may be some interface not only between implicit and explicit learning, but among a larger number of simultaneous and/or hierarchical processes. Taking the studies together, this seems the most viable way to reconcile them, and is consistent with multi-level processing established in other areas of cognitive psychology. Positing interaction effects without specifying how they interact is not a satisfying solution, but it is a start.

A similar situation exists regarding implicit knowledge. Although subjects have often made judgments which required more knowledge than they could report, numerous studies have also shown that less of that knowledge is inaccessible to consciousness than previously supposed. As a result, Reber (1989) has changed his position from asserting implicit knowledge as being unverbalizable, to merely maintaining that some degree of gap exists between performance and what can be reported. The degree of abstractness, as determined by transferability, also remains a matter of contention. If all transferability originates with subjects' identification of local similarities, then at least some of the abstraction process is probably conscious, and abstraction may take place both below and above the consciousness threshold.

A another important unresolved issue is the relationship between implicit learning and implicit knowledge. For Reber they are necessarily bound together, but the weight of the research is against a strict pairing. Subjects told to figure stimuli out have demonstrated implicit knowledge, and subjects who were asked to memorize stimuli have exhibited explicit knowledge. Although these findings do not lead unambiguously to the conclusion that one kind of learning has become a different kind of knowledge, it is plausible to think of stimuli as being processed both implicitly (automatically) and explicitly (analytically), each to varying degrees according to task conditions and internal factors, and then further processed and/or retrieved on the basis of particular task demands.

Finally, a problem that does not seem to have been raised in the psychological literature but which would have come up very soon in any discussion by linguists is that of underdetermination. The main motivation for work on a Universal Grammar that putatively underlies all language acquisition is that the language data that a child receives vastly underdetermines the very precise and subtle grammar that she eventually demonstrates her knowledge of. Although the MAGs used in psychological experiments of implicit learning are immensely more simple than any natural language grammar, it is clear even from the very basic one illustrated in Figure 1 that a subject could not in principle abstract the underlying structure of the MAG simply from a finite set of strings that it generates. This is because the subject would have no way of knowing that a string had to start with the choices at S_1 or end with the choices at S_6, or could embed a single element only at S_2 or S_3 but no others, etc.; in other words, the subject cannot know that the grammar is not bigger than it actually is. Without knowing something about the rules of the grammar *a priori*, it is impossible to exclude features just because they are so far unattested. This fact alone should undermine Reber's insistence that implicit learning leads to tacit knowledge of the structure of the stimulus domain, and is consistent with the fact that subjects with this putative tacit structural knowledge do not do better than they do on MAG tasks (better than chance is not all that impressive!).

13 Implicit learning in second language acquisition

One area where conclusive findings regarding implicit learning would attract much attention is the field of second language acquisition. The critical features of implicit learning seem to describe fairly accurately what must happen in first language acquisition. For the most part, children do not work at consciously deriving structure from the complex stimulus environment of their language input, and adults who have more or less completed the language acquisition process are unable to describe but a small portion of the knowledge that their language behavior reflects. Although much less is known about second than first language learning, a corresponding partial characterization of the second language learning situation would look very different. Conscious learning seems to play a much larger role than in primary language acquisition, and the success rate of internalizing a second language grammar, especially among adult learners, is dismally low. Better understanding of the role of implicit learning in second language acquisition could help to explain patterns of results among second language learners, and in the best case might even suggest some fruitful modifications in language teaching practice.

On the other hand, although second language learning is apparently an excellent example of the "complex stimulus environment" needed for research on implicit learning, and the results of such studies would likely be of immense practical interest, there are good reasons why theoretical claims in SLA involving implicit learning and the implicit/explicit dichotomy should begin very modestly. The first relates to the substantial basic conceptual disagreements that still remain among psychologists. When the term implicit learning is used in the SLA literature, it is generally either used with no reference, in which case it becomes a vacuous concept like Krashen's *acquisition*, or with reference to one of Reber's conception, which has weakened considerably over the years and yet still does not find widespread support among others in the field. A more challenging reason is the fundamental differences between language acquisition and structure learning in the MAG sense. Although MAGs are considered to be "complex stimulus domains," they are extremely simple compared to language, with its phonological, lexical, morphological, and syntactic rules in constant interaction. Next, unlike MAGs, natural language is structured hierarchically; this of course adds further to its complexity, but also allows for the incremental processibility and memory storage in salient chunks. Finally, and most importantly, structure in natural language is processed in relation to meaning. Although language can in principle be analyzed independent of meaning (as in the case of our recognition that "Colorless green ideas sleep furiously." is a grammatical sentence), it is arguably never processed in terms of structure alone, and it is highly unlikely that much could be learned that way, implicitly or explicitly. generalizability of artificial grammar learning (and other tasks that have been used so far) to anything that goes on in the learning of a natural language. Empirically, these features of natural language also imply that incorporating adequate controls on the variables in research on real language learning will be exceptionally difficult. This last problem will become clear in the L2 studies that will now be discussed.

14 L2 research on implicit and explicit knowledge

An early study of second language learners of French which attempted to use implicit and explicit knowledge as independent variables was that of Bialystok (1979). The distinction between the two types was whether or not they could be articulated or consciously acted upon. Unfortunately, articulation and conscious action are not the same thing, and neither one matched well Bialystok's operationalization of implicit vs. explicit as simply the degree of difference in performance on a speeded and unspeeded grammaticality judgment task. The rationale was that if performance significantly improved in the unspeeded condition, then implicit knowledge was insufficient, and explicit knowledge was necessary for optimal performance. Her conclusion was that implicit knowledge was in general sufficient for simple judgments, but when more detailed responses were required, explicit knowledge intervened. However, since she was not rigorous enough in isolating the two types of knowledge, all that she unambiguously showed was that more detailed responses take more time. Nevertheless, her use of time as a dependent variable is intriguing, suggesting that response times could be used in future research to further clarify the properties of implicit learning, and her discussion of the relative ease of detection and verbalization of different types of errors was useful.

Another study dealing with implicit vs. explicit knowledge, Hulstijn and Hulstijn (1984), was more refined in its research design but still failed to isolate implicit knowledge as a variable. In this study, learners of Dutch as a second language were tested on the accuracy of two specific grammatical constructions as they were produced in story retellings under four conditions: combinations of fast vs. slow and information-oriented vs. grammar-oriented. The researchers found that learners lacking explicit knowledge of the two structures, as elicited in an interview, improved just as much from the fast information-oriented condition to the slow grammar-oriented condition as did the learners who were able to verbalize such knowledge. The researchers interpreted their findings as supporting an information-processing view of second language acquisition, whereby executive control plays in equal role in the learning of different types of learners, while the independent factor of metalinguistic knowledge varies considerably. An interesting aspect of Hulstijn and Hulstijn's findings is that they highlight the problem of equating explicit knowledge with accurately verbalizable knowledge and implicit knowledge with the rest. A related problem with both of the studies discussed so far is their premature assumption that implicit knowledge is the core of language knowledge onto which is overlain varying amounts of relatively unimportant explicit knowledge.

Eight years later, but with no further refinement in the characterization of implicit learning, is a study by Green and Hecht (1992), dealing with the ability of German learners of English to correct ungrammatical English sentences and to verbalize the relevant rule underlying the correction. Implicit knowledge was taken to be demonstrated in cases when the learners could correct a sentence but not correctly identify the rule that was violated. The researchers found that the learners were able to verbalize the rules, which dealt with 12 errors commonly made by German learners, less than 50% of the time, even though all learners had previously been taught these rules. In contrast, they were able to successfully correct the errors 78% of the time. This gap 38% was considered to represent implicit knowledge. Although the assumption of implicit knowledge based on the gap between judgments and reasons is in itself problematic, Green and Hecht's distinction is even less defensible, as all of the sentences were ungrammatical, and the incorrect part was pointed out in the text, and so that the subjects were very likely showing specific local knowledge in producing their best guess as to a correction.

15 L2 research on implicit and explicit learning

Two recent L2 studies have attempted to manipulate implicit learning experimentally as an independent variable. The first one, done by N. Ellis (1991), featured three learning conditions—implicit (exemplars only), explicit (rules), and structured (rules with examples of how to apply them)—as applied to the learning of a complex phonological rule (soft mutation) in Welsh. The implicit condition was least effective; the structured condition was the most.

Robinson's (1996) study involved the learning by Japanese ESL student of one easy and one hard rule of English. Learners were randomly divided into four learning conditions: implicit (similar to Ellis'), instructed (roughly comparable to Ellis' structured group), rule-search (whereby learners were instructed to look for rules but were given no hints or feedback concerning their progress in finding such rules); and incidental (in which learners were asked to focus on the meaning of the sentences they saw). As in Ellis' study, and as in almost all studies that have manipulated the amount of relevant explicit information available to learners, the most learning occurred in the condition with the most explicit information provided, *viz.* the instructed group. However, their rate of advantage decreased on the hard (pseudocleft) rule as opposed to the easy (adverb fronting) rule, somewhat vindicating Reber's and Krashen's idea that explicit learning works better for easy rules.

Nevertheless, the use of the terms *easy* and *hard*, as well *implicit*, cannot be taken at face value in any of the studies in which they are used to define variables; it is always important to critically consider the relation between the theoretical construct and its operationalization in a particular study. In the case of both Ellis' (1991) and Robinson's (1996) studies, *implicit* actually refers to task directions which specify that subjects should attempt to memorize; what the subjects actually do is another matter. In Robinson's study, *easy* and *hard* refer to the judgments of one group of native-speaking English teachers; it is a big step to infer that the former but not the latter would be conducive to explicit learning in either the sense of Krashen or Reber. All of the L2 studies to date demonstrate the problems of trying to isolate empirically the theoretical implicit/explicit distinction . If viewed on their other merits, however, each of them has contributed to illuminating the effects of various task conditions in relation to various of features of learning and knowledge.

16 Conclusion

Interest in the implicit/explicit distinction continues to grow, both among psychologists and SLA scholars. In psychology, the issues are rapidly becoming clearer and researchers are holding themselves more accountable to the often conflicting findings of their counterparts. Research tasks using artificial grammars, though not directly transferable to the infinitely more complex task of learning a natural language, have kindled the imaginations of second language researchers toward devising tasks to examine the workings of implicit learning within the context of acquiring a second language. Although the operationalization of implicit vs. explicit knowledge in second language acquisition thus far has been relatively unrefined, the assistance available from cognitive psychology is increasingly becoming better developed and more readily accessible , and sophistication in L2 research methodology is also progressing rapidly.

Even so, it is quite likely that the dichotomy between implicit and explicit learning will ultimately turn out to be false: either a continuum of explicitness of a single learning mechanism, or a wider variety of learning processes will turn out to be the proper characterization. Both in terms of moving faster toward the final outcome of the debate, and of gaining understanding of the SLA process in the absence of tidy distinctions, L2 researchers should work toward sorting the multitude of factors that could underlie differences in performances on related tasks by the same learners, but without losing sight of the eventual theoretical goal.

NOTES

* I would like to thank Herb Roitblat for his valuable comments on an earlier draft, and Mitsuko Nakajima for her patience and encouragement, as always, in getting this one completed.

Address for correspondence: School of Policy Studies, Kwansei Gakuin University, 2-1 Gakuen, Sanda-shi, Hyogo-ken 669-13 Japan; E-mail: mark@ksc.kwansei.ac.jp

REFERENCES

Abrams, M. & Reber, A. (1988). Implicit learning: Robustness in the face of psychiatric disorders. *Journal of Psycholinguistic Research* 5, 875-887.

Allen, R. & Reber, A. (1980). Very long-term memory for tacit knowledge. *Cognition, 8,* 175-185.

Bialystok, E. (1979). Explicit and implicit judgments of L2 grammaticality. *Language Learning, 29,* 81–103.

Brody, N. (1989). Unconscious learning of rules: Comment on Reber's analysis of implicit learning. *Journal of Experimental Psychology: General, 118,* 236-238.

Brooks, L.R., & Vokey, J.R. (1991). Abstract analogies and abstracted grammars: Comments of Reber (1989) and Mathews et al. (1989). *Journal of Experimental Psychology: General, 120,* 3, 316-323.

Dienes, Z., Broadbent, D., and Berry, D. (1991). Implicit and explicit knowledge bases in artificial grammar learning. *Journal of Experimental Psychology: Learning, Memory and Cognition, 17,* 5, 875-887.

Dulany, D.E., Carlson, R.A., & Dewey, G.I. (1984). A case of syntactical learning and judgment: How conscious and how abstract? *Journal of Experimental Psychology: General, 113,* 541-555.

Dulany, D.E., Carlson, R.A., & Dewey, G.I. (1985). On consciousness in syntactic learning and judgment: A reply to Reber, Allen, and Regan. *Journal of Experimental Psychology: General, 114,* 25-32.

Ellis, N. (1991). Rules and instances in foreign language learning: Interactions of explicit and implicit knowledge. *European Journal of Cognitive Psychology, 5,* 289-319.

Ellis, R. (1993). The structural syllabus and second language acquisition. *TESOL Quarterly, 27,* 91-113.

Green, P.S., & Hecht, K. (1992). Implicit and explicit grammar: An empirical study. *Applied Linguistics, 13,* 160–184.

Hulstijn, J., & Hulstijn, W. (1984). Grammatical errors as a function of processing constraints and explicit knowledge. *Language Learning, 34,* 23–43.

Johnson-Laird, P.N. (1983). *Mental models.* Cambridge: Harvard University Press.

Krashen, S. (1981). *Second language acquisition and learning.* Oxford: Pergamon.

Mathews, R.C., Buss, R.R., Stanley, W.B., Blanchard-Field, F., Cho, J.R. & Druhan, B. (1989). Role of implicit and explicit process in learning from examples: A synergistic effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition,, 15,* 1083-1100.

Perruchet, P., & Pacteau, C.. (1991). Synthetic grammar learning: Implicit acquisition of abstract knowledge about artificial grammar: Some methodological and conceptual issues. *Journal of Experimental Psychology: General, 120,* 112-116.

Reber, A.S. (1967). Implicit learning of artificial grammars. *Journal of Verbal Learning and Verbal Behavior, 6,* 855-863.

Reber, A.S. (1976). Implicit learning of synthetic grammars. *Journal of Experimental Psychology: Human Learning and Memory , 2,* 89-94.

Reber, A.S. (1989a). Implicit learning and tacit knowledge. *Journal of Experimental Psychology: General, 118,* 219-235.

Reber, A.S. (1990). On the primary and the implicit: Comment on Perruchet & Pacteau. *Journal of Experimental Psychology: General, 119,* 3, 340-342.

Reber, A.S., & Allen, R. (1978). Analogic and abstraction strategies in synthetic grammar learning: A functionalist interpretation. *Cognition, 6* 17-24.

Reber, A.S., & Lewis, S. (1977). Implicit learning: An analysis of the form and structure of a body of tacit knowledge. *Cognition, 5,* 333-361.

Reber, A.S., Allen, R., & Regan, S. (1985). Syntactical learning and judgment: Still unconscious and still abstract. *Journal of Experimental Psychology: General, 114,* 17-24.

Reber, A.S., Kassin, S.M., Lewis, S., & Cantor, G. (1980). On the relationship between implicit and explicit modes in the learning of a complex rule structure. *Journal of Experimental Psychology: Human Learning and Memory , 6,* 492-502.

Robinson, P. (1996). Learning simple and complex second language rule under implicit, incidental, rule-search, and instructed conditions. *Studies in Second Language Acquisition, 18,* 27-67.

Schmidt, R. (1990). The role of consciousness in second language learning. *Applied Linguistics, 11,* 129–158.

Servan-Schreiber, E., & Anderson, J.R. (1990). Learning artificial grammars with competitive chunking. *Journal of Experimental Psychology: Learning, Memory and Cognition, 16,* 592-608.