IV Processes in SLA

11 Implicit and Explicit Learning

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1 Introduction

From both a practical and a theoretical point of view it is important to understand the difference between implicit and explicit learning mechanisms and the role they play in second language learning. One of the most frequently asked questions in language teaching circles is whether grammar should be taught explicitly, and one of the central issues in the psycholinguistics of second language acquisition is whether adults can learn a language fully through the same implicit learning mechanisms used by the child in learning a first language. The implicit/explicit dichotomy, however, is hard to define, and has often been confused with various other dichotomies. Therefore, this chapter will devote substantial attention to how implicit and explicit learning have been defined and studied in cognitive psychology, and to what the second language field can learn from this discipline, before reviewing the SLA literature on implicit and explicit learning itself, and discussing the differential role of the two learning mechanisms for different aspects of grammar and for learners of different ages.

2 The Cognitive Psychology of Implicit and Explicit Learning

2.1 *Definitions*

The definition of implicit learning has something in common with the well-known problem of defining intelligence. Just as intelligence researchers first developed a number of predictive tests, and only later started worrying about the psychological mechanisms that determine performance on such tests, the literature on implicit learning reflects an early focus on certain tasks, and subsequent attempts at analyzing the learning, storage, and retrieval mechanisms that explain this performance, and at defining their fundamental nature.

For Arthur Reber, the pioneer of implicit learning research, the central issue was lack of consciousness of the structure being learned. He defined implicit learning as “a primitive process of apprehending structure by attending to frequency cues” as opposed to “a more explicit process whereby various mnemonics, heuristics, and strategies are engaged to induce a representational system” (1976, p. 93). Hayes and Broadbent are slightly more precise in stating that implicit learning is “the unselective and passive aggregation of information about the co-occurrence of environmental events and features” (1988, p. 251).

Because of the difficulty of defining consciousness or awareness (see section 2.5), however, a number of alternative suggestions have been made, mainly involving intentionality and automaticity (for an overview, see Frensch, 1998). In my view, however, both of these concepts are clearly distinct from what is involved in implicit learning. Subjects in experiments on implicit learning usually have the intention of learning something, even though they may learn something different from what they intended to learn (something more abstract than the surface structure of the stimuli they try to memorize). Automaticity is really the result of a learning process, not a characteristic of the learning process itself, and is hard to define. (For recent overviews of automaticity, see Anderson and Lebiere, 1998; DeKeyser, 2001; Segalowitz, this volume. For more discussion of incidental learning, see Hulstijn, this volume.) Given that replacing awareness by intentionality or automaticity does not resolve the conceptual problems, and given that awareness is the defining feature used in the second language literature on implicit and explicit learning, implicit learning will be defined here as learning without awareness of what is being learned.

It is important, furthermore, to distinguish implicit learning from two concepts it is often confused with in the second language literature: inductive learning and implicit memory. Inductive learning (going from the particular to the general, from examples to rules) and implicit learning (learning without awareness) are two orthogonal concepts (see figure 11.1). Via traditional rule teaching, learning is both deductive and explicit. When students are encouraged to find rules for themselves by studying examples in a text, learning is inductive and explicit. When children acquire linguistic competence of their native language without thinking about its structure, their learning is inductive and implicit. The combination of deductive and implicit is less obvious, but the concept of parameter setting in Universal Grammar could be seen as

	Deductive	Inductive
Explicit	Traditional teaching	Rule discovery
Implicit	Using parameters	Learning L1 from input

Figure 11.1 The inductive/deductive and implicit/explicit dimensions

an example; supposedly learners derive a number of characteristics of the language being learned from the setting of the parameter, and this clearly happens without awareness.

In the same vein, implicit memory and implicit learning are in principle independent concepts. Even though implicitly acquired knowledge tends to remain implicit, and explicitly acquired knowledge tends to remain explicit, explicitly learned knowledge can become implicit in the sense that learners can lose awareness of its structure over time, and learners can become aware of the structure of implicit knowledge when attempting to access it, for example for applying it to a new context or for conveying it verbally to somebody else. In Reber's own experiments with artificial grammars, instructions encourage explicit retrieval, which may lead to making knowledge itself more explicit (cf. Buchner and Wippich, 1998).

2.2 *Basic findings*

Empirical research on implicit learning falls largely into three categories: artificial grammars, sequence learning, and control of complex systems. In each of these areas a considerable number of studies have shown that subjects can learn to use complex knowledge to perform on a variety of tasks without being aware of the exact nature of that knowledge (for a concise and readable overview, see, e.g., Cleeremans, Destrebecqz, and Boyer, 1998).

The oldest paradigm, and the one that continues to generate the most research to this day, is artificial grammar learning (AGL). The first such experiment by Reber (1967) did not draw much attention, but subsequent experiments (e.g., Reber 1976; Reber, Kassin, Lewis, and Cantor, 1980) and the controversy they generated (see, e.g., Dulany, Carlson, and Dewey, 1984; Reber, Allen, and Regan, 1985) led to a small industry of artificial grammar studies of ever increasing complexity and sophistication (e.g., Altmann, Dienes, and Goode, 1995; Buchner, 1994; Dienes, Broadbent, and Berry, 1991; Gomez, 1997; Gomez and Schvaneveldt, 1994; Knowlton and Squire, 1994, 1996; Meulemans and Van der Linden, 1997; Pothos and Bailey, 2000; Redington and Chater, 1996; Servan-Schreiber and Anderson, 1990; Shanks, Johnstone, and Staggs, 1997). Experiments in this paradigm expose learners to a set of letter strings (or equivalent series of symbols) generated by a set of rules in the form of a Markovian finite-state grammar. Subjects never get to see the rules, and are generally not aware of the rules after being exposed to a set of exemplar strings; yet they perform above chance when they are unexpectedly asked to classify new strings into those that conform to the structure of the exemplars and those that do not.

The sequence learning paradigm has also been quite productive. Since the early studies by Nissen and Bullemer (1987) and Lewicki, Czyzewska, and Hoffman (1987), a number of other experiments have confirmed that subjects exposed to a sequence of light flashes appearing in various locations or to long symbol strings with recurrent patterns become sufficiently sensitive to these patterns to be able to predict future sequences, again without being aware of the underlying patterns (e.g., Cleeremans and Jiménez, 1998; Cleeremans and McClelland, 1991; Cohen, Ivry, and Keele, 1990; Curran and Keele, 1993; Jiménez and Méndez, 1999).

In the third paradigm, control of complex systems, subjects learn to interact with a computer to control an output variable by manipulating input variables (e.g., Berry and Broadbent, 1984; Dienes and Fahey, 1995). For instance, they learn to keep production of a simulated sugar factory within bounds by manipulating variables such as amount of raw material processed. Again, they manage to do this without being aware of the complex formula the computer uses to relate input variables to output.

In all of these experimental paradigms, subjects learn to use complex knowledge without being aware of its underlying structure. Central to the ongoing debate about the nature of implicit learning, however, is Reber's (1976, 1989, 1993) claim that subjects learn abstract knowledge implicitly. Some researchers have claimed that the learning in such experiments is both explicit and concrete (e.g., Dulany et al., 1984; St John and Shanks, 1997); others have denied only the abstractness of the knowledge (e.g., Pothos and Bailey, 2000; Redington and Chater, 1996), the implicitness of the learning (e.g., Shanks and St John, 1994; Jiménez and Méndez, 1999), or the possibility of having both at the same time (e.g., Gomez, 1997; Perruchet and Pacteau, 1990, 1991). Let us now turn to a more detailed discussion of these issues.

2.3 The implicitness issue

Among the first to challenge Reber's claims of implicit learning of abstract rules were Dulany et al. (1984). These researchers actually quoted Reber and Allen (1978) to show that subjects in AGL experiments were aware of some knowledge: during retrospection these subjects mentioned "first and last letters, bigrams, the occasional trigram, and recursions" (1978, p. 202) as important in their decision-making. What allows subjects to make grammaticality judgments, Dulany et al. argued, was "conscious rules within informal grammars rather than . . . unconscious representations of a formal grammar" (1984, p. 541). In other words, subjects had not induced the finite-state grammar underlying the strings in Reber's experiments, but had explicitly remembered fragments of strings, which gave them enough information to perform reasonably well on the grammaticality judgment test. More importantly, these authors showed with data from their own experiment that subjects' judgments could be accounted for by their reported rules without significant residual. Several other studies have presented similar results (e.g., Perruchet and Pacteau, 1990, 1991; St John and Shanks, 1997).

An important piece of evidence in favor of the implicit interpretation of AGL comes from work with amnesic patients (e.g., Knowlton and Squire, 1994, 1996). As these patients' explicit memory is severely impaired, and as they still manage to perform as well as normals, implicit memory must be involved. This does not mean, however, that the learning itself was implicit; implicit memory does not necessarily imply implicit knowledge. Moreover, as several researchers have argued (e.g., Gomez, 1997; Redington and Chater, 1996), the fact that there were no control subjects in these studies leaves open the possibility that some learning takes place during the test. Finally, even amnesic patients may be able to remember explicitly some of the most salient features of the learning strings, such as initial trigrams (Gomez, 1997).

A different experimental approach was taken by Cleeremans and Jiménez (1998) and Jiménez and Méndez (1999). These researchers used a dual-task condition to show how diminished attention affects sequence learning. Cleeremans and Jiménez (1998) found the dual-task condition to be harmful for deterministic sequences only, not probabilistic ones. Jiménez and Méndez (1999) focused further on probabilistic sequences and found that, while division of attention barely affected learning, selective attention to the predictive dimensions was necessary to learn about the relation between these dimensions and the predicted one. Neither of these two studies, however, has anything precise to say about awareness.

We must conclude then, that there is very little hard evidence of learning without awareness, and agree with Carlson that "many if not most of the empirical demonstrations of supposedly unconscious phenomena are methodologically or theoretically flawed. Few stand up to serious attempts to replicate or to more carefully assess the contents of subjects' awareness and their relation to observed performance" (1997, p. 290).

2.4 The abstractness issue

Just as several studies have attempted to provide evidence to counter Dulany et al.'s (1984) claim that conscious knowledge can account completely for subjects' performance in AGL experiments, several researchers have tried to present evidence against their claim that subjects only learn concrete fragments and not abstract rules. This evidence is mainly of two kinds: separate manipulation and analysis of grammaticality and similarity, and transfer of learning to changed letter sets.

Beginning with Vokey and Brooks (1992), a number of studies have attempted to disentangle the effects of grammaticality (sensitivity to underlying structure) and mere surface similarity to training strings. Meulemans and Van der Linden (1997), for example, claimed to show that when subjects have seen few example strings, they are more sensitive to similarity. When they have seen most of the grammatical strings possible, the only effect observed is that of grammaticality. In principle grammaticality and similarity can be operationalized independently, because strings that are superficially similar can violate a structural rule, whereas strings that are very different from the ones seen previously can still follow that rule. It is very hard to avoid confounding the two variables, however. Johnstone and Shanks (1999) showed that information about grammatical rules and chunk locations was confounded in Meulemans and Van der Linden's (1997) study, and that all of their data could be explained by knowledge about the positional constraints on specific chunks. Finally, in one of the most sophisticated studies to date, drawing on Nosofsky's (1989) generalized context model (a similarity-based model of categorization), Pothos and Bailey (2000) did not find grammaticality to be an important predictor of string categorization in comparison with chunk strength and especially similarity. It appears doubtful, then, that grammaticality judgments in AGL experiments really reflect sensitivity to grammaticality instead of mere familiarity with surface characteristics.

The issue of transfer to changed letter sets has been called "the Granada of unconscious rule learning . . . the last remaining argument that implicit grammar learning produces abstract, rule-like knowledge that cannot be reported" (St John and Shanks, 1997, p. 189). If subjects can do well on grammaticality judgment tests for strings that use different letters but have the same underlying grammatical structure as the learning strings, then, the standard reasoning goes, they must have learned that underlying abstract structure rather than memorized concrete string fragments. A number of studies have indeed reported such findings (e.g., Brooks and Vokey, 1991; Gomez and Schvaneveldt, 1994; Knowlton and Squire, 1996; Mathews et al., 1989; Whittlesea and Dorken, 1993); some have even reported transfer across visual/auditory modalities (Altmann, Dienes, and Goode, 1995; Manza and Reber, 1997).

It is doubtful, however, that such transfer necessarily implies abstract learning. Redington and Chater (1996) argued strongly that such transfer phenomena are compatible with the hypothesis that subjects learn fragments (bigrams and/or trigrams) during the training phase of the experiment, and only abstract across the fragments at test time. They showed that a variety of models that include only fragment knowledge can equal or even exceed the performance by human subjects found in a variety of transfer experiments reported in the literature. Furthermore, they argued, control subjects without training have been observed to perform at the same above-chance levels as experimental subjects, which suggests that the performance of the latter too can be explained entirely by learning at test, and is not necessarily due to anything learned during training, let alone abstract knowledge.

Yet another problem for the abstractness account is the lack of a complexity effect under implicit learning conditions, as documented in various experiments described in Reed and Johnson (1998). They define complexity as the number of discrete elements that need to be taken into account in sequence learning experiments or other target location prediction tasks, and show that rules of different complexity show dramatically different learning rates under explicit but not implicit learning conditions. This absence of a complexity effect in the implicit condition, they argue, can be interpreted as showing that implicit learning results in less abstract representations, so that complexity is not an issue.

Finally, a question related to the abstractness issue is that of contiguity. Cleeremans and McClelland (1991), in an experiment on sequence learning, and Mathews et al. (1989) as well as St John and Shanks (1997), in AGL tasks, showed that implicit learning is severely hampered when the learning task requires establishing a relationship between elements that are at some distance, separated by several other elements.

In conclusion, then, it seems that implicit learning is at its best when only concrete and contiguous elements are involved. Neither the experimental disentangling of similarity and grammaticality nor the transfer phenomena documented in the AGL literature have provided convincing evidence that anything abstract is learned implicitly.

2.5 *Methodological problems*

The empirical studies listed in the previous sections already illustrate some of the methodological issues in the field of implicit learning. The crux of the issue is finding measures of implicit and explicit learning that are both pure and sensitive, so that they show exactly how much is learned through either process, nothing more and nothing less. This issue is all the more important as the amount of learning taking place in most experiments, even though statistically significant, is not very large. Typically subjects score 55–70 percent, where 50 percent reflects mere chance, given that most tests take the form of a simple yes/no grammaticality judgment. With such small amounts of learning, the slightest imperfection in the measures of what has been learned can have a big impact on the results. It is important then, that tests of implicit and explicit learning be equally sensitive, and that they probe the kind of knowledge that underlies performance. Shanks and St John (1994) refer to these two requirements as the sensitivity criterion and the information criterion, and they argue that tests of implicit learning tend to be more sensitive than tests of explicit learning (which often rely on verbalization).

As it is virtually impossible to design tests of implicit and explicit learning that are exactly equally sensitive, especially to find tests that measure explicit knowledge exhaustively, Reingold and Merikle (1988) have proposed a different solution to the measurement problem. If the explicit measure is at least as sensitive to conscious knowledge as the implicit measure, and the implicit measure shows more knowledge than the explicit measure, then this implies the existence of processing without awareness. There have been few attempts, though, to use this logic to demonstrate implicit learning (cf. Stadler and Roediger, 1998). The process-dissociation procedure proposed by Jacoby (1991) has been more influential (cf. Buchner and Wippich, 1998). It is a tool to estimate the separate contributions of the two types of processes to a single task, but has been questioned because of problems with differential response bias in explicit and implicit memory tests (Buchner, Erdfelder, and Vaterrodt-Plünnecke, 1995).

Furthermore, testing needs to be conducted at the right time; otherwise, if knowledge seems to be implicit, it can be claimed that learning was explicit but that explicit knowledge was lost in the meantime. Unfortunately, however, no clear criterion exists for deciding on an appropriate testing time (cf. Reed and Johnson, 1998).

Finally, while speeded tests undoubtedly are more problematic for the retrieval of explicit than implicit knowledge (e.g., Turner and Fischler, 1993), time pressure does not guarantee a pure measure of implicit knowledge. Conversely, any experiment of short duration is inherently biased against implicit learning, as the accumulation of instances in memory takes much more time than the short cut provided by explicit insight.

In conclusion, then, no perfect tests or procedures exist for distinguishing the results of implicit and explicit learning. At this point researchers have to content themselves with eliciting knowledge under conditions that are more or less conducive to the retrieval of implicit and explicit knowledge, and then infer to what extent the learning itself may have been implicit or explicit. Therefore, it seems prudent to follow Stadler and Roediger's advice to "focus on the differential effects of implicit and explicit orientations on learning, rather than on attempts to demonstrate that learning is implicit in some absolute sense" (1998, p. 107).

2.6 Conclusion: implicit induction of abstract structure?

How much can be learned implicitly? AGL experiments typically show a very limited amount of learning: 55–70 percent correct judgments on a grammaticality judgment post-test, where chance performance would be 50 percent. It is doubtful, however, that even this amount of knowledge is completely implicit (lack of verbalization is not a sufficient argument), let alone that it was acquired completely implicitly (as noted above, explicit memory resulting from explicit learning can be lost between learning and testing – especially in the case of amnesics).

Even if one believes that some knowledge is acquired, stored, and used implicitly, it is doubtful that this knowledge is ever really abstract in nature (even experiments with transfer to different symbols or modalities do not constitute conclusive proof). Perruchet and Pacteau (1990) argued that knowledge could be abstract or could be learned implicitly, but not both. Similarly, Gomez (1997) showed that "simple" knowledge (of first-order dependencies) could be learned implicitly, but not more complex knowledge (involved in learning second-order dependencies or in transfer to stimuli with the same underlying syntax but new surface features); and Shanks, Johnstone, and Staggs (1997) claimed to show implicit learning in some of their experiments and abstract learning in others, but admitted they had not done both in the same experiment. Their experiments 1 and 2 used the flawed transfer argument to show abstraction; their experiment 3 did not disentangle grammaticality from similarity (as they acknowledge); and most importantly, their experiment 4 showed that, when the rules (of a biconditional grammar) precluded learning by similarity, the implicit learners not only learned less than the explicit learners, but actually scored at the chance level.

A thorough reading of the literature on implicit learning, then, must leave one very skeptical about the possibility of implicit learning of abstract structure, at least by adults.

3 Implicit and Explicit Second Language Learning

Several recent literature reviews provide an overview concerning the role of a number of related concepts such as consciousness, awareness, attention, noticing, and focus on form in second language learning (see especially Doughty and Williams, 1998; Long and Robinson, 1998; Norris and Ortega, 2000; Spada, 1997). As these literature reviews show, a considerable amount of work suggests there is a positive role for some kind of attention to form, that is, either through the explicit teaching of grammar and explicit error correction, or at least through more indirect means such as input enhancement. These literature reviews also make it clear, however, that relatively few studies have consisted of a direct comparison of implicit and explicit learning, everything else being the same. The appendix to Norris and Ortega (2000), for example, lists 14 direct comparisons of implicit and explicit instruction or error correction (out of 77 studies reviewed). This classification was based on the definition of DeKeyser (1995) that an instructional treatment is explicit if rule explanation forms part of the instruction (deduction) or if learners are asked to attend to particular forms and try to find the rules themselves (induction). "Conversely, when neither rule presentation nor directions to attend to particular forms were part of a treatment, that treatment was considered implicit" (Norris and Ortega, 2000, p. 437).

Sections 3.1 and 3.2 will be limited to the SLA literature on implicit/explicit learning in this narrow sense of direct controlled comparisons between the two (comparisons with a no-treatment group are excluded). For broader issues concerning the role of attention or focus on form, see the aforementioned references as well as Robinson (this volume). First laboratory studies will be reviewed, and then classroom studies will be discussed. The following two sections will provide different kinds of evidence. Section 3.3 deals with the use of implicit and explicit knowledge after a substantial amount of learning has taken place, and section 3.4 examines connectionist models of SLA.

3.1 Laboratory studies

A small number of studies have compared implicit and explicit learning of new L2 material in a laboratory context (studies of error correction are not reviewed here). Some of these studies dealt with learners who simply volunteered for an experiment involving a language they had no contact with otherwise (Alanen, 1995; de Graaff, 1997; DeKeyser, 1995; N. Ellis, 1993); others dealt with learners who were studying the language in question in the classroom, but who were given a special experimental treatment on some point they had not covered before (Doughty, 1991; Leow, 1998; Robinson, 1996, 1997).

One of the earliest focused laboratory studies is N. Ellis (1993), an experiment involving the "soft mutation" of initial consonants in Welsh. Ellis compared three groups of learners. The random group received exposure to numerous examples of consonant alternations in random order. The grammar group received explicit explanation of the rules in question, followed by the same randomized examples. The structured group received explicit rule explanation, followed by two examples after each rule, and then the same random presentation of examples as the other two groups. While the random group was found to be the fastest in learning to judge the well-formedness of sentences seen before, it was also the slowest in generalizing its knowledge to judge new sentences. The grammar group showed solid explicit knowledge of the rules, but little ability to apply them to well-formedness judgments. Only the structured group did well on both tests of explicit rule knowledge and grammaticality judgments. Clearly the most explicit treatment, the only one that made learners aware of how rules apply to examples, outperformed the other two. Similar results were found by Michas and Berry (1994), in an experiment involving the pronunciation of Greek words by native speakers of English. One experiment showed the advantage of explicit rule presentation over word/pronunciation pairings; a second experiment showed that explicit presentation of the rules was useful only if followed by practice.[1]

Alanen (1995) used locative suffixes and a rule of "consonant gradation" in semi-artificial Finnish as the learning target. Four groups were involved in the experiment: mere exposure, input enhancement, rule presentation, and both rule presentation and input enhancement. The groups with rules did better than the other two on subsequent production tests, but the input enhancement group did not outperform the control (mere exposure) group. There was a qualitative difference between the latter two, however: the control group omitted more suffixes, while the input enhancement groups supplied more erroneous ones. It should be noted that rule presentation included examples in this study, so that both the rule presentation and rule presentation with input enhancement groups are comparable to Ellis's structured condition. The results then, are very comparable: in both studies the groups with the most explicit treatments (rules + examples) did best.

DeKeyser (1995) looked at the interaction between two treatment conditions (implicit, defined as mere exposure to numerous sentence/picture pairs, and explicit, defined as similar exposure along with explicit explanation of the relevant rules) and two types of rules (categorical rules, i.e., straightforward morphological form/function mappings, and prototypical rules, i.e., probabilistically applying rules of allomorphy) in a computerized experiment with an artificial language called Implexan. While there appeared to be a slight advantage for the implicit group with regard to the prototypicality patterns, the explicit group strongly outperformed the implicit group on the categorical rules. In fact, even after exposure to thousands of relevant examples, the performance of the implicit group was essentially random.

Advantages for explicit learning were also found in another computerized experiment involving an artificial language called eXperanto and resembling Spanish (de Graaff, 1997). One group (implicit) participated in a variety of structural as well as meaning-focused activities; the other group (explicit) received rule explanation in addition to these activities. De Graaff found a clear main effect for explicit instruction on several kinds of post-tests, but did not find the hypothesized interactions with rule complexity and the syntax/morphology distinction. Explicit instruction was simply better overall.

Both Doughty (1991) and Robinson (1996, 1997) worked with learners of ESL, Doughty in a computerized experiment, Robinson in a traditional format. Doughty (1991) targeted relative clauses, and compared three groups: rule-oriented learners (who were given explicit rules), meaning-oriented learners (who received enhanced and elaborated input), and learners who were simply exposed to many examples of the relative clause structures in question. Both instructed groups scored higher than the mere exposure group on production tests. The meaning-oriented group did better than the rule-oriented group in comprehension, possibly because this group received extra elaboration about meaning. It appears that both instructed groups had their awareness of the relevant aspects of relativization raised (the rule group through animation of moving sentences plus very simple metalinguistic rules; the meaning group through enhanced and elaborated input), and that, therefore, both did better than the mere exposure group in acquiring relativization.

Robinson (1996) compared four groups: incidental (focus entirely on meaning), implicit (subjects were told to remember sentences), rule-search (subjects were urged to find the rules), and instructed (the rules were presented to the subjects). The first two treatments can be called implicit in a broader sense, and the latter two explicit, respectively inductive and deductive. For both easy and hard rules (respectively about pseudoclefts of location and about subject–verb inversion after adverbials), the explicit-deductive group performed best, and the explicit-inductive group worst or nearly so on a grammaticality judgment post-test. This experiment agrees with the other ones mentioned in the sense that the groups with rule awareness do best. It provides the additional information that subjects may not be very good at becoming sufficiently aware of the rules through their own efforts: Robinson shows that the rule-search, incidental, and implicit groups respectively provided 11, 9, and 6 correct rule statements, compared to 22 for the instructed group (1996, p. 46, table 4).

A similar comparison between four groups was later made by Robinson (1997), but with a visual enhancement group instead of a rule-search group. This time the learning target was a rule of dative alternation applied to nonsense verbs embedded in English sentences. Here again the most explicit group, that is, the instructed group, was found to perform best on a grammaticality judgment post-test (except for sentences that were seen during the learning phase, where all conditions performed equally well).

Finally, two experiments with learners of Spanish as a second language also showed the advantage of learners with rule awareness over other groups. Leow (1998) compared four groups in an ingeniously designed experiment involving crossword puzzles: the four combinations of +/− orientation to, and +/− detection of, morphological irregularities in the morphology of the preterit. The two groups that were led to become aware of the irregularities because of the layout of the crossword puzzle ("+ detection") clearly outperformed the two other groups on a variety of post-tests, regardless of whether the instructions had drawn their attention to the irregularities or not ("+/− orientation").[2]

Rosa and O'Neill (1999) likewise found that awareness crucially determined the level of intake of a Spanish structure, in this case past counterfactual conditional sentences. They distinguished four treatments (+/− explicit rule instruction × +/− rule search during a problem-solving task) and a control group, and made a three-way distinction regarding awareness as assessed through a think-aloud protocol (at the level of understanding, at the level of noticing, and no awareness; cf. Schmidt, 1990, 1994, 1995, 2001). Their results showed significant effects of treatment on awareness, of awareness on intake (as measured by a multiple-choice post-test), and, not surprisingly then, of treatment on intake. Both explicit instruction and rule-search made a significant difference for awareness, but only awareness at the level of understanding made a significant difference for intake, and only the group with neither explicit instruction nor rule-search showed significantly less awareness than the other treatment groups.

In conclusion, all laboratory studies that involve a direct comparison of implicit and explicit learning conditions show an advantage for explicit learning, except perhaps where that learning is inductive (Robinson's, 1996, rule-search condition). Explicit induction worked better in Rosa and O'Neill's – instruction, + rule search group than in Robinson's rule-search condition, probably because of a more advantageous ratio between rule difficulty and learner sophistication (see section 4). The evidence from laboratory experiments, then, is overwhelmingly in favor of explicit learning. It should be taken into account, however, that nearly all these studies are of rather short duration; DeKeyser's (1995) study provided the longest treatment (about 12 weeks). Therefore, it could be argued that this body of literature based on laboratory experiments is biased against implicit learning.

3.2 *Classroom studies*

Very few studies have compared otherwise identical implicit and explicit treatments in a real classroom setting. In fact, Norris and Ortega (2000) identify only three, to which one older study can be added.

Scott (1989, 1990) conducted two very similar experiments with college students of French as a foreign language. In both studies, an explicit group was presented with rules about relative pronouns and the subjunctive, without any practice, while an implicit group read a text flooded with relevant forms (in the 1990 study this group was told about the presence of the forms in the text). Both studies showed a significant advantage for the explicit group on written post-tests; the 1989 study also included an oral post-test, which consisted of only five items, and did not yield any significant differences. Neither treatment condition appears very realistic, as the explicit condition subjects never received any practice, and the treatment was too short for implicit learning to work.

VanPatten and Oikkenon (1996) appears to be another study comparing implicit and explicit treatments, but does not really make that comparison upon closer inspection. Three groups were compared: explicit information only, structured input only (including comprehension exercises and feedback), and "regular processing instruction," the latter being a combination of explicit explanation, systematic practice, and explicit feedback referring back to the rules. Object pronouns in Spanish as a foreign language were the target of instruction. On the production post-test, the results were as follows: the most explicit group (regular processing instruction) did best, followed by the structured input group and the explicit information only group. (The post-test difference is largely due to pre-test differences, though; gain scores for the three groups were not significantly different.) On the comprehension post-tests, the results were similar, except that the first two groups virtually coincide, leaving the third far behind. VanPatten and Oikkenon conclude from these results that it was structured input and not explicit information that was helpful to the learners, but it is clear from their description of the treatments that the structured input group must also have engaged in explicit learning. Even though learners in this group were never given the rules, they were constantly given yes/no feedback, which must have led them to figure out the system (it boils down to a simple morphological alternation). Rather than an implicit group, then, this is an explicit inductive group. On the other hand, the explicit information group was never given any relevant practice; its poor results, then, are comparable to those of the "grammar group" in N. Ellis (1993). In other words, instead of an explicit and an implicit treatment, there was a good explicit-inductive and a poor explicit-deductive treatment. The order of performance of the three groups, then, is as one would expect: good explicit-deductive ("processing"), good explicit-inductive ("structured input"), and poor explicit-deductive ("explicit information only").[3]

One older study should be mentioned in this context. The Swedish GUME project is often quoted as evidence that global methods do not make a difference. Initial results, reported in Levin (1969), indeed showed no difference between implicit and explicit treatments for teaching three different ESL structures to 14-year-old Swedish students. Follow-up studies, however, yielded different results: "The Explicit method was almost uniformly superior at all age, proficiency, and aptitude levels, i.e. the difference in learning effect between the methods was the same irrespective of type of learner" (von Elek and Oskarsson, 1973, p. 39; cf. also Oskarsson, 1973).

Just as for the laboratory studies, then, we can conclude that the classroom studies that have focused narrowly on the implicit/explicit distinction have shown an advantage in explicit learning (Scott, 1989, 1990; von Elek and Oskarsson, 1973), or not really made an implicit/explicit comparison (VanPatten and Oikkenon, 1996). The evidence is very scant, however; surprisingly few studies have made this narrowly focused but essential comparison in a classroom context.

Both for the laboratory studies and the classroom studies, it should be pointed out that the dependent variable has always been a test that allows for some degree of monitoring of explicit knowledge. Even though there was some time pressure in various studies (de Graaff, 1997; DeKeyser, 1995; N. Ellis, 1993; Robinson, 1996, 1997), this probably merely made the use of explicit knowledge more difficult, and not impossible. The development of explicit declarative knowledge into fully implicit, automatized procedural knowledge takes more time than any of these studies allowed for. DeKeyser (1997), however, is a fine-grained analysis of how explicit knowledge of second language grammar rules can be gradually automatized through prolonged systematic practice.

3.3 *The use of implicit and explicit L2 knowledge*

Several studies since the early 1980s or so have investigated in some detail the role that implicit and explicit knowledge play in language use. An early example is Bialystok (1979). This often-quoted study involving 317 students of French as a second language showed that L2 learners at various levels of proficiency were equally good at making grammaticality judgments under time pressure (maximum three seconds allowed) and under more relaxed conditions. Only when they had to make more detailed judgments about what part of the sentence was problematic or what rule was violated did time pressure make a difference. Bialystok inferred from these data that learners make their grammaticality judgments on the basis of implicit knowledge, and only switch to the use of explicit knowledge when more fine-grained decisions are required. As mentioned in sections 2.5 and 3.2, however, time pressure makes the use of explicit knowledge harder, but does not exclude it completely. This is especially important as the learners in this study were relatively advanced, and as the mistakes in the incorrect sentences were rather elementary. It remains to be seen to what extent the results would generalize to more challenging grammaticality judgments or to situations with more extreme time pressure.

Also well known is Green and Hecht's (1992) large-scale study of the role that rules played in grammaticality judgments and sentence corrections made by 300 German students of English as a second language at various stages of learning, and in various school systems. The researchers found a rather low correlation between rule knowledge and ability to correct (and the degree of causality was probably even lower). Some of their figures, however, are open to reinterpretation. For instance, they show that in 43 percent of cases students could make a correction without knowing the relevant rules, but the researchers do not point out that students could often guess corrections (elements to be corrected were underlined, and many rules were dichotomous). On the other hand, at least some of their figures *do* suggest a rather strong correlation between rule knowledge and ability to correct. Where students knew the correct rules, they could correct the sentence 97 percent of the time; where they knew an "incorrect" (potentially just incomplete or very clumsily formulated) rule, they could correct 70 percent of the time; and where they knew no rule, they corrected 55 percent of the time. Most importantly, however, this study may be an instance of differential sensitivity of the testing to implicit and explicit knowledge (see section 2.5). Implicit knowledge is overestimated because guessing corrections is very easy for many items, while explicit knowledge is underestimated, because learners find it hard or impossible to formulate, even when it does help them in deciding between competing forms.

Han and Ellis (1998) used a very different methodology to get at the same question. They factor-analyzed a series of tests (oral production, grammaticality judgment, metalinguistic knowledge, TOEFL, SLEP), and found two factors that could be interpreted as implicit and explicit. Their results are hard to interpret too, however, because, as they make clear themselves, none of their tests is a pure measure of either implicit or explicit knowledge. Moreover, the results are of doubtful generalizability, because only one structure was at issue (verb complements), and this happens to be a case where it is very hard to formulate a rule, which puts explicit knowledge at a clear disadvantage.

More positive evidence for the role of explicit knowledge comes from Hulstijn and Hulstijn (1984), who found that learners of Dutch as a second language performed significantly better on word order rules in a story retelling task when they had explicit knowledge of these rules than when they did not. These results obtained for all the combinations of the experimental variables (+/− focus on grammar × +/− time pressure).

These four studies have all dealt with grammaticality judgments or other focused tests. It is, of course, well known that, in more spontaneous performance, the gap between explicit knowledge and use may be even bigger. An interesting recent illustration, for instance, is found in Macrory and Stone (2000). After four or five years of French in a British secondary school, students were found to have a fairly good grasp of the morphology of the French present perfect tense in the sense of being able to provide explicit rule statements or scoring highly on a discrete-point gap-filling test, but to omit the auxiliary most of the time in spontaneous discourse, except in largely formulaic utterances (cf. also Myles, Hooper, and Mitchell, 1998, on chunk learning of French verb forms in British secondary schools).

The literature reflects two diametrically opposite perspectives about how the second language teaching profession should deal with this gap between explicit knowledge and use. One point of view is often associated with Krashen (e.g., 1982, 1985, 1994, 1999), who posits that the results of (explicit) "learning" can never lead to implicit ("acquired") knowledge, and that the role of L2 instruction should really be to provide large quantities of comprehensible input for implicit learning ("acquisition"), not to provide explicit rules and systematic practice of these rules. In other words, in this view the gap cannot be bridged, or "learned competence does not become acquired competence" (Krashen, 1985, pp. 42–3). This view is often referred to as the non-interface position.

The other point of view is represented by, among others, DeKeyser (1997, 1998), Hulstijn (1995, 1999), McLaughlin (1978, 1990; McLaughlin and Heredia, 1996), Schmidt (e.g., 1990, 1994, 1995; Schmidt and Frota, 1986), and Swain (1985; Swain and Lapkin, 1995), who see explicit learning and practice as useful for at least some rules. In this view it is the role of practice to gradually bridge the gap between explicit knowledge and use. An intermediate point of view is that of proponents of focus on form, not focus on forms (cf., e.g., Doughty and Williams, 1998; Long and Robinson, 1998): learners are made to notice a feature of the input, in other words they become explicitly aware of a structure, but the focus-on-form techniques themselves (such as input enhancement) are not necessarily explicit. Another intermediate point of view is taken by R. Ellis (e.g., 1997, ch. 7), who argues that the role of explicit learning is really to help learners notice the gap between input and their own production, while the goal of systematic practice is limited to item learning and the improvement of fluency.

Unfortunately, very little empirical evidence exists that systematically documents the change of L2 knowledge as a result of practice over a long period of time. Studies on the role of different kinds of practice, such as Allen (2000), DeKeyser and Sokalski (1996), Robinson (1997), Salaberry (1997), VanPatten and Cadierno (1993), and VanPatten and Oikkenon (1996) all deal with short-term practice. DeKeyser (1997), however, traced students' performance on systematic comprehension and production exercises over a two-month period, and found the same learning curves in terms of error rate and reaction time that have been documented for a variety of cognitive domains outside of language learning. He also found the practice effect to be largely skill-specific (comprehension or production). DeKeyser concludes from these findings that "the ability to comprehend or produce sentences is not necessarily acquired through the implicit mechanisms of a separate mental module" (1997, pp. 211–13).

Krashen argues that DeKeyser's (1997) findings "only confirm that in his study we are dealing with learning, not acquisition" (1999, p. 253), that is, explicit not implicit learning. The point, however, is not whether students' (initial) learning was explicit; it clearly was, as DeKeyser (1997) makes clear. The point is whether the declarative knowledge that results from explicit learning processes can be turned into a form of procedural knowledge that is accessible in the same way as implicitly acquired knowledge. How one looks upon this issue depends in part on one's definition of "acquired" knowledge. If one takes lack of awareness to be as crucial for "acquired" knowledge as for implicit learning, then the end product of the learning process documented in

DeKeyser cannot be called implicit, as students are still aware of the rules. If, however, the criterion for "acquired" knowledge is that it be available with the same degree of automaticity as implicitly acquired knowledge, then it is not clear why the end product of automatization processes as documented in DeKeyser (1997) could not be considered "acquired." Moreover, it is quite possible that, after large amounts of communicative use and complete automatization of the rules, learners eventually lose their awareness of the rules. At that point they not only have procedural knowledge that is functionally equivalent to implicitly acquired knowledge, but even implicit knowledge in the narrow sense of knowledge without awareness.

This perspective is completely consistent with the general literature on cognitive skill acquisition (see, e.g., Anderson and Lebiere, 1998; DeKeyser, 2001) and implicit knowledge (see, e.g., Buchner and Wippich, 1998; Reed and Johnson, 1998). Moreover, there is no evidence in the second language acquisition literature that explicit learning and practice cannot lead to automatized procedural knowledge, only a dearth of evidence that it can – and the latter is not surprising as very little research has even tried to document automatization processes in L2. (Relative) absence of evidence is not evidence of absence.

3.4 Connectionist models of SLA

An overview of the empirical literature on implicit and explicit L2 learning and knowledge would not be complete without mentioning the small but growing body of work on connectionist modeling (see also Ellis, this volume). Connectionists claim that the linguistic knowledge usually represented by rules can be represented equally well or better by low-level associations between concrete forms, and that this is how humans actually represent such knowledge. This view, of course, makes the debate over implicit/explicit learning of rules moot; there are no rules in the connectionist concept of knowledge, only statistical associations between input and output patterns, and all knowledge is acquired and represented completely implicitly.[4] In the L1 literature, much of the debate for and against connectionism has focused on the past tense of English verbs (see, e.g., Rumelhart and McClelland, 1986, and Elman et al., 1996, for the connectionist viewpoint; Pinker, 1999, and Pinker and Prince, 1988, for the critique; and Jaeger et al., 1996, for an attempt at providing neurological evidence). The connectionist literature on L2, however, has largely been limited to gender assignment in French.

Sokolik and Smith (1992) showed how a system trained on a set of noun/gender pairings could generalize to new words with 75 percent accuracy after just five cycles through the learning set; apparently the system had become sensitive to the cues to gender present in the word endings. The Sokolik and Smith (1992) experiment has been criticized on a number of grounds. S. E. Carroll (1995), for example, pointed out that, unlike a human being, the model does not have to learn that French has gender, that only nouns have gender, and there are only two gender classes. Matthews (1999) carried out a series of experiments that strongly suggest that what happens in his (and by extension Sokolik and Smith's) model is mere memorization of the gender of specific nouns rather than the learning of phonological cues. More importantly, however, from the point of view of an SLA researcher, it is hard to take the Sokolik and Smith model as representative of the differences between L1 and L2 acquisition. The researchers formalized the difference between L1 and adult L2 by (i) zero initial weights for input/output connections for L1 and random initial weights for L2, and (ii) a slower learning rate for L2 than for L1. Neither of those formalizations seems realistic: (i) even if L1 influence could possibly be modeled as a set of pre-existing weights, it could hardly be argued that the pattern would be random, and (ii) slower learning is not characteristic of adult L2. On the contrary, adults learn faster initially, but are limited in ultimate attainment (see, e.g., Slavoff and Johnson, 1995).

For the time being then, researchers interested in how cues to French gender and similar fuzzy patterns can be learned in L2 will probably benefit more from studies with human learners. Tucker, Lambert, and Rigault (1977) show how native speakers are sensitive to phonological cues in the stem and use this knowledge to assign gender to new words; they also show, however, that native speakers are not explicitly aware of these cues. Holmes and Dejean de la Bâtie (1999) even provide experimental data which suggest that word endings are not the primary basis for gender attribution by native speakers, who seem to rely more on lexical associations. The data for L2 learners, however, suggest that the latter are more sensitive to word endings. S. E. Carroll (1999), on the other hand, conducted an experiment which "lends no support to the hypothesis that beginning anglophone learners of French are sensitive to or encode phonological patterns in stimuli that they then map onto gender classes" (p. 72). It should be pointed out, however, that the short duration of the experiment would bias in favor of the (explicit) learning of the semantic and morphological cues and against the (implicit) learning of the less salient phonological cues.

In conclusion, while L1 speakers can largely ignore phonological cues for existing words because they have memorized the gender of all but the rarest individual words, L2 learners have more of a need for such cues (Holmes and Dejean de la Bâtie, 1999). As they do not seem to pick these cues up very easily (S. E. Carroll, 1999), it may be useful to teach (at least the most common and reliable) cues explicitly, as Tucker, Lambert, and Rigault (1968) have already suggested on the basis of an experiment with college students of L2 French. (For further discussion of the learning of protypicality patterns, see section 4.)

Beyond the issue of the possible representation of French gender or other prototypicality patterns in advanced learners, it is not clear what connectionist models can contribute to a theory of second language learning at this point. While it appears to be true that the changes that take place in more advanced stages of L2 learning can often be modeled as a gradual change in sensitivity to different cues (see, e.g., MacWhinney, 1997), this does not mean that later stages of learning *have* to proceed this way, and certainly not that *initial* learning should also be a matter of implicit acquisition of sensitivity to these cues.

It is perfectly possible that, for many learners and many rules, the explicit learning of declarative rules and systematic practice to proceduralize them is a very convenient short cut to the point where connectionist-type fine-tuning of procedural knowledge can begin.

4 Which Learning for Which Elements of Language?

As indicated in sections 3.1 and 3.2, a modest number of studies have made comparisons between implicit and explicit learning for very specific structures (e.g., English dative alternation in Robinson, 1997; French relative pronouns and subjunctive forms in Scott, 1989; Welsh consonant mutation in N. Ellis, 1993). To some extent these studies give an idea of the range of structures that might be better learned explicitly than implicitly. Few empirical second language acquisition studies, however, have directly addressed the issue of differential effectiveness of implicit and explicit learning as a function of the nature of the element of grammar to be learned.

Both Reber (e.g., 1976, 1993; Reber et al., 1980) in cognitive psychology and Krashen (e.g., 1982, 1994) in applied linguistics have repeatedly argued that implicit learning is particularly advantageous for complex structures. As such structures are hard to grasp explicitly for most people – and can be impossible to grasp for many, especially without instruction – it is not surprising that implicit learning, however fragile it may be (see above, especially section 2.6), will show a relative advantage for such structures. Robinson (1996) did indeed find that implicit induction was second best out of four conditions and explicit induction worst out of four for hard rules, while the implicit condition was the worst out of four for easy rules. Hard rules involved pseudo-clefts of location and easy rules the optional subject–verb inversion after adverbials in English.

Drawing on what we know about the various roles of instruction in general for L2 acquisition (cf. especially Long, 1983, 1988; Long and Robinson, 1998), on Schmidt's (1990, 1994, 1995, 2001) hypothesis that noticing, but not necessarily understanding, is important for L2 acquisition, and on recent evidence that instruction is important to enhance subsequent noticing (Peckham, 2000), one can hypothesize different degrees of usefulness of explicit teaching for different levels of difficulty, as shown in table 11.1. It is important to note, however, that rule difficulty is an individual issue that can be described as the ratio of the rule's inherent linguistic complexity to the student's ability to handle such a rule. What is a rule of moderate difficulty for one student may be easy for a student with more language learning aptitude or language learning experience, and therefore the role of instruction for that element of grammar may vary from bringing about the learning of a structure that otherwise would not be learned to merely speeding up the learning process. Conversely, for a weaker student, the goal may not be to get the student to learn the rule at

Table 11.1 The role of instruction for rules of various levels of difficulty

Rule difficulty	*Role of instruction*
Very easy	Not useful (not necessary)
Easy	Speeding up explicit learning process
Moderate	Stretching ultimate attainment
Difficult	Enhancing later implicit acquisition by increasing chances of noticing
Very difficult	Not useful (not effective)

issue, but to draw enough attention to the forms involved so that the student will notice them more at some level and at least implicitly acquire some concrete uses of these forms through subsequent exposure rather than acquire the more abstract rule during instruction. Thus, for one and the same rule, the goal as well as the degree of effectiveness of explicit instruction will vary depending on the *subjective difficulty* of the rule.

A further complication, besides individual differences, is the fact that the *objective difficulty* of the rule itself is more than simply a matter of complexity. Novelty and abstractness of semantic categories also play a big role (e.g., in learning aspect, articles, or classifiers), as well as salience. DeKeyser (2000), for instance, argued that subject–verb inversion in yes-no questions is easily learned explicitly because of its salience, in contrast with subject–verb inversion in *wh*-questions. Bardovi-Harlig (1987) found that preposition stranding was learned before pied piping in L2 English, in spite of it being more marked, because it is more salient.

Hulstijn (1995; Hulstijn and de Graaff, 1994) hypothesizes an even wider variety of factors in determining when explicit rule learning is effective, among others complexity, UG status, subset–superset relationships, scope and reliability of the rule, semantic redundancy, and the possibility of item learning. De Graaff (1997) tested (the implications of) two of these hypotheses in his experiment with Dutch learners of a semi-artificial language ("eXperanto"). While the hypothesized interaction of implicit vs. explicit condition with complexity was partially confirmed (i.e., for syntax only and not for morphology), the hypothesis that there would be an interaction between implicit vs. explicit learning and morphology vs. syntax was not. The latter hypothesis was formulated because morphology was assumed to be more amenable to item learning than syntax.

DeKeyser (1995) made a distinction *within* morphology, which *did* interact with implicit vs. explicit learning. In an experiment with four morphological rules in an artificial language, he found that clear-cut categorical rules were learned much better in an explicit condition (which included traditional rule presentation along with picture/sentence pairs), whereas fuzzy prototypical rules, similar to the ones documented for English past tenses by Bybee and

Slobin (1982; see also Bybee and Moder, 1983), were learned slightly better in an implicit condition (involving exposure to picture/sentence pairs but no grammar explanation).

Williams (1999) also found an interaction between implicit/explicit learning and a distinction within morphology. In a series of experiments with native speakers of English learning pseudo-Italian, he found that the learning of (semantically redundant) agreement rules correlated strongly with various measures of memory, whereas the semantically non-redundant rules for marking plural on the noun or person on the verb usually did not correlate with these memory measures. Williams interpreted correlations between learning and memory as evidence of rather passive, implicit, "data-driven processes."

In comparing the findings from DeKeyser (1995) and Williams (1999) it is important to point out that the agreement rules in Williams's experiments all came down to euphony. What is being learned implicitly then, besides segmentation into morphemes, is concrete sound–sound correspondences, for instance the association of various occurrences of *–i* throughout the noun phrase (when article, noun, and adjective all mark the masculine plural). What was learned relatively well in the implicit condition in DeKeyser (1995) was also a concrete association between certain stems and certain allomorphs that go with those stems. Likewise, both the categorical rules in DeKeyser (1995) and the form–function mappings in Williams (1999) involve the learning of a more abstract pattern: associating certain morphemes with the semantic function not otherwise visible in the same phrase, and taking a different concrete form in the other (noun vs. verb) phrase. The two studies may have more in common, then, than would seem at first sight. Even though DeKeyser elicited implicit vs. explicit learning experimentally, while Williams inferred the learning processes from the results (correlations with memory), and even though Williams makes a distinction between form–function mapping and agreement, while DeKeyser distinguishes categorical rules and prototypical patterns, both studies show that implicit and explicit learning processes are differentially effective for the learning of abstract and concrete elements.

This finding is reminiscent, of course, of the position that a number of cognitive psychologists have taken, viz. that implicit learning is necessarily rather concrete, and that really abstract learning is necessarily explicit (see especially Gomez, 1997; Perruchet and Pacteau, 1990, 1991; Reed and Johnson, 1998). It also fits in with the finding of Saffran et al. (1997) that word boundaries in an artificial language were learned completely implicitly and incidentally by children as well as adults (through exposure to a tape-recording playing in the background while the subjects were engaged in a drawing task). As word boundaries can be learned merely on the basis of transitional probabilities between syllables, they are another example of implicit learning at its best: through association of concrete elements in close proximity.

This conclusion that implicit learning is best for the association of concrete elements in close proximity is not contradicted by the finding in N. Ellis and Schmidt (1997) that distant agreement in an artificial language was more correlated with memory than local agreement. The elements to be associated were still very concrete invariant morphemes, and the distance intervening between the words to be associated was one or two words. Clearly, as the burden on memory goes up with longer distances, the correlation with memory measures will go up till eventually the link between two morphemes becomes too difficult for associative memory to establish, and at that point the correlation between learning and memory measures will disappear. (See the findings from Cleeremans and McClelland, 1991, Mathews et al., 1989, and St John and Shanks, 1997, reported earlier, which show the limitations of implicit learning in this respect.)

In conclusion, abstractness and distance play a major role in the differential effectiveness of implicit and explicit learning, along with rule scope, rule reliability, and salience. The harder it is to learn something through simple association, because it is too abstract, too distant, too rare, too unreliable, or too hard to notice, the more important explicit learning processes become.

5 Age and Context Differences

It has often been hypothesized that children and adults use very different mechanisms for (second) language learning. The most elaborate formulation of this idea is to be found in Robert Bley-Vroman's (1988) Fundamental Difference Hypothesis. In order to explain a variety of observed differences in strategy and success between children and adults, Bley-Vroman posits that children use Universal Grammar and domain-specific learning procedures, while adults draw on native language knowledge and general problem-solving systems. Even though Bley-Vroman does not use the terms implicit and explicit, his distinction largely coincides with this dichotomy. Children's use of Universal Grammar and language-specific learning mechanisms happens outside of awareness, while adults can use their analytical abilities to think at least to some extent about the structure of the L2 (and its differences with L1).

Adults vary widely in their (verbal) analytical abilities, of course, and many studies have shown a strong correlation between such abilities, either in the broader sense of verbal intelligence or in the narrower sense of language learning aptitude (cf., e.g., J. B. Carroll, 1981, 1990; Sasaki, 1993; Skehan, 1989, 1998; Wesche, Edwards, and Wells, 1982; for recent overviews see Sawyer and Ranta, 2001, and Skehan, 1998). For children much lower correlations between aptitude and L2 learning have been found. Harley and Hart (1997), for instance, showed that analytic ability was not a significant predictor of second language proficiency for students who entered an immersion program in grade 1, while it was the only significant predictor of the same second language proficiency measures for students who started in grade 7. Harley and Hart (1997) left open the possibility that this may have been due to the degree of attention to form in the latter program, but other research (DeKeyser, 2000; Harley and Hart, 2002; Reves, 1982, quoted in Skehan, 1998) has shown that aptitude is a significant predictor of proficiency in naturalistic learning contexts too. DeKeyser (2000) focused on the interaction between age and aptitude in a study with Hungarian immigrants to the United States, showing that age was a significant predictor of proficiency for lower- but not for higher-aptitude learners, and that aptitude was a significant predictor for older, but not for younger learners. Such age differences in predictive validity of aptitude certainly fit with the hypothesis that adults learn largely explicitly, while children learn implicitly. DeKeyser (2000) argues that this is how the critical period hypothesis ought to be understood: somewhere between early childhood and puberty children gradually lose the ability to learn a language successfully through implicit mechanisms only. Skehan (1998, p. 234) also sees the close of the critical period as the end point of the separation between linguistic processing and general cognition.

The shift during childhood from implicit to explicit processes explains the two main findings about age differences in second language learning: children learn better and adults learn faster (for recent overviews, see Birdsong, 1999; Harley and Wang, 1997; Marinova-Todd, Marshall, and Snow, 2000). Children do better in terms of ultimate attainment because many elements of language are hard to learn explicitly (especially, of course, for those adults who have limited verbal ability); adults learn faster because their capacities for explicit learning let them take short cuts. As a result, given ample time in an unstructured environment, children come out on top. In a traditional school context, however, where time is limited and learning is highly structured, adults and older children learn more in the same amount of time. Muñoz (2001), for instance, recently demonstrated how, after the same number of EFL classroom hours in Barcelona, older learners (starting at age 11) performed better on a variety of tests than younger learners (starting at age 8). Particularly interesting in this context is also the finding from the GUME Project (von Elek and Oskarsson, 1973) that with an implicit method, children learned more than adults, while with an explicit method, adults learned more than children.

Such age differences have important practical implications that are often misunderstood. Rather than suggesting the importance of starting early, they indicate that the instructional approach should be different depending on age: full-scale immersion is necessary for children to capitalize on their implicit learning skills, and formal rule teaching is necessary for adolescents and adults to draw on their explicit learning skills.

6 Conclusions and Future Directions

In spite of a large body of sophisticated research, cognitive psychologists have not been able to provide convincing evidence that people can learn abstract patterns without being aware of them. The learning that takes place in artificial grammar and sequence learning tasks is not only quantitatively limited in the sense that subjects perform barely above chance; it also seems qualitatively limited to rather concrete patterns of contiguous elements, or accompanied by some kind of awareness, or both.

SLA researchers have similarly failed to show any significant learning of abstract patterns without awareness. At least one experiment has shown specifically that no abstract patterns were learned implicitly in spite of thousands of exposures to relevant examples of simple rules (DeKeyser, 1995). Several others have shown not only that explicit learning, especially deductive, is significantly more effective than implicit learning, but also that any learning that takes place in the "implicit condition" is often due to failure of the learners to stick to the instructions for implicit learning; thus their (partial) learning is the result of (partial) awareness (e.g., Robinson, 1996). Furthermore, L2 studies that have dealt with broader variables such as focus on form have provided evidence for the advantage of such focus compared to mere exposure or focus on meaning; the most likely interpretation of such research is that focus on form is necessary to make learners consciously notice the abstract patterns that are not easily learned implicitly.

It is only fair to say, however, that the amount of L2 research narrowly focused on the implicit–explicit distinction is, first, quite limited, not only in number of studies, but also in duration and in scope of the learning target. Second, most of this research has been conducted in laboratory studies of limited ecological validity rather than in classrooms, and no studies exist that trace the role of implicit and explicit learning longitudinally in untutored second language acquisition.[5] Third, the criterion measures invariably tend to be very constrained, involving grammaticality judgments or fill-in-the-blank tests rather than freely constructed discourse. Finally, while the criterion measures appear constrained and artificial from the point of view of the applied linguist or language teacher, they are far from being constrained enough to meet the methodological requirements identified in the psychological literature for guaranteeing pure implicit/explicit learning or for yielding a pure measure of implicit/explicit knowledge (see section 2.5). Nor has the issue of abstractness of knowledge been given much attention, except in one or two studies. How then can the field of SLA make progress toward a better understanding of a question of such fundamental importance both to theories of acquisition and to language teaching practice?

Clearly we cannot just extrapolate findings about AGL to SLA. A number of researchers have discussed the strong limits on the generalizability of AGL research (e.g., DeKeyser, 1994, 1995; Schmidt, 1994, 1995; VanPatten, 1994). We need to conduct research on actual second language learning, but what kind? The usual trade-off between internal and external validity is felt particularly strongly when the (operational) definition of what constitutes a treatment is as contentious as in the field of implicit learning. If hard-core experimental psychology cannot provide sufficient rigor to guarantee "pure" learning conditions, then how are we to attain such standards in more realistic contexts, where the whole grammar of a real second language is learned rather than a finite-state grammar that can be fully described on a square inch of paper, and where learners have a myriad of uncontrollable experiences in and out of the classroom before, during, and after the treatment?

Three different options exist. One is to conduct very narrow experiments, under strictly controlled conditions (probably by a computer), with very small fragments of a (real or made-up) second language. This can satisfy the cognitive psychologist, and maybe the SLA researcher, but probably not the applied linguist interested in classroom applications (see DeKeyser, 1997; N. Ellis and Schmidt, 1997; and especially Hulstijn, 1997; Yang and Givón, 1997, for further discussion of laboratory research on SLA). A second option is to conduct more realistic experiments, in actual classrooms, with much larger fragments of a language that the students are not just learning for the sake of the experiment, but making an effort to control the treatments more than is usually the case in classroom research. This may satisfy educational psychologists and applied linguists, and maybe classroom-oriented SLA researchers, but not cognitive psychologists. A third approach is to try to compromise even more than the previous two options already do, and to try to provide longer, broader, more varied, and therefore more realistic treatments than previous laboratory experiments, but to conduct the research in a more strictly controlled environment than a real classroom, either through an entirely computerized mini-curriculum or with specially designed materials, carefully trained teachers, and hand-picked students. I personally favor the third option, but certainly feel that the other two options are valuable to provide different pieces of the mosaic and to convince people with different disciplinary backgrounds.

Regardless of which option future researchers choose, however, they will have to come to grips with the issues discussed in section 4. We cannot keep generalizing about the psychology of SLA on the basis of a few structures in a few languages, but instead have to make a concerted effort to vary learning targets systematically along psycholinguistically relevant dimensions. Studies such as de Graaff (1997), DeKeyser (1995), Robinson (1996), and Williams (1999) already show the value of this approach, but much work remains to be done to define and operationalize concepts such as abstractness, complexity, contiguity, and difficulty in a way that will maximize the likelihood of detecting interactions between implicit/explicit learning processes and structural characteristics of learning targets.

Furthermore, we cannot ignore the interaction of both learning conditions and linguistic features with learners' aptitudes. Not only is the study of aptitude–treatment interactions of great potential value for educational practice (see, e.g., for educational practice in general, Corno and Snow, 1986; Cronbach and Snow, 1977; Jonassen and Grabowski, 1993; and for second language teaching, McLaughlin, 1980; Sawyer and Ranta, 2001; Skehan, 1989, 1998), but the study of the three-way interaction between aptitudes, treatments, and psycholinguistic features of the learning targets can provide much more insight into all three of these factors than the study of any one of them in isolation can hope to accomplish. Again, studies such as Robinson (1996) and Williams (1999) hold great promise in this regard (see box 11.1).

Box 11.1 Robinson (1996) and Williams (1999)

Robinson (1996)

Main research questions: Will implicit and incidental treatments yield similar results? Will rule search and instructed conditions similarly pattern together? Will complex structures be learned better by the implicit and incidental groups?

Subjects: One hundred and four intermediate ESL students (95 Japanese, 5 Chinese, 5 Korean).

Independent variables: Between subjects: four conditions (implicit, incidental, rule-search, instructed). Within subjects: simple vs. complex rules.

Dependent variables: Speed and accuracy of response in grammaticality judgment test for pseudoclefts of location (hard rule) and subject–verb inversion after adverbials (easy rule).

Results: Implicit/incidental learners do not outperform other learners on complex rules, but instructed learners outperform all others for simple rules.

Williams (1999)

Main research questions: What is the relationship between memory for input and inductive learning of morphological rules?

Subjects: Fifty-eight British university students (divided over three experiments).

Independent variables: Real vs. pseudo-Italian (the latter with random suffixes), typographical enhancement vs. control, memory performance during training.

Dependent variables: Agreement and form–function mapping on translation post-test.

Results: The findings are complex, but the correlations between memory during training and performance on the translation post-test suggest that agreement rules are largely the result of data-driven (implicit) learning, while form–function mappings result from conceptually driven (explicit) learning. (See section 4 for further discussion, as well as box 19.1 in this volume for more information on other aspects of this study.)

Comments

Robinson (1996) is particularly interesting because of its comparison of multiple treatments for different kinds of structures, which in this case showed an unexpected grouping of treatments, and an interaction between treatments and rule types. Far too often overly general conclusions are drawn from overly broad operationalizations of treatments and overly narrow operationalizations of learning targets.

Williams (1999) is very interesting because of the contrasting methodology. Instead of trying to control different learning processes experimentally through instructions and stimuli, Williams inferred them from the post-test correlations with different aptitude measures.

Both Robinson (1996) and Williams (1999), then, provide a more complete picture than many other studies by looking at the interaction between different learning processes, aptitudes, and L2 structures, but they do this in very different ways.

A disadvantage that both studies share with practically all other research that compares implicit and explicit L2 learning is the short duration of the treatment and the lack of ecological validity from the point of view of regular classroom teaching. Combining experimental rigor with ecological validity is an elusive goal in educational research. We agree with Kasper and Dahl (1991) that ecological validity should not be a sacred cow, but treatments of longer duration are desirable because shorter treatments are biased in favor of explicit learning.

Finally, the time may have come for SLA researchers to be more ambitious in their attempts to contribute to cognitive science. Prominent cognitive psychologists say that they "know of no comprehensive treatment of the role of consciousness at various stages of learning" (Carlson, 1997, p. 63), and advise researchers to "focus on the differential effects of implicit and explicit orientations on learning, rather than on attempts to demonstrate that learning is implicit in some absolute sense" (Stadler and Roediger, 1998, p. 107). We should not be too reluctant, then, to try to document the role of such different orientations in various aspects of the L2 learning process. This would provide cognitive science with a context that is not only more realistic than AGL or sequence learning experiments, but if we are lucky, may turn out to yield results that are easier to interpret too.

NOTES

1 For an excellent study on the interaction of rules and examples outside of the language domain, see Anderson, Fincham, and Douglass (1997).

2 It should be pointed out, however, that the learners in the + orientation/ – detection condition (crossword puzzle two) were implicitly given the wrong information about the irregular verb forms, which makes for a strange comparison.

3 VanPatten and Oikkenon (1996, p. 507) explicitly reject the role feedback could have played for the structured input group, because it was not explicit (metalinguistic). Clearly, given our definition of "explicit" as involving awareness, this lack of metalinguistic explicitness in the feedback does not matter, as long as the feedback brings about awareness by leading the learners to figure out the system inductively.

4 Rumelhart and McClelland (1986, p. 217) even reserve the term "implicit" for connectionist knowledge representation, and call Chomskyan-type rules "explicit inaccessible," in the sense that they are represented in the mind as rules, but without speakers being aware of them as such.

5 Claims have been made that the Tukano tribes in the Vaupes region of Amazonia routinely learn an L2 well

as adults (they can only marry a speaker of a different language). Studies of language among the Tukano (e.g., Sorensen, 1972; Jackson, 1983), however, invariably deal with language as an element of the marriage system and cultural identity, and have never documented learning processes in detail (or exact levels of ultimate attainment, for that matter).

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