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GENERALIZABILITY AND AUTOMATICITY OF SECOND LANGUAGE LEARNING UNDER IMPLICIT, INCIDENTAL, ENHANCED, AND INSTRUCTED CONDITIONS

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This experimental study examines the extent to which 60 adult Japanese ESL learners were able to acquire a rule regulating the argument structure frames of novel verbs of English after exposure to grammatical examples of sentences containing the verbs. Training took place under conditions with no focus on form (implicit and incidental conditions) and with focus on form (enhanced and instructed conditions). The presentation of instances during training was manipulated as a test of predictions made by Logan's (1988, 1990, 1992) memory-based *instance theory* of automaticity. Results measured in reaction times show similar slopes for automaticity on trained examples in each condition but significant differences in the extent of learning, with the focus on form conditions outperforming the no focus on form conditions in transfer of learned knowledge to accurate judgments of new ungrammatical sentences. Implications are drawn from the results regarding the acquisition of rule-based versus memory-based knowledge from exposure to stimuli in each training condition and the influence of this knowledge on decision-making about grammaticality during the transfer task.

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This paper describes an experimental study of SLA motivated by three current lines of research in cognitive psychology and SLA theory, with the aim of contributing to an increased understanding of the learning processes activated by exposure to second language (L2) input under four training conditions. These conditions are an *implicit* condition, in which subjects are encouraged to remember instances of input; an *incidental* condition, in which subjects are encouraged to process input for meaning; an *enhanced* condition, in which subjects are encouraged to process input for meaning while simultaneously noticing selected features of the form of input; and an *instructed* condition, in which subjects are taught rules regulating the input and are encouraged to apply them to examples. The three lines of research that motivate the research hypotheses for differences in the nature and predicted extent of learning under each training condition concern (a) the relative effectiveness of learning under conditions with a conscious focus on form versus learning in conditions with no focus on form (Doughty, 1991; Doughty & Williams, 1996; Leeman, Arteagoitia, Fridman, & Doughty, 1995; Long, 1988, 1991; Long & Robinson, 1996; Schmidt, 1990, 1995); (b) the development of automaticity in learning as a function of exposure to multiple instances of input (Logan, 1988, 1990, 1992; Logan & Etherton, 1994; Logan & Klapp, 1991; Robinson & Ha, 1993); and (c) the debate over whether decision-making processes operating on the knowledge bases established by learning in each condition, and reflected in the transfer grammaticality judgment task, are memory-based or rule-based (Knowlton & Squire, 1994, 1996; McAndrews & Moscovitch, 1985; Perruchet, 1994; Perruchet & Pacteau, 1990; Reber, 1989, 1993; Robinson, 1996a, 1996b, 1997; Servan-Schreiber & Anderson, 1990; Shanks & St. John, 1994; Vokey & Brooks, 1992). The background and the findings obtained from these lines of research are briefly described below.

THE NOTICING HYPOTHESIS AND FOCUS ON FORM

A number of recent experimental and quasi-experimental studies of the effect of L2 instruction have compared the effects of second language learning under conditions that facilitate a focus on form with learning under conditions that do not (see Long & Robinson, 1996, for a review). One impetus for this research was the observation that naturalistic, uninstructed SLA (see Long, 1988) and immersion programs that provide extensive exposure to comprehensible input without form-focused instruction (see Harley & Swain, 1984; Swain, 1988, 1991; Trahey & White, 1993) do not result in acquisition of a number of features of L2 morphosyntax.

A second impetus to this research has been the theoretical dispute about the role of consciousness during SLA, in the sense of attention to the form of input. Krashen (1981, 1982, 1985, 1994) has argued that two processes operate during SLA, an unconscious process of abstraction called "acquisition" and a conscious process called "learning." Consciously learned knowledge, Krashen claims, is limited to rules that are easy; it can only account for a small part of our knowledge of the L2, and it is limited in its usefulness, serving only to edit the production initiated by the unconscious acquired system. Most SLA, Krashen claims, is the result of unconscious processes (see Gregg, 1984; Larsen-Freeman & Long, 1991; and McLaughlin, 1987,

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for critiques of Krashen's theory). In contrast, Schmidt (1990, 1993, 1995; Schmidt & Frota, 1986) has distinguished three senses of the term "unconscious" as applied to language learning: (a) learning without awareness, (b) learning without intention, and (c) learning without explicit metalinguistic knowledge of what has been learned. Although unconscious learning in the latter two senses is possible, Schmidt argues, learning without awareness in the sense of attentional allocation is not possible and, further (based initially on introspective evidence of his own learning of Portuguese), learning without awareness at the level of "noticing" the form of input is not possible, "The 'noticing hypothesis' states that what learners notice in input is what becomes intake for learning" (Schmidt, 1995, p. 20). Noticing, then, involves the allocation of focal attention and rehearsal in short-term memory and is argued to be a necessary, but not sufficient, condition for SLA (see Robinson, 1995c; Tomlin & Villa, 1994).[1]

Findings from the focus on form research have shown positive short-term effects for a variety of instructional techniques that focus learner attention on form from the provision of pedagogic rules in experimental (Alanen, 1995; DeKeyser, 1995; Robinson, 1996b; Robinson & Ha, 1993) and classroom (Eckman, Bell, & Nelson, 1988; Master, 1994; Spada & Lightbown, 1993) settings to less explicit forms of input enhancement, such as underlining or italicization of targeted instructional forms in reading materials (Doughty, 1991; Leeman et al., 1995; Shook, 1994) that serve to initiate learner noticing and possibly, therefore, following Schmidt's hypothesis, learning. However, certain limits to the effectiveness of these techniques have been observed, such as the interaction between rule complexity and learning. This suggests that conscious rule learning is only effective for categorical rules describing simple patterns of covariance (DeKeyser, 1995; cf. de Graaff, this issue) and that complex pedagogic rules can lead to large-scale overgeneralization (Robinson, 1996b) or that rule instruction without exposure to sufficient examples is ineffective (N. Ellis, 1993). Therefore rule presentation and learning has limitations as a feasible pedagogic technique (Long & Crookes, 1992; Long & Robinson, 1996; Robinson, 1996a, 1996c). Learning via focus on form through input enhancement in the context of meaningful activities has a number of advantages over pedagogic rule learning because, for example, this helps ensure that functional coordinates of language are noticed along with targeted structures. However, although some positive effects for input enhancement versus exposure to comprehensible input alone have been observed (e.g., Doughty, 1991; Leeman et al., 1995; White, Spada, Lightbown, & Ranta, 1991), as Schmidt (1995) points out, such studies typically lack the sensitive measures of awareness that would be necessary to establish a clear causal connection between learner noticing, input enhancement, and learning. Furthermore, it is not clear how or why input-enhancement techniques differ in their facilitation of noticing or to what extent the attentional demands of more complex pedagogic tasks degrade noticing (Robinson, 1995b, 1996c, 1996d).

In contrast to Schmidt, others have maintained that Krashen's acquisition or learning distinction is a valid one claiming unconscious processes are largely responsible for adult SLA, as for child L1 acquisition (Schwartz, 1993; Zobl, 1995) and that the two modes of learning are subserved by distinct memory systems (Paradis,

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1994) and that for SLA to occur all that is necessary is meaningful exposure to positive evidence of grammatical L2 structure (Schwartz, 1993; Schwartz & Gubala-Ryzak, 1992). In line with this position, some have claimed that their studies show evidence of nonattentional learning, or SLA without noticing (Schachter, Rounds, Wright, & Smith, 1996). Similarly, Reber (1989, 1993) has established an influential paradigm of research into the acquisition of rules regulating artificial finite-state grammars and claimed that implicit nonconscious learning, following instructions to simply memorize stimuli generated by the grammar, occurs and is superior to explicit learning, following instructions to consciously search for rules. Whether implicit learning is unconscious, taking place without the subjective experience of noticing the critical aspects of the stimuli to be learned, and is abstract and generalizable to new contexts is an issue disputed by critics who argue implicit learning is simply the result of item-specific memory for instances encountered and noticed during training, rather than abstract, memory-independent rule-based knowledge (see the discussion below).

MEMORY-BASED VERSUS RESOURCE-BASED THEORIES OF AUTOMATICITY

Although the issue of the relation between attention and learning has been the subject of a considerable number of studies in the field of cognitive psychology and SLA, no studies to date have examined the development of automaticity in learning under conscious, focus on form conditions versus conditions with no conscious focus on form. This is a particularly important issue to address for SLA because many have argued that if implicit unconscious L2 learning is possible it is likely to be a slow process (N. Ellis, 1993, 1994; Krashen, 1982, 1985) and consequently automatized over a longer period of time than explicit instructed learning (Long & Robinson, 1996). Furthermore, as Logan (1988, p. 516) points out, in some memory-based theories of automaticity there are few fundamental differences between the processes whereby knowledge becomes automatized and the acquisition of other learned abilities such as categorization. Logan's *instance theory* of automaticity (Logan, 1988, 1990, 1992) proposes a close relation between the two and differs from resource-based theories of the development of automaticity (e.g., Anderson, 1983; LaBerge & Samuels, 1974; Shiffrin & Schneider, 1977; cf. DeKeyser, this issue). Resource-based theories link automaticity with a single-capacity model of attention and describe automaticity as the consequence of gradual withdrawal of attention from a task and the speed-up of control processes under attentional supervision in short-term memory. The basic assumptions of such theories, although often invoked in the SLA literature (e.g., McLaughlin, 1987; McLaughlin, Rossman, & McLeod, 1983; Skehan, 1996; Towell & Hawkins, 1994; VanPatten, 1990), have been challenged by multiple-resource theories of attention (Wickens, 1989) and by memory-based theories of automaticity (see Schmidt, 1992; Strayer & Kramer, 1990, for review).

In particular, Logan's instance theory claims that automatic performance is the result of single-step direct retrieval of previous solutions to a problem from memory.

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Logan argues that initial performance of a task is algorithm-driven, but as instances of specific solutions to a task accumulate in memory retrieval of these instances becomes the basis of performance. As instances accumulate, retrieval time speeds up, and memory retrieval outperforms the algorithm. Instance theory assumes the following: (a) All instances of stimuli are obligatorily encoded in memory (though the extent of encoding depends on the quality and quantity of attention directed at the stimuli), (b) retrieval of instances is an obligatory consequence of attending to similar stimuli (and consequently there is little transfer of the automaticity built up via experience of old instances to novel instances of the same type), and (c) all instances are represented separately in memory (rather than "strengthening" a single representation). Automatic performance, Logan claims, is therefore unconscious in the sense that a solution "springs to mind" as a consequence of obligatory retrieval from memory. Logan and colleagues (Klapp, Boches, Trabert, & Logan, 1991; Logan, 1988, 1990, 1992; Logan & Etherton, 1994; Logan & Klapp, 1991) have studied the predictions of instance theory on tasks requiring subjects to solve alphabet arithmetic problems (of the type $a + 3 = d$, $b + 3 = ?$) in which the presentation of instances of a problem is manipulated (some instances occurring many times, some occurring few times) and have found that, as predicted, initial solutions are slow, as they would be if algorithm-driven, but later solutions are fast, as they would be if retrieved from memory. They have also found that reaction time (an index of retrieval speed from memory) decreases as a function of the number of exposures to an instance, with little transfer of the automaticity built up on trained instances to new examples (though cf. Kramer, Strayer, & Buckley, 1990). Automaticity, then, Logan argues, is memory-based and item-dependent rather than rule-based. Similar explanations of the knowledge base established by learning under the implicit conditions of experiments by Reber, described earlier, have been offered by critics of his claim that implicit learning is abstract and rule-governed.

RULE ABSTRACTION OR MEMORY FOR EXAMPLES DURING IMPLICIT LEARNING?

There are three versions of the memory-based counterarguments to Reber's claims about the abstract product of implicit learning. Vokey and Brooks (1992) claim that performance in the transfer grammaticality judgment test following training on letter strings generated by the artificial grammars used in Reber's studies is based on *similarity* of instances encountered during training to those encountered at test. They report that degree of similarity of training and transfer instances affected transfer test judgment more than rule conformity (see also McAndrews & Moscovitch, 1985). Vokey and Brooks suggest that dual knowledge and rule and instance models of representation (Knowlton & Squire, 1994, 1996; Logan, 1988; Rothkopf & Dashen, 1995) as well as distributed memory models (McClelland & Rumelhart, 1985) could explain their findings. Perruchet and Pacteau (1990) argue that *veridical* memory for specific bigrams or letter pairings occurring during training affect judgments, to the extent that transfer test strings containing these frequently presented bigrams tended to be accepted as grammatical, even when the whole string violated

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the rules of the grammar.[2] Similarly, Servan-Schreiber and Anderson (1990) found that inducing *chunking* by presenting visually spaced groups of bigrams and trigrams in the training session affected transfer test performance, because ungrammatical strings that contained chunks tended to be wrongly judged grammatical whereas, of the ungrammatical sentences, those that violated chunks were rejected most often (see N. Ellis, 1996; Perruchet, 1994; Reber, 1993; Robinson, 1996a; Shanks & St. John, 1994, for further discussion).

The position taken below, in specifying the hypotheses for accuracy in the transfer grammaticality judgment test of the present study, is in line with the preceding memory-based explanations of implicit learning—that is, that the knowledge base established by learning under implicit and incidental conditions consists of veridical memory-based representations of instances encountered during training, rather than abstract rules. Where instances encountered during training in the four conditions of the present study are also present in the transfer grammaticality judgment test, memory will determine the decision about acceptability, but, following Logan, little transfer of the decision about acceptability will be expected for novel instances of the same type encountered in the transfer set. This is in line with the characterization of implicit L2 learning as a data-driven memory-based process (Brooks, 1978; Perruchet & Pacteau, 1990; Robinson, 1996a, 1996b; Schmidt, 1995; Shanks & St. John, 1994; Whittlesea & Dorken, 1993) and would be in line with the observation of N. Ellis (1993) that implicit L2 learning is "laboriously slow," because many instances would need to be encountered and noticed in input (with adequate quality and quantity of attention, as Logan claims) before accurate grammaticality judgments could be made on the basis of memory retrieval. In contrast, explicit form-focused learning in the enhanced and instructed training conditions is argued to be rule-based and, therefore, is expected to be more generalizable to novel instances encountered in the transfer test. This is obviously so for instructed learners, because they are taught the rule (described in the Method section, later) during training. Learners in the enhanced condition must induce the rule themselves, with the aid of the input-enhancement technique (also described later) that is intended to direct learners' focal attention to the "necessary features" (cf. Smith & Sloman, 1994) of sentences correctly classified as grammatical and ungrammatical (though whether it does so is a question that the present study is intended to address). Nonetheless, for form-focused learners in both conditions, it is expected that previously encountered instances in the transfer set will receive faster responses than novel instances, because memory retrieval will outperform the algorithm in those cases, as predicted by Logan.

In summary, predictions for learning under the four conditions of the present study are based on the assumption that all learning involves attentional allocation but that generalizable learning will result from noticing the structural correlates of rules and using the rules to guide grammaticality judgments in the transfer task. This is expected to occur in the instructed and enhanced conditions, because in these conditions the focus on form is intended to facilitate relevant noticing. Implicit and incidental learning will be memory-based, item-specific, and nongeneralizable, because training task demands in these conditions, although leading to obligatory

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encoding of instances in memory, are unlikely to lead learners to notice the structural coordinates or necessary features of rules. Because learners in these conditions will therefore have no algorithm to rely on in the absence of memory for grammatical examples, performance on novel sentences in the transfer test will be poor. These predictions are in line with Schmidt's noticing hypothesis and with Shanks and St. John's conclusion to a review of implicit learning studies:

> [T]here is little actual support . . . for unconscious rule induction (i.e., for implicit learning) or for the unconscious learning of any other type of information . . . however we do find evidence for a dissociation between a rule induction system and an instance memorization system. (1994, p. 402)

THE PRESENT STUDY

Method

Subjects. Subjects for the study were 60 native speakers of Japanese, aged between 19 and 24 years old, enrolled in undergraduate and graduate courses at Aoyama Gakuin University, Tokyo. All had completed 6 years of formal high school education in English. Subjects were predominantly third- and fourth-year undergraduates, the mean level of subjects in each condition being third-year undergraduates. Subjects were offered 2,000 Yen ($20) in return for their participation in the study.

Procedures.

Training conditions. Subjects were randomly assigned to one of four training conditions. In each condition, subjects were required to read 55 stimulus sentences generated by the rule used in the study. The training set sentences and their frequency of occurrence and relation to the rule targeted in the present study are described in the Materials section, later. In each condition, the training set sentences were presented in the same fixed random order on a Macintosh computer screen for a fixed period of 10 seconds each. Following each stimulus-sentence presentation, subjects were asked a follow-up question, which differed according to the training condition being delivered. Subjects in all conditions were allowed as much time as they wanted to respond to each question. They were given feedback in the form of a "correct" or "incorrect" message before the next stimulus sentence appeared on screen. Subjects in all conditions took part in a computerized introduction to the training demands of their particular condition during which the procedure for responding "yes" by pressing the C key and "no" by pressing the M key was explained to them. Then they practiced responding to three questions in this practice phase before the presentation of the training set sentences and the follow-up questions.

The implicit training condition was explained to subjects as an exercise in reading and remembering the position of words in sentences and replicates, using natural language stimuli, the training condition for implicit learners in Reber's studies (Reber, 1989, 1993). After viewing each stimulus sentence, subjects were asked follow-up questions of the type "Did the words _____ and _____ occur next to

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each other in the sentence you just saw?" Then they received feedback that remained on the screen until they responded to the "Press any key to continue" prompt, whereupon the next stimulus sentence appeared. The same feedback procedure was followed in all conditions.[3]

Both the incidental and enhanced conditions were explained to subjects as an exercise in understanding the meaning of sentences. The first of these replicates the learning condition that Krashen argues leads to unconscious acquisition (processing and understanding the meaning of input without intentionally focusing on grammatical form). Krashen (1981, 1982, 1985, 1994) has argued that access to comprehensible input is the necessary and sufficient condition for L2 learning and that when learners are, for example, reading to understand message content then formal knowledge (e.g., of grammatical features, collocations, or vocabulary meaning) is acquired incidentally. In the incidental condition, subjects were exposed to the same randomly ordered series of sentence stimuli, appearing for 10 seconds each, as in all other conditions, and were presented with follow-up questions focusing on the meaning content of each sentence. However, in the enhanced condition a focus on form technique was additionally used to draw learner attention to the structural correlates of the rule. This rule (described in more detail later) is that verbs with monosyllabic stems can occur in either double object or *to*-object sentences, whereas verbs with disyllabic stems can only occur in *to*-object sentences. The enhancement took the form of a box drawn around words and verb stems in the following manner John sooked. The number of syllables in each verb were always boxed for each sentence. For disyllabic verbs and monosyllabic verbs with *to*-objects, the accompanying *to*-object was also boxed, whereas for monosyllabic verbs in double object sentences the indirect object was boxed. The incidental condition, therefore, involves a focus on meaning, whereas the enhanced condition involves a simultaneous focus on form and meaning. Subjects in both conditions received the same practice session and answered the same yes or no comprehension questions during training. No subjects in the enhanced condition asked why certain words and parts of words had been boxed, and no explanation was offered by the researcher.

The practice session for the instructed condition consisted of an explanation of the rule targeted for the study, which was the basis for the stimulus training sentences and transfer set sentences. In contrast to the enhanced condition, focus on form was metalinguistic in the instructed condition, and it replicates the environment that Krashen argued leads only to conscious learning. The rule explanation was brief, lasting no more than 2 or 3 minutes for each instructed subject, and it was illustrated by the researcher with written materials. Subjects were asked to remember the rule and refer to the written explanation, if necessary, as they completed the training session. Afterward, subjects completed a practice session on the computer. During the practice and training sessions, subjects were asked metalinguistic questions of two types that related to the rule explanation they had been given. These questions were "Did the verb have one/two syllables?" and "Was an object with 'to' used?" These questions had been practiced and explained during the earlier preteaching session.

Training and transfer sessions. All subjects completed a transfer session immedi-

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ately after training. The training session lasted approximately 25 minutes for subjects in all conditions, and the transfer session was completed in, on average, from 2 to 5 minutes. Before the transfer session began, all subjects were reminded that the sentences they had just seen were all grammatical and that now they were to see more sentences. They were told to decide whether the sentences were grammatical or ungrammatical and asked to press C for grammatical and M for ungrammatical. They were asked to do this as quickly as they could. During the transfer session, 30 sentences were presented in the same fixed random order for all subjects. In addition, two distractor sentences were presented first and second to avoid distortions in reaction time due to unpreparedness for the task. Responses to these two sentences were not entered into the analyses.

Debriefing. After the transfer session, all subjects answered a debriefing questionnaire written in Japanese. Subjects were invited to answer in either English or Japanese, whichever they felt comfortable with. The questions of interest to the present study were whether they had noticed any rules during the training session, whether they had been looking for rules, and whether they could say what the rules were.

Materials.

The pedagogic rule. The rule presented to subjects in the instructed condition, which formed the basis of the sentence types presented during the training and transfer sessions, was one presented to subjects in a previous study of the development of automaticity during L2 rule learning (Robinson & Ha, 1993) and describes a syllabic constraint on verbs that take the dative alternation in English (cf. Mazurkewich & White, 1984). The rule is that verbs with one syllable in the stem, such as *give,* take the dative alternation (*John gave Mary the cake/John gave the cake to Mary*), whereas verbs with two syllables in the stem can only occur with "*to*-object" constructions (*John donated the piano to the church/*John donated the church the piano*). As explained in the earlier paper, this rule is a simplification of the actual criteria determining dative alternation (for discussion of the correct linguistic formulation of the rule, see e.g., Pinker, 1989; Wolfe-Quintero, 1993), but it is typical of pedagogic rules that abstract away from the full range of linguistic facts in order to identify regularities that are assimilable for learners (see Faerch, 1986; Robinson, 1996a, 1996b; Westney, 1994). In approaches to pedagogy that rely heavily on rule explanation, such rules would normally be supplemented during subsequent instruction with information and/or examples of exceptions to the rule in order to develop fuller understanding. This rule was illustrated for instructed learners and formed the basis of sentences presented in the training and transfer sessions.

An additional feature of the rule presentation and the training and transfer set sentences in the present study was the use of novel verbs in all sentences, as in Robinson and Ha (1993). The purpose of using novel artificial verbs was to control for prior knowledge and for experience of sentences of English with dativizable and nondativizable verbs (as in Pinker, 1989). The artificial verbs were invented by the researcher and are illustrated in the training and transfer set sentences given in Tables 1 and 2. Despite the artificiality of the verbs, it was possible to ask meaningful

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Table 1. Sentence types and frequency of presentation in the training set

	Sentence	Type	No. of Presentations
1.	Mary donked a car to the old woman.	1	×10
2.	Nick menided some hot coffee to Sue.	2	×9
3.	Jane nawked Larry an expensive ring.	3	×8
4.	Bill reliped a long letter to Jack.	2	×7
5.	Guy looled the cracked plate to the waitress.	1	×6
6.	Peter pelled the English teacher an excellent paper.	3	×5
7.	Bob pogged Julie a silver box.	3	×4
8.	Jean frepaned some warm clothes to Charles.	2	×3
9.	Sally jigged Paul a French meal.	3	×2
10.	Mike tussed the two wheels to Mark.	1	×1

Note: type 1 = one-syllable verb with *to*-object; type 2 = two-syllable verb with *to*-object; type 3 = one-syllable verb with indirect or direct object.

questions about the content of sentences, and subjects in the incidental and enhanced conditions were equivalent in accuracy in answering these questions, all subjects responding correctly to more than 70% of the comprehension questions during training.

Training set sentences. There were 10 training set sentence tokens. These were of three types. These types were those grammatical sentence types used to explain the rule to learners in the instructed condition. Type 1 sentences contained monosyllabic verbs in *to*-object constructions. Type 2 sentences contained disyllabic verbs in *to*-object constructions. Type 3 sentences contained monosyllabic verbs in double object constructions (see Table 1). In addition, the number of instances of presentation were manipulated during training, such that the first sentence was presented 10 times throughout the training set, the second sentence was presented 9 times, the third sentence 8 times, and so on, making a total of 55 training set sentences. In this way, some tokens of each sentence type were presented many times and few times (e.g., type 1, sentence 1 presented 10 times; sentence 5 presented 6 times; and sentence 10 presented once). These 55 sentences were presented in a fixed random order for subjects in all conditions.

Transfer set sentences. During the transfer grammaticality judgment task, 30 sentences were presented in a fixed random order for all subjects: the same 10 sentences that formed the training set (old grammatical sentences), 10 new tokens of the same type as the grammatical sentences presented during training (new grammatical sentences), and 10 new tokens of the type that is ungrammatical following the rule presented in the instructed condition (disyllabic verbs with double object constructions, new ungrammatical sentences) (see Table 2).

Research Hypotheses. There are two groups of hypotheses for the present study. The first group (Hypotheses 1–6) concern overall accuracy and reaction time on the three types of sentences presented in the transfer set: old grammatical, new grammatical, and new ungrammatical sentences. The second group (Hypotheses

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Table 2. Sentence types presented in the transfer set

Sentence	Type
Old grammatical sentences	
1. Mary donked a car to the old woman.	1
2. Nick menided some hot coffee to Sue.	2
3. Jane nawked Larry an expensive ring.	3
4. Bill reliped a long letter to Jack.	2
5. Guy looled the cracked plate to the waitress.	1
6. Peter pelled the English teacher an excellent paper.	3
7. Bob pogged Julie a silver box.	3
8. Jean frepaned some warm clothes to Charles.	2
9. Sally jigged Paul a French meal.	3
10. Mike tussed the two wheels to Mark.	1
New grammatical sentences	
1. Carl zugged a bike to the busy girl.	1
2. Frank ballended some green tea to Jill.	2
3. Ben dirked Betty a velvet evening gown.	3
4. Steve salooped a large cake to Amy.	2
5. May pilled the empty bucket to the farmer.	1
6. Sadie dagged the old man a fur hat.	3
7. June cibbed Francis a diamond necklace.	3
8. Margot drivened some new books to the library.	2
9. Wes nogged Stan a huge bottle.	3
10. Jay wezzed the Italian coins to Phil.	1
New ungrammatical sentences	
1. George temeeded John the small spoon.	4
2. Sandy bivarded Patrick some Swiss cheese.	4
3. Loiuse strivanked the girl a nice present.	4
4. Tom chompaded the policeman his gun.	4
5. Ann farnoogled Suzie some money.	4
6. Geoff rebanked Doug a black sofa.	4
7. Tara diflooged the waiter a tip.	4
8. Dave pimoded Diane a relaxing holiday.	4
9. Bruce repoded the crying baby a soapy bath.	4
10. Carol blaggered Harry a running shoe.	4

Note: type 1 = one-syllable verb with *to*-object; type 2 = two-syllable verb with *to*-object; type 3 = one-syllable verb with indirect or direct object; type 4 = two-syllable verb with indirect or direct object.

7–9) concern only performance on the old repeated grammatical instances in the transfer set.

Hypothesis 1. Accuracy on old grammatical sentences will be equivalent for subjects in all conditions, because the prior exposure provided during training will ensure that the decision is memory-based.

Hypothesis 2. Accuracy on new grammatical sentences will be higher for instructed learners than for all others, because they have a rule to guide their decisions. Learners in the enhanced condition who may have noticed the rule via the enhancement technique will be more accurate than implicit and incidental learners who will have no memory or rule to guide decisions.

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Hypothesis 3. Accuracy on new ungrammatical sentences will be higher for instructed learners than for all others, and enhanced learners will be more accurate than implicit and incidental learners for reasons already given.

Hypothesis 4. Reaction time on old grammatical sentences will be equivalent for subjects in all conditions, because the responses will be memory-based, and all conditions have had equivalent exposure to these instances during training.

Hypothesis 5. Reaction time to new grammatical sentences will be faster for instructed learners than for all others, because they have a rule to guide decision-making. Enhanced learners will be faster than implicit and incidental learners, because noticing may have facilitated the development of a rule that can be used in the absence of memory. Implicit and incidental learners, without rules or memory for the new instances, will be slowest.

Hypothesis 6. Reaction time to new ungrammatical sentences will be faster for instructed learners than for all others, and enhanced learners will be faster than implicit and incidental learners for reasons given immediately above.

Hypothesis 7. Implicit and incidental learners will be more accurate on transfer set instances of old grammatical sentences that occurred many times in the training set, versus those that occurred few times, because multiple exposures result in faster memory retrieval, and where retrieval is weak due to fewer exposures implicit and incidental learners will have no rule to guide decision-making.

Hypothesis 8. For enhanced and instructed learners, there will be no difference in accuracy of response to old grammatical transfer set sentences occurring many times during training, versus those occurring few times, because in the absence of memory retrieval there will be a rule to guide decisions.

Hypothesis 9. For subjects trained in all conditions, there will be faster responses to those instances presented many times during training versus those instances presented fewer times. This is predicted by Logan's instance theory and the power law of practice.

Analyses. To address Hypotheses 1–6, two repeated-measure analyses of variance (ANOVAs) of accuracy and reaction time to the transfer set sentences were performed with condition as a between-subjects factor and grammaticality as a within-subjects factor. These were followed by separate ANOVAs of accuracy and reaction time to the three types of transfer set sentences (old grammatical, new grammatical, and new ungrammatical) and post hoc comparisons to establish between group differences. To address Hypotheses 7–9, separate repeated-measure ANOVAs for subjects in each condition were performed. In addition, a priori planned comparisons of the performance on old grammatical transfer set sentences presented many times in training versus sentences presented few times were made. All analyses were performed on a Macintosh Quadra 950, using Statview SE and SuperAnova statistical software. The alpha level was set at 0.05 for all analyses.

Results

Transfer Set Accuracy. The results of the repeated-measure ANOVA for accuracy to transfer set sentences shows significant main effects for condition, $F(3,$

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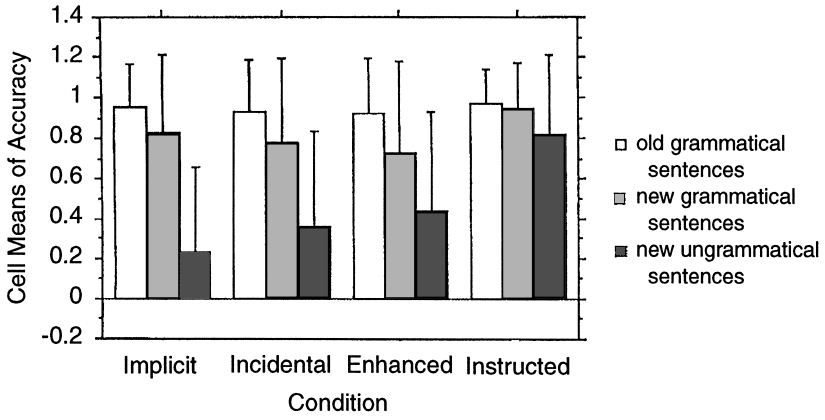


Figure 1. Mean accuracy on grammatical/ungrammatical, old/new sentences in the transfer set.

56) = 17.672, $p < .01$, and for grammaticality, $F(2, 112) = 118.314$, $p < .01$, and a significant interaction of condition and grammaticality, $F(6, 112) = 7.900$, $p < .01$ (see Figure 1).

Hypothesis 1. Hypothesis 1 is supported. The results of the ANOVA for accuracy on old grammatical transfer set sentences shows no significant main effect for condition, $F(3, 56) = 0.709$, $p = .55$. As shown in Figure 1, subjects in all conditions are more than 90% accurate on these sentences.

Hypothesis 2. Hypothesis 2 is partially supported. The ANOVA for accuracy on new grammatical transfer set sentences shows a significant main effect for condition, $F(3, 56) = 5.023$, $p < .01$. Post hoc comparisons using Fisher's protected least significant difference procedure (Fisher's PLSD) show a significant difference between the instructed condition and all others at the $p < .05$ level but no significant difference between the enhanced and implicit, $p = .11$, or incidental, $p = .42$, conditions. As predicted, there is no significant difference between the implicit and incidental conditions, $p = .42$.

Hypothesis 3. Hypothesis 3 is largely supported. The results of the ANOVA for accuracy on new ungrammatical transfer set sentences shows a significant main effect for condition, $F(3, 56) = 16.147$, $p < .01$. Post hoc comparisons show a significant difference between the instructed condition and all others and a significant difference between the enhanced and implicit conditions, $p = .02$, though not between the enhanced and incidental conditions, $p = .37$. As predicted, implicit and incidental conditions are not significantly different, $p = .18$.

Transfer Set Reaction Time. The results of the repeated-measure ANOVA for reaction time to transfer set sentences show significant main effects for condition, $F(3, 56) = 7.589$, $p < .01$, and for grammaticality, $F(2, 112) = 67.836$, $p < .01$, and a significant interaction of condition and grammaticality, $F(6, 112) = 3.904$, $p < .01$ (see Figure 2).

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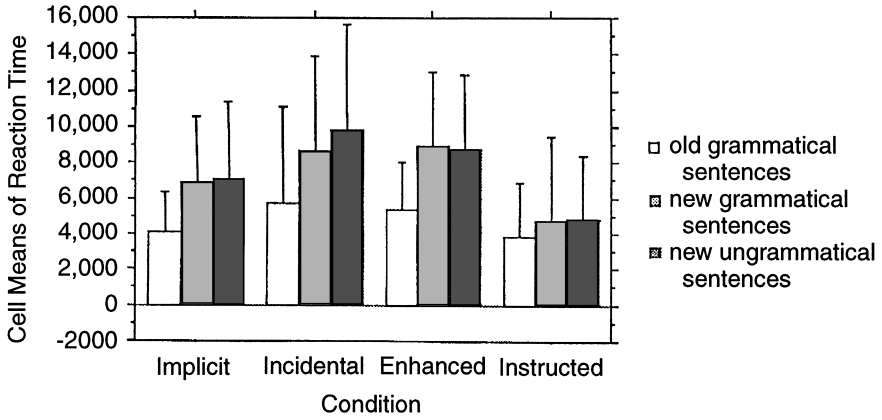


Figure 2. Mean reaction time on grammatical/ungrammatical, old/new sentences in the transfer set.

Hypothesis 4. Hypothesis 4 is supported. Results of the ANOVA for reaction time to old grammatical transfer set sentences show no significant main effect for condition, $F(3, 56) = 2.680$, $p > .05$. Reaction time to these sentences is faster for subjects in all conditions than for reaction time to the other sentence types (see Figure 2).

Hypothesis 5. Hypothesis 5 is partially supported. The ANOVA for reaction time to new grammatical transfer set sentences shows a significant main effect for condition, $F(3, 56) = 8.519$, $p < .01$. Post hoc comparisons show a significant difference between the faster instructed condition and all other conditions. As predicted, the implicit and incidental conditions are not significantly different, $p = .06$, but the enhanced condition is significantly slower than the implicit condition and is not significantly different from the incidental condition, $p = .78$. This contradicts Hypothesis 5, that is, that the enhanced condition would be faster than the implicit and incidental conditions.

Hypothesis 6. Hypothesis 6 is only partially supported. The ANOVA for reaction time to new ungrammatical transfer set sentences shows a significant main effect for condition, $F(3, 56) = 7.667$, $p < .01$. Post hoc comparisons show that the instructed condition is significantly faster than all other conditions. However, contrary to this hypothesis, the enhanced condition is not significantly faster than the implicit or incidental conditions, and the implicit condition is significantly faster than the incidental condition.

Summary of the Results for Hypotheses 1–6. The hypotheses for accuracy are largely supported by these results. All conditions are equivalent on old grammatical sentences, as predicted in Hypothesis 1. Instructed learners are more accurate on new sentences in the transfer set than learners in all other conditions, showing more ability to generalize knowledge learned during training, as predicted in Hypotheses 2 and 3. Implicit and incidental learners are equivalent in accuracy, and enhanced learners are more accurate than implicit learners on new ungrammatical

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sentences. However, enhanced learners are not more accurate than incidental learners on these sentences or than either incidental or implicit learners on new grammatical sentences. The predictions for equivalent speed on old sentences (Hypothesis 4) and for the superior speed of instructed learners on new sentences (Hypotheses 5 and 6) are confirmed. However, contrary to Hypotheses 5 and 6, enhanced learners are not faster than implicit or incidental learners on new sentences and are, in fact, slower than implicit learners on these sentences (see Figure 2).

Instance Specific Analyses. To examine evidence for the instance specific predictions about speed and accuracy on old grammatical transfer set sentences made in Hypotheses 7–9, planned a priori means comparisons of accuracy and reaction time to pairs of sentences of the same type, presented many times and few times during training, were made for subjects in each condition. These comparisons were the following: comparison (a) between sentence 1 (10 instances) and sentence 10 (1 instance), both one-syllable *to*-object sentences; comparison (b) between sentence 2 (9 instances) and sentence 8 (3 instances), both two-syllable *to*-object sentences; and comparison (c) between sentence 3 (8 instances) and sentence 9 (2 instances), both one-syllable double object sentences.

Hypothesis 7. Hypothesis 7 is not supported, because there is no significant difference in accuracy to the sentences of each type presented many times versus few times during training for the implicit and incidental conditions (see Table 3).

Hypothesis 8. Hypothesis 8 is supported. There is no significant difference in accuracy on any of the comparisons in the enhanced or instructed conditions (see Table 3).

Hypothesis 9. Hypothesis 9 is partially supported. No comparisons of reaction time to transfer set sentences presented many versus few times during training are significant for the implicit, incidental, or enhanced conditions (see Figure 3). Only in the instructed condition does the first comparison show the predicted difference, $p = .02$, with sentence 1, presented 10 times during training, eliciting faster responses than sentence 10, presented once. Reaction time to transfer set sentences presented during training does not follow the power law of practice (cf. DeKeyser, this issue; Ellis & Schmidt, this issue; Logan, 1988, 1992)—$\log y$ (reaction time) = $\log x$ (number of instances of exposure in training)^N—showing a degenerate fit to the linear falling slope predicted by exposure to increasing numbers of instances (correlations between observed and predicted values are as follows: implicit $r^2 = .237$, incidental $r^2 = .010$, enhanced $r^2 = .111$, instructed $r^2 = .121$).

Discussion

Generalizability and Focus on Form. Instructed learners are clearly superior to learners in other conditions in their ability to generalize the knowledge developed during training to novel transfer set sentences. As Hypothesis 1 predicted, all conditions were equivalent and high in accuracy on the old repeated training set sentences, consistent with the claim that they based their judgment about grammaticality on memory for previous occurrence of these sentences. Also as predicted, the instructed

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Table 3. Descriptive statistics for accuracy and reaction time to transfer set sentences presented many and few times during training

			Reaction Time (in ms)		% Accuracy	
Condition/Type	Token	Presentations	*M*	*SD*	*M*	*SD*
Implicit						
Type 1	S 1	×10	3,722.0	2,170.5	93.3	25.8
	S 10	×1	5,050.7	2,305.8	93.3	25.8
Type 2	S 2	×9	3,061.9	1,019.9	100	0.0
	S 8	×3	3,594.2	1,183.4	93.3	25.8
Type 3	S 3	×8	4,451.6	3,568.5	100	0.0
	S 9	×2	3,956.4	2,344.6	80	41.4
Incidental						
Type 1	S 1	×10	4,185.2	2,405.4	86.7	35.2
	S 10	×1	6,106.4	4,308.4	86.7	35.4
Type 2	S 2	×9	5,734	4,913.8	86.7	35.2
	S 8	×3	4,797.4	2,728.5	93.3	25.8
Type 3	S 3	×8	7,947.3	9,610.2	93.3	25.8
	S 9	×2	5,431.8	4,718.7	93.3	25.8
Enhanced						
Type 1	S 1	×10	4,855.2	3,557	100	0.0
	S 10	×1	6,140.7	3,182.1	93.3	25.8
Type 2	S 2	×9	4,805.2	2,106.4	93.3	25.8
	S 8	×3	5,878.6	3,831.9	93.3	25.8
Type 3	S 3	×8	4,715.2	1,592	93.3	25.8
	S 9	×2	4,280.6	2,542.1	93.3	25.8
Instructed						
Type 1	S 1	×10	3,074	3,121.8	93.3	25.8
	S 10	×1	4,773.8	5,120.6	100	0.0
Type 2	S 2	×9	3,169.9	1,852.6	93.3	25.8
	S 8	×3	3,647.4	2,020.9	93.3	25.8
Type 3	S 3	×8	4,377.5	2,751.9	93.3	25.8
	S 9	×2	2,950.9	1,598.4	100	0.0

condition is superior in accuracy to all other conditions on new grammatical sentences. However, the implicit and incidental conditions perform with high accuracy on these sentences, about 80%, and are equivalent to the enhanced condition. As the results for performance on new ungrammatical sentences show, however, accurate performance on the new grammatical sentences is not evidence of the acquisition of generalizable knowledge. Implicit learners wrongly accept around 80% of the ungrammatical sentences, appearing to adopt the strategy of approving all sentences as grammatical. This is not affected by the relative similarity of the new grammatical and ungrammatical sentences to the previously experienced sentences either. Implicit learners (correctly) accept around 80% of the new grammatical sentences and (incorrectly) accept 80% of the new ungrammatical sentences (see Figure 1). That is, the preference for accepting sentences as grammatical is not affected by the fact that ungrammatical sentences are less similar to the training set sentences than the

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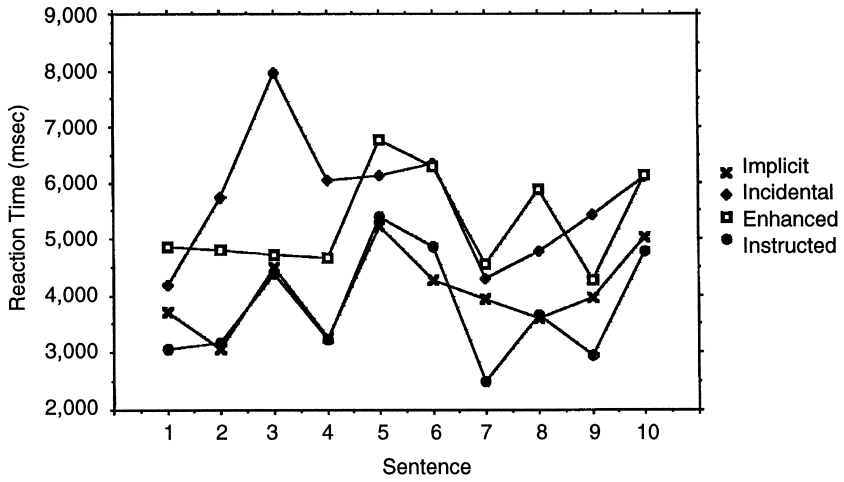


Figure 3. Reaction time in milliseconds to the ten transfer set sentences repeated from the training set for all conditions.

Key: Sentence 1 occurred 10 times in training, sentence 2 occurred 9 times, sentence 3 occurred 8 times, sentence 4 occurred 7 times, sentence 5 occurred 6 times, sentence 6 occurred 5 times, sentence 7 occurred 4 times, sentence 8 occurred 3 times, sentence 9 occurred 2 times, sentence 10 occurred 1 time.

new grammatical sentences. This is support, then, for the inference that implicit learners draw on veridical memory for previously experienced instances in making decisions about grammaticality but do not show sensitivity to—and therefore access to representations of—differences in the relative similarity of the new sentences, a finding in line with the instance-memory explanation of Perruchet (1994), rather than the similarity abstraction explanation of implicit learning put forward by Vokey and Brooks (1992) and already reviewed.

As predicted by Hypothesis 3, the instructed condition is superior to all others in judging new ungrammatical sentences. Also as predicted, the enhanced condition, although low in accuracy on these sentences, is superior to the implicit condition. The enhancement technique, coupled with attention to meaning, therefore leads to more generalizable, non-item-specific learning than the memorization encouraged in the implicit condition. The enhanced condition also has a higher (though nonsignificant) mean accuracy on these ungrammatical sentences than the incidental condition. Although suggestive of the advantages that longer term exposure to enhanced and meaningful material might have over processing for meaning alone, this finding also appears to contradict arguments that simultaneous attention to form and meaning degrades the quality of attention paid to both (see VanPatten, 1990), because both incidental and enhanced learners performed with equivalent accuracy on the comprehension questions during training. Clearly, memory-based decisions influenced both incidental and enhanced learners in their responses to old grammatical sentences, but enhanced learners show evidence of the acquisition of a generalizable knowledge base.

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Automaticity and Focus on Form. Does the manipulation of instance presentations affect reaction time equivalently in all conditions? Responses to the last instance of each type presented during training do not appear sensitive to this manipulation for any condition, because there is no clear difference in response time to the last instances of sentences presented fewer times (sentences 8–10) and the last instances of sentences presented many times (sentences 1–3) (see Table 1 for these sentences). This is in line with previous findings for the null effects of instance manipulation during training on training set reaction time for a rule-instructed group (Robinson & Ha, 1993), and it differs from the findings of Logan (1988) for the effects of this manipulation on responses to alphabet arithmetic problems. It is likely that the training period for the present study was too short to result in the effects found by Logan. However, as in the previous study, there is a clear facilitative effect of prior exposure on reaction time for old grammatical sentences in the transfer set, versus new sentences, with significantly faster performance on these old sentences for subjects in all conditions (see Figure 2), suggesting—like the accuracy data—memory-based decisions about these sentences, in line with Hypothesis 4 and with instance theory.

As the results for Hypothesis 7 showed, instance manipulation during training did not significantly affect accuracy on instances repeated during the transfer set for subjects in any condition. This was not expected for implicit and incidental learners, because more obligatorily encoded instances should have led to decreased retrieval time and, therefore, more determinate and correct judgments of grammaticality for transfer set presentations of those instances than for instances encoded fewer times during training and subsequently encountered in the transfer set. However, accuracy on the old sentences is high in all conditions, as already discussed, suggesting that for implicit and incidental learners even the priming achieved by one or two presentations in training (sentences 9 and 10; see Table 1) is sufficient to promote accurate memory-based retrieval (see Logan, 1990). Subjects in all conditions are sensitive to this general priming effect and, as the result for Hypothesis 9 shows, the only effect for instance manipulation in the transfer set is found for instructed learners' significantly faster reaction time to sentence 1 (presented 10 times in training) versus sentence 10 (presented one time) (see Figure 3).

However, there are significant differences between conditions in reaction time to new transfer set sentences. As predicted by Hypotheses 5 and 6, instructed learners are significantly faster on these sentences than all others (see Figure 2), because they have access to a rule to guide decision-making. Implicit learners, without rule or memory to guide them, are also significantly faster than enhanced learners (on new grammatical sentences) and incidental learners (on new ungrammatical sentences) possibly because they adopt the strategy of accepting all sentences as grammatical rather than engaging the knowledge base developed during training in their decision-making. In contrast, incidental and enhanced learners are almost twice as slow as instructed learners on new sentences. Clearly, the enhanced learners did not develop a determinate rule—as confirmed by responses to the debriefing questionnaire, in which only instructed learners made reference to the criterial feature of the rule, that is, the number of syllables in the verb stem.[4] However,

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many incidental and enhanced learners, in responding to the question "Can you say what the rule was?" mentioned the position of direct and indirect objects in sentences, whereas few implicit learners verbalized any aspect of the rules. Furthermore, although similar numbers of implicit, incidental, and enhanced learners reported that they were looking for rules (8, 6, and 8, respectively), enhancement clearly facilitated noticing, because 10 enhanced learners reported that they had noticed rules, in contrast to 5 incidental and only 4 implicit learners. The slow reaction time for incidental and enhanced learners, then, on new sentences is understandable if they had been consciously trying to find rules while they read for meaning during training. In the transfer phase, they may have been reflecting on the hypotheses developed earlier and trying to generate predictions about grammaticality based on their prior experience with the training set. Transfer of processing demands encouraged during training (reading for meaning and reading for meaning while attending to form) to the transfer task would also result in slower performance for incidental and enhanced learners versus instructed learners, because the training and transfer task demands are more similar for instructed learners and are therefore more easily transferred, leading to faster responses (see Blaxton, 1989; Whittlesea & Dorken, 1993). Nonetheless, responses to the old sentences are equivalent in speed for instructed, incidental, and enhanced subjects, suggesting that two knowledge bases are contributing to transfer task performance, that is, "slow effortful hypothesis testing on the one hand, and fast, efficient memorization of instances and fragments on the other" (Shanks & St. John, 1994, p. 370).

SUMMARY AND CONCLUSION

Summary of Findings for Generalizability and Automaticity

Hypothesis 1 of the present study predicted that prior exposure to grammatical stimuli presented during training under implicit, incidental, enhanced, and instructed conditions would facilitate high and equivalent accuracy across conditions when the same items were presented again in a transfer grammaticality judgment task. This hypothesis was confirmed. It was also predicted that learning in the enhanced and instructed focus on form conditions would show evidence of greater *generalizability* to novel stimuli in the transfer task than learning in the implicit and incidental conditions. Results for Hypothesis 2 showed this to be true for instructed learners, with higher accuracy on new grammatical items than all other learners, but not for enhanced learners versus implicit and incidental learners. Results for Hypothesis 3 showed this to be true for instructed learners who had significantly higher accuracy than all others on new ungrammatical items and partially true also for enhanced learners with significantly higher accuracy on these items than implicit learners. However, accuracy on these items was equivalent for enhanced and incidental learners (see Figure 1).

Hypothesis 4 predicted that responses to the stimuli presented during training would be fast and equivalent in *automaticity* across conditions in the transfer grammaticality judgment task. This was confirmed. Hypotheses 5 and 6 predicted that

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responses in the enhanced and instructed focus on form conditions, guided by more determinate rule knowledge gained during learning, would be faster than in the implicit and incidental conditions. This was true only for the instructed learners, who were significantly faster than all other learners in responses to new grammatical and new ungrammatical items. Incidental and enhanced learners were equivalent and slowest in responses to these items (see Figure 2). Given these results, the following conclusions can be drawn about the interaction of rule-based and memory-based learning in the four conditions of this study:

1. Implicit knowledge is memory-based and limited in its generalizability. Access to it is fast.
2. The knowledge acquired during incidental and enhanced learning is also partially memory-based, but the enhanced learners in particular show evidence of the development of a generalizable rule-based representation. Access to this is slow and effortful, in contrast to decisions based on memory for prior experiences.
3. Instructed learning of rules results in generalizable knowledge and fast decision-making about new sentences, because the rules are accurate, determinate, and practiced. However, as for all other learners, decisions about previously experienced sentences are faster than decisions about new sentences, suggesting that rule-based knowledge developed through conscious effort and implicit memory-based knowledge interact in decision-making.

Laboratory Studies and Classroom Studies of SLA

Each of the experimental learning conditions operationalized in this study have, at one time or another, been favored by approaches to second language pedagogy. Implicit learning through mere exposure and memorization characterizes, to some extent, the Audiolingual Approach (see Decoo, 1996). Incidental learning through focus on meaning and the attempt to make input comprehensible characterizes the Natural Approach (Krashen & Terrell, 1983) and Prabhu's Procedural Syllabus (Prabhu, 1987), whereas the explicit teaching of grammar rules has a long history as an approach to language teaching. In recent task-based approaches to pedagogy, focus on form via the enhancement of selected features of the input to meaningful activities is a characteristic feature of instruction (Doughty & Williams, 1996; Long, 1991; Long & Crookes, 1992; Long & Robinson, 1996). Thus, research into which of these conditions is most effective in promoting SLA, and how quickly, has practical relevance. It also has theoretical relevance, because explanations, rather than simple descriptions, of the effect of instruction on SLA necessarily involve reference to causal cognitive resources, such as attention and memory. The influence of these resources on learning under different conditions can most effectively be determined through laboratory studies of SLA where there is a greater possibility of controlling the influence of extraneous variables on instruction and thereby of isolating and explaining the different effects that instructional techniques have on memory and attentional demands. Computerizing instructional conditions and exposure to L2 input also greatly facilitates replication, because the same experimental software used to deliver instruction and provide exposure can be used again with different populations (see Harrington & Robinson, 1977). It is not possible to replicate class-

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room-based instruction and exposure with the same degree of precision. Laboratory studies also allow sensitive measurement of phenomena, such as reaction time, that can be useful in making inferences about learned abilities, such as automaticity, or about access to different memory systems. This is not possible in descriptive studies of the effect of instruction in classrooms.

However, classroom-based studies are needed both as a way of testing findings from theory-driven laboratory studies and as a way of generating new insights into learning. It is often the case, for example, that laboratory studies, in attempting to control for variables like the extent of prior knowledge through the use of artificial or semiartificial language, may abstract too much away from the realities of language use and structure, thereby limiting the usefulness of their findings. The present study is a case in point. It may have been that the use of artificial verbs interfered with the process of interest in the incidental and enhanced conditions by making it difficult to process the sentences for meaning in the way natural language samples are processed. Similarly, restricting the stimuli to sentences, rather than extended text, may have reduced the challenge they posed to the learner, causing only shallow processing, whereas deeper processing may have produced different results. It is also true that the criterial feature of the rule used in the present study—the occurrence of one or more syllables in the verb stem—has low perceptual saliency and no semantic or pragmatic utility, and this could have contributed to the poor performance of implicit, incidental, and enhanced learners. Of course, the time frame, too, of laboratory research is often much shorter than the time frame within which learners typically operate in classrooms—another limitation of the present study. Nonetheless, as long as their limitations are acknowledged and understood, laboratory studies provide the researcher and practitioner alike with the clearest window on issues of common interest to both, which are often invoked by theories of SLA, and proponents of approaches to pedagogy, but too rarely empirically studied, such as the nature of implicit knowledge, the development of automaticity, and the relationship of rule-based to memory-based knowledge during learning.

NOTES

1. Following Schmidt (1990, 1995), the claim that this paper aims to examine is that there is no learning without the subjective experience of being aware of (i.e., noticing) the formal characteristics of the input to be learned. Although attention is necessary to noticing, attention to input at the level of "detection" (see Tomlin & Villa, 1994) need not be accompanied by noticing, and so, it is argued, it will not lead to learning. The issue distinguishing noticing and detection is one of the quality of attention allocated to input. Detection requires minimally low levels of peripheral attention to take place. The training conditions for the present study aim to ensure that all stimuli presented during training are detected, but task demands constitutive of two training conditions, that is, the enhanced and instructed conditions, attempt to lead learners to allocate focal attention to critical aspects of the form of input necessary to noticing and learning, whereas the task demands in the implicit and incidental conditions do not aim to do this (see Robinson, 1995c, for fuller discussion of the relationship among attention, detection, awareness, and noticing).

2. Veridical memories are exact instantiations of what was attended to, that is, instances, not memories that are represented abstractly by prototypes or by patterns of similarity.

3. Although this operationalization of an implicit condition is motivated by Reber's research (see Reber, 1989, 1993), a previous experimental study of SLA (Robinson, 1996a, 1996b, 1997) has shown that when natural language data are presented as the target of learning, then this condition *does* lead many subjects to focus on form and to engage in explicit rule search and hypothesis testing about grammaticality. Furthermore, as one of the reviewers of this paper pointed out, the attentional demands of the implicit condition may have

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inhibited learning in the present study because attention is drawn to word position, rather than the internal syllabic structure of words. However, it is noticing verb syllabicity that is critical to learning the rule regulating which of the verbs presented do and do not alternate, and noticing this information is inhibited by this operationalization of Reber's implicit memorization condition. It is also true that in the SLA literature (e.g., R. Ellis, 1994; Krashen, 1985, 1994) implicit learning is most often associated with the processing encouraged by the task demands in the incidental condition of the present study. This is particularly so in the case of learning that results from "implicit negative feedback," in which corrections to learner utterances, in the form of recasts, are incorporated into interaction that is primarily aimed at clarifying and exchanging conversational meaning (see Long, in press; Mackey, 1995; Oliver, 1995). Although there are similarities in the levels of accuracy achieved by implicit and incidental learners in the present study and in Robinson (1996a), there are important differences between the learning that occurs in these conditions, too. For example, incidental learning, in contrast to implicit learning, appears to be insensitive to differences in learners' aptitude (see Robinson, 1995a, 1996b, 1997) and to be more sensitive to the semantic and pragmatic acceptability of input, whereas implicit learning via memorization is more sensitive to the frequency of co-occurring words regardless of semantic and pragmatic acceptability (see Robinson, 1996a, 1996b).

4. The influence of subjects' existing knowledge of which verbs do and do not alternate in English was controlled for in the present study by the use of artificial verbs. Kevin Gregg has pointed out to me that the simplified pedagogic rule regulating the distinction between grammatical and ungrammatical verb argument structures in the present study may have negatively affected the responses of those in all conditions who were aware of the more complex semantico-syntactic constraints on verbs that dativize in English. To this extent, the use of novel verbs is justified only as a means of controlling for prior knowledge of lexical items, not as a means of controlling for prior knowledge of the linguistic domain. It is also true that no pretest of rule knowledge was used to select subjects, partially due to the problem of drawing subjects' attention to the rule as formulated here during the pretest, which would then have subverted the aim of the implicit, incidental, and enhanced conditions. However, the results of responses to the debriefing questionnaire show that prior knowledge was very unlikely to have been an influence, because no subjects in the implicit, incidental, and enhanced conditions could verbalize the critical feature of the rule determining alternation, that is, syllabicity.

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