

PROBLEMS OF KNOWLEDGE AND THE IMPLICIT/EXPLICIT DISTINCTION IN SLA THEORY CONSTRUCTION

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Distinctions between implicit and explicit forms of knowledge are frequently invoked by second language researchers. However, there are competing uses of these terms, and their relationship to similar distinctions made in cognitive psychology between implicit and explicit learning and memory is not always clear. This paper aims to clarify the conceptual basis for such distinctions by comparing their use in theories of automaticity (Logan, 1988; Shiffrin & Schneider, 1977); skill learning (Anderson, 1983) and implicit learning (Reber, 1989, 1993) with their use in some recent cognitive theories of second language learning (McLaughlin, 1987; Krashen, 1985; Ellis, 1993). It is claimed that, in theorizing second language cognition, one needs to distinguish between levels of description of the cognitive system (Bunge 1973), but to infer relations between them. These are the neurophysiological level (of memory), the representational level, (of knowledge) and the information processing level (of cognitive function and learning). The implicit /explicit distinction refers to an operational distinction between task conditions at the level of cognitive function. Vertical inferences across levels must be related to the task conditions whereby the explicit/implicit distinction is implemented. This is largely the case in experimental research in cognitive psychology, but not so in much SLA theorizing, which assumes a distinction at one level without adequately specifying the inferences made about its vertical relation to other levels, thus creating terminological confusion.

INTRODUCTION

A number of second language researchers (e.g., Bialystok, 1979, 1982; Ellis 1990, 1993a; Krashen, 1985; McLaughlin, Rossman & McLeod, 1983; Sharwood-Smith, 1981, 1991) refer to distinctions between types of knowledge using the terms 'implicit' and 'explicit'. However, it is not always clear how their different uses of these terms relate to each other, or to similar distinctions between implicit versus explicit memory, and implicit versus explicit learning which are made in cognitive psychology (e.g., Schacter, 1987;

Reber, 1989). The non-complementary nature of the different constructs that researchers invoke by using these terms is made clear when, for example, the issue of the interface between the two knowledge forms is addressed. Bialystok (1979, 1982) and Ellis (1993a) both claim that explicit knowledge can 'feed in' to implicit knowledge. In contrast Krashen (1985) proposes that similar knowledge constructs (acquired, unconscious knowledge versus learned, conscious knowledge) are non-interfaced. Reber (1989) also supports a non-interface position but claims that explicit learning can have a negative effect on the development of implicit representations. In contrast, Mathews et al. (1989) claim that the knowledge base established during learning is the result of a synergetic, mutually complementary cycle of implicit to explicit to implicit modes of learning. The interface issue is just one example of the conceptual conflicts and incompatibilities that are masked by superficially similar distinctions between implicit and explicit knowledge.

My aim in this paper is to clarify the conceptual basis for such distinctions by comparing their use in theories of automaticity (Logan, 1988; Shiffrin & Schneider, 1977); skill learning (Anderson, 1983) and implicit learning (Reber 1989,1993) with their use in some recent cognitive theories of second language learning (Ellis, 1993a; Krashen, 1985; McLaughlin, 1987). In the first section of this paper I distinguish between three levels of description in the construction of theories of cognition. I then describe how inferences about the organization of these levels can be made on the basis of contrasting performance under implicit and explicit task conditions. In the second section I discuss the extent to which it is possible to compare models of the relations between these levels, and to claim that a distinction between forms of knowledge appropriate to one research question can be appropriated for the purposes of theorizing a different area. In the final section I discuss these issues in the context of recent claims (Ellis 1993a, b) for a role for implicit knowledge in second language syllabus design.

THE PROBLEM OF LEVELS IN INFERRING IMPLICIT PROCESSES

There are levels of idealization and description in the analysis of cognition, (Bunge 1973; Changeux & Dehaene, 1989; Eimas & Galaburda, 1989), in particular those cognitive processes responsible for second language

acquisition, as there are in the analysis of language (Lyons, 1968), or of the visual system (Marr, 1982). By this I do not mean that the cognitive system itself is rigidly compartmentalized along the lines of the levels I will describe, but rather that our descriptions of the workings of the system are appropriate to the particular problems we address by describing and analyzing it. Consider, for example, an analogy to the traffic system of a major city. For traffic control purposes one might study the movement and density of traffic at certain times along particular routes, and subsequently decide whether to broaden certain roadways, or reduce the intervals between stop signs at intersections. For civic planning purposes, perhaps, one would study the amount of available parking space and its proximity to centers of activity like shopping malls, cinemas etc., and subsequently recommend the need for additional parking lots. Describing traffic at the traffic flow level and at the parking lot level requires a characterization of different features of the overall traffic system. Of course, the two levels interact; parking is important to traffic flow, and traffic flow is important to parking, but they require different observational notations, as do descriptions of the mental activity that takes place during information processing, and descriptions of the neural architecture of memory.

The problems we address by analyzing the cognitive system also predispose us to adopt a particular level of idealization, or abstraction away from neurophysiology and the facts of cellular composition. Take, for example, the analogy to the traffic system again. This involves i) the facts of the amount of available parking space, ii) the facts of the numbers of vehicles occupying the space or in transit, and iii) the facts of movement between places at certain times, which give rise to the notions 'rush hour', 'traffic hold up', etc. This latter level, like the description of human information processing, requires a characterization of phenomena of a different order of abstraction than the first level, which is concerned essentially with available parking space (memory), or the second level, which is concerned with the nature of its occupancy (knowledge).

The notion of levels, then, is a consequence of the need to circumscribe the phenomena which can be usefully studied for a particular purpose, using experimental tasks appropriate to that purpose and level (Bunge 1973; Marr 1982). As such, distinguishing between levels of description is in no way oppositional to the view that memory and representations are distributed

throughout the entire cognitive system, or the view that information is processed in parallel, rather than in a linearly serial fashion (Changeux & Dehaen, 1989; Eimas & Galaburda, 1989; Hintzman, 1986; McClelland & Rumelhart, 1985; Morris, 1989). Levels, that is, do not correspond to divisions and hierarchies in grey matter; they are simply consequences of the limited scope and task specificity of our observations of mental phenomena during the process of building models of the cognitive system.

In the following I describe memory at the neurophysiological level, knowledge at the level of representation, and learning at the level of cognitive function during information processing. Of course, inferences can be made across levels, as must be the case in any comprehensive theory of cognition or of second language learning. Problems arise, though, when explanations of second language cognitive processes mix levels of description, claiming facts obtained on tasks appropriate to one level of description necessarily indicate facts about another level. Task appropriacy is therefore a crucial determinant of the validity of the claims that can be made about phenomena. The implicit/explicit distinction refers to task conditions which manipulate degree of awareness at the level of cognitive function. Whether cognitive functioning under these task conditions reveals evidence of dissociations between neurophysiological systems of memory, or of forms of knowledge representation, is an inference in need of further support from tasks appropriate to the description and explanation of these particular levels. Whether it is valid evidence of a difference in learning processes depends on our understanding of the role of control processes, involving the allocation of attention, in information processing.

The Neurophysiological Level

Memory is a complex physiological system of neuronal tissue with cellular, biophysical and molecular attributes (Squire & Zola-Morgan, 1991; Thompson, 1986). Each of these attribute systems has mechanisms which interact to determine memory trace circuits, i.e. the formation of synapses between neurons, and which contribute to the plasticity of localized neural networks, i.e. the capacity of the network to establish new or modify old synapses (Robbins, 1992; Thompson, 1986). Various functional subsystems of

memory have been proposed; between short-term, or working memory, and long-term, or reference memory (Cowan 1988); between episodic 'personal' memory, and semantic factual memory, and between declarative memory and procedural memory (see McKoon, Ratcliffe & Dell, 1986; Snodgrass, 1987; Tulving, 1984). Some physiological evidence exists for separate stores corresponding to memory for procedural skill and to long term memory for declarative information (see Cotman & Lynch, 1989; Paradis, 1993; Squire & Zola-Morgan, 1991). Claims have been made that these memory systems are differentially responsible for the storage of morpho-syntax (procedural memory) and lexical items (declarative memory) in bilinguals (Paradis, 1993: 5), and possibly, therefore, with procedural versus declarative vocabulary (Robinson, 1989, 1992) during second language learning. Tasks may draw differentially on one or the other system (Paradis, 1993), and this may be evident in lexical performance on language learning tasks (Robinson, 1993). Evidence of functional dissociations on explicit and implicit measures of memory is sometimes taken to confirm the episodic/ semantic distinction (see Schacter, 1987 and below). The contents of memory are the patterns of activation formed over neurons (Alkon, 1988) that occur at various stages of information processing. At the neurophysiological level knowledge is isomorphic with these patterns of activation, and therefore with the contents of memory.

The Representational Level

There are many theories of how these patterns of activation function as representations of processed information (see Johnson & Hasher, 1987). I will restrict myself to the issue of how knowledge of language might be represented, and to distinguishing between two currently influential positions which can be characterized as 'abstractionist' and 'distributive' (see McClelland & Rumelhart, 1985; Vokey & Brooks, 1992). The abstractionist position claims that patterns of activation constitute a memorial representation of patterns of invariance inherent in the exemplar set, because 'memory by its basic nature somehow abstracts the central tendency of a set of disparate experiences, and gives relatively little weight to the specific experiences that gave rise to these abstractions' (McClelland & Rumelhart,

1985: 159). Such abstract patterns of invariance have been termed schemata or prototypes, and work on concept categorization (Posner & Keele, 1968, 1970; Rosch, 1975) has appeared to support this position (though see Anderson 1991). Knowledge of language, in this view, is represented as a system of high level generalizations or rules. Such schematic representations may be emergent, and non-local, (Keil, 1989; Smith & Medin, 1981) or domain specific and modular (Fodor, 1983) and shaped by innate, genetically determined mechanisms at the neurobiological level. The X-bar schema, and the principles and parameters described by Chomsky (1986), which motivate the second language research described by White (1989), are examples of the latter claim about the representation of our knowledge of language.

In contrast distributive positions claim patterns of activation, or representations are 'a conspiracy of the entire ensemble of memory traces of the individual experiences we have had with that unit' (McLelland & Rumelhart, 1985: 160), and stress the contribution of memory representations for unique events, or individual instances, to abstract knowledge, as in the 'competition model' of language learning proposed by MacWhinney (1987); the 'multiple trace theory' of memory storage and retrieval proposed by Hintzman (1986); Nosofsky (1988) and Anderson's (1991) adaptive theories of categorization, and Gasser's (1990) connectionist lexical memory model of second language sentence production. Such knowledge is distributed over the entire contents of memory, which is viewed as a single interconnected workspace. In contrast, the abstractionist position assumes that abstract rules or schemata are stored in a separate semantic memory. Pinker (1991) claims that both rule-and-representation, abstractionist theories, and associationist, distributive theories are partly right and characterize different aspects of our knowledge of our first language. For example, associationist theories are needed to explain the acquisition of irregular past tense morphology, since such features are not reducible to formal statements or rules. However, some rules, e.g. those for stating the conditions on regular past tense morphology, are necessary, and there is evidence of their productivity in preferred forms of denominal verbs¹ (Kim, Pinker, Prince, Prasada, 1992; Lachter & Bever,

¹Irregular past tense mappings, claim Kim et al (1991), e.g. fly/flew or stick/stuck, are learned associatively and marked as such in the lexicon. Regular past tense markings are generated by rule, rather than learned associatively. Kim et al claim there is evidence for the primacy of rule governed regular past tense morphology in the preferred forms of denominal

1988). Johnson & Hasher (1987: 640) acknowledge the possibility that mixed representations may arise in a domain. This mixed representation position is not to be confused with Krashen's (1985) position which is that our knowledge of some aspects of a second language is doubly represented in an acquired, and a learned system.² Sasaki (1992) has recently objected to dual knowledge formats of the type proposed by Krashen, on the grounds that they make unreasonable storage and memory demands. Smolensky (1988) stresses the compatibility of the two theories, and Schmidt (1990: 149) suggests that second language learning under implicit, not explicit conditions (see below) may result in representations of the form proposed by associationist, distributive theories.

The Level of Cognitive Function

Knowledge is functionally differentiated. For example, we have knowledge that enables us to form concepts (Keil, 1989; Smith, 1989); to recognize patterns (Neisser, 1967); to perform skilled activity (Anderson, 1983; Salthouse, 1986; Wicken, 1989); to recall events in which we participated (Tulving, 1985), and to infer facts about events in which we did not (Pellegrino, 1985), as well as to communicate through a first and second language. Learning is the process by which such knowledge is gained. It may involve an innate, prespecified component at the neurophysiological level

verbs in English. Because nouns, unlike verbs, are never marked for irregular morphology, which is learned associatively, 'verbs with noun roots –denominal verbs– are regular even if they are phonologically identical to irregular verbs, hence: *flied out*/**flew out* to center field; *high–sticked*/**high–stuck* the goalie' (1991: 173).

²Krashen claims that what can be informally and unconsciously acquired exceeds what can be formally and consciously learned. One reason is that linguists (and language teachers who derive their descriptive apparatus and notation from linguists) 'readily admit that they can describe only fragments of natural language'(1981: 114). Further, only 'easy' rules are learnable, for example those for pluralizing NPs, the third person singular morpheme for regular present tense verbs, and regular and irregular past tense morphemes (1981: 114–115). More complex rules can only be acquired. Consequently, while about 5% of the possible rules of a language can be doubly represented in an acquired and a learned system, the remaining 95%, consisting of, as yet, unformalized rules, or difficult rules, can only be acquired (see Krashen 1976: see also Larsen–Freeman & Long 1991: 240 for further discussion of Krashen's position on this matter and Bialystok 1979 and Green & Hecht 1991 for further discussion of the easy hard rule distinction).

(Chomsky, 1986). Knowledge may subsequently be added through ' an endogenous process of internal representational change ' (Karmiloff-Smith, 1990: 59), or through restructuring as a consequence of interaction with the environment (Carey, 1988; McLaughlin, 1990b). In cognitive learning theory, (as opposed to behaviorist learning theory which views learning as the accumulation of simple stimulus-response reflexes, see Houston, 1976; Narendra & Thathachar, 1989; Roitblat, 1987) this is assumed to be regulated and constrained by the allocation of limited attentional resources to process the information needed to accomplish learning tasks. In this approach information processing is under executive control, and control processes operate to regulate the allocation of attention needed for encoding and retrieval of information in memory (Atkinson & Shiffrin, 1968; Cowan, 1988). Memory is the affected capacity, and control processes are the causal capacity: interaction between the two is assumed to be necessary for the acquisition and retention of knowledge. However, as Cowan (1988) notes, research in cognitive psychology has not yet settled on a view of attentional resource allocation consistent with the properties of memory. Specifications of the interaction between them at the level of cognitive function is therefore necessarily speculative, though essential to the elaboration of theoretical models of the processes involved in converting input to intake (Chaudron, 1985; Ellis, 1993a; Sharwood-Smith, 1991).

Attentional Control, Automaticity and Learning

Schmidt (1990, 1992) has distinguished between uses of the term 'consciousness' that refer to knowledge, intention and awareness, and the extent to which such distinctions can be invoked to explain aspects of second language development. I will concentrate here on his distinction between the levels of awareness involved in perception, noticing and understanding, and their role in learning. Figure 1 (Appendix 1) is a model of the attentional control system suitable for describing the processing of information during grammaticality judgements tasks, on sentence stimuli, as in the transfer tasks of implicit learning experiments³ (Reber, 1989). Paths taken by information

³In this research implicit learning is defined as the process whereby implicit knowledge is acquired and is the basis for valid inferences about its representation. It is true that some

about input are represented by solid arrows; communication and control links among mechanisms and actions are represented by dotted arrows. Input is consciously perceived on entry to the comparison mechanism which compares the representation of the attended input with representations stored in memory (A1). Matches with stored representations, and consultation with other rule-like representations or schemata via mechanisms of e.g., association, generalization, differentiation, hypothesis-testing, bring additional information about the input into awareness which provides input to the executive decision mechanism (A2). At this level noticing, the result of the allocation of focal attention, occurs. This mechanism then selects from an array of possible actions. Initially the input may be noticed but not understood, resulting in executive decisions to make further comparisons (A3), and to reattend to the dimensional analysis of the input (A4). This is the process whereby understanding is achieved, or not. Practice, in attention based theories (McLaughlin, 1987; McLaughlin, McLeod & Ross, 1983; Shiffrin & Schneider, 1977) results in faster and more determinate information from the executive decision mechanism, leading to faster, more automatic decisions by reducing the need for attentional effort along A3 & 4. Logan (1988, 1990) has proposed that this process only characterizes the controlled phase of processing. Automaticity is the result of accumulated memories for specific instances, which after reaching a certain threshold of activation become a more efficient means of decision making and the executive mechanism (B1) subsequently responds on that basis alone. Evidence for this is taken to be the

claim implicit knowledge preexists the learning process, as is argued in the case of language, for example, by Chomsky (1986) and others who maintain that genetically determined configurations of possible languages interact with, and so preempt in some way, contact with the data of experience. If such knowledge remains available to second language learning adults it could also be claimed to be a form of implicit knowledge that preexists the learning process. However, the question of its availability in second language learning remains a matter of dispute (see Bley-Vroman 1989; Chaudron & Bley-Vroman 1990), as does the need to posit such a construct in order to explain first language development (Bohannon 1988). While the two senses of implicit knowledge distinguished here, knowledge which is innately prespecified and knowledge which is the result of implicit learning, are not incompatible, it is the extent of the role of the latter that Reber is concerned to investigate: 'Implicit acquisition of complex knowledge is taken as a foundation process for the development of abstract, tacit knowledge of all kinds. The stepping off place is that there is, at this juncture, no reason to place any priority on particular biological determinants of a specific kind. All forms of implicit knowledge are taken as essentially similar at their deepest levels.' (1989: 219).

fact that response time to instances of a problem decreases as a function of the number of presentation times, and is significantly faster than response times to novel instances of the same problem, while accuracy remains the same for novel and repeated instances. Two forms of learning are claimed to occur on these tasks, learning in the controlled phase of the task, during which rules are consulted, and awareness is at the level of understanding, and instance learning which becomes the basis of responses later in the task, where awareness remains at the level of noticing. Both are equally effective on these tasks, though instance learning is unsuited to more complex task conditions, Logan claims (1988: 518). They differ only in their demands on attentional and memory resources (see Robinson & Ha, 1993), and resemble forms of learning induced by implicit and explicit task conditions.

Implicit and Explicit Task Conditions

Performance under implicit and explicit conditions has been assessed on tasks requiring memory for previously presented material (see Paradis, 1993; Roediger, Weldon & Challis, 1989; Schacter, 1987, 1989) and on learning tasks requiring acceptability judgements of strings generated by artificial grammars (see Reber, 1989, 1992; Reber & Allen, 1978). Dissociations in the performance of normal, elderly and abnormal populations (amnesics, psychotics, dyslexics, aphasics) have been observed, demonstrating the robustness and superiority of implicit learning and memory, in contrast to learning and memory under explicit conditions. Automatic processes too, claims Reber (1992: 6) are examples of implicit systems, (though see McLaughlin, Rossman & McLeod 1983: 143 who identify implicit learning as a controlled process) and like implicit memory and learning they operate independently of factors affecting reflective and conscious processing. The consciousness dominated forms of cognition, Reber claims, are ontogenetically and phylogenetically later evolved than their unconscious counterparts, and completely dissociated from them⁴ (Reber, 1992).

⁴Reber's explanation of implicit learning is not one which draws heavily on other work in cognitive psychology. Rather than achieve explanation by integrating evidence from dissociations with cognitive frameworks established to explain other phenomena, a procedure which he claims 'will not work' (1992: 10), Reber maintains, 'the classic functionalist stance...(that)... the deep dissociation between implicit and explicit needs to be

Recently second language researchers have studied the effects of learning under the two conditions on second language learners' ability to identify well formed examples of stimuli generated by artificial (Nation & McLaughlin, 1986), semi-artificial (Hulstijn, 1989, 1990) and natural language grammars (Doughty, 1991; N.Ellis, 1993). To date there have been no studies that examine the memory performance of second language learners under implicit and explicit task conditions, though the distinction holds promise for those researchers concerned to motivate and refine existing measures of memory employed in aptitude batteries (Skehan, 1989; Stansfield, 1990).

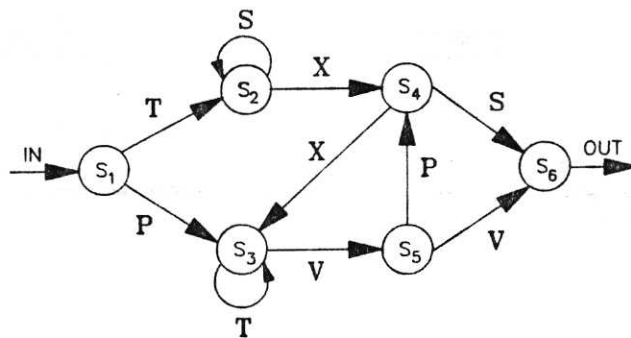
Memory research and research on learning in cognitive psychology have operationalized the distinction between explicit and implicit task conditions differently. In memory experiments, performance on direct measures of memory, which require conscious cued recall and recognition of previously presented stimuli, has been contrasted with performance on indirect measures of recall and recognition, for example word fragment or word-stem completion tasks (Merikle & Reingold, 1991; Richardson-Klavehn & Bjork, 1988; Schacter, 1987). The latter do not overtly instruct the learner to access the previously presented material. Debate continues over the question of whether differential performance on these tasks (Light & Singh, 1987; Russo & Parkin, 1993) is an artifact of the similarity of processing demands made at study and at test (Roediger, Weldon & Challis, 1989), or is a consequence of access to different memory systems (Paradis, 1993; Schacter 1989; Tulving, 1984, 1985, 1986), a claim which must be acknowledged as an

viewed from the context of the adaptive value that such a division has for the organisms that possess it and from the evolutionary advantages that would accrue to any species that exploited it' (1992: 10). Reber is explicit about the fact that he has no "'theory" of the cognitive unconscious in the standard sense', or what he calls a 'formalization of a set of principles that can provide a representation of the existing data', stating that 'I do not believe we are anywhere near ready for such an undertaking' (1992: 12). Reber's work, then, is primarily of descriptive importance for second language researchers, and contrasts with the heavily theory laden approach to describing innate constraints, and therefore implicit knowledge, familiar from the Chomskyan paradigm (1986; White 1989). However, for such descriptive information to be of value to second language acquisition theory construction it must be integrated within a model of the relations between the levels of cognition I have described above. This will require less caution than Reber typically displays in integrating the data with explanations of the interaction between memory and attention at the level of cognitive function developed for other purposes (e.g., Logan 1988; Shiffrin & Schneider 1977; Hinzman 1986; Schacter 1989; Nosofsky 1992).

inference across levels of description.

The implicit/explicit distinction has been operationalized in studies of learning by contrasting performance under conditions requiring a conscious search for rules, with those in which instruction is given simply to memorize presented examples. The examples are strings generated by a finite state grammar⁵ (Reber, 1967, 1989; Reber & Allen, 1978; McAndrews & Moscovitch, 1985; Vokey & Brooks, 1992) which is assumed to represent a stimulus domain of a sufficient level of complexity that it could not be consciously learned in its entirety in the time available for the task. The contrast is made between relative speed and accuracy of performance of subjects from both groups on a transfer acceptability judgement test. Subjects trained under implicit conditions typically outperform those trained under explicit conditions, though the explicit condition is equally effective if the rules to be learned are simple and the structure of the stimulus domain is made salient (see Schmidt, 1993 for a summary). The extent of conscious

⁵In the following grammar strings of symbols are generated in a left-to right, non-hierarchical fashion by following a path of arrows from the initial state 1 to the terminal state 6 (e.g. T [S] X S). Such a grammar was chosen, comments Reber (1989: 220), in part because it can generate a large number of strings to use as stimuli, and because it is 'sufficiently complex ...that the underlying formal structure is not within the conscious memorial domain of the typical subject upon the subject's entering the laboratory'(1989: 220).



(from Reber 1989:220)

awareness is assessed via measures of the degree to which subjects can verbalize their knowledge of the rules underlying the stimulus domain.

Debate continues over whether the representation resulting from exposure during the implicit condition is abstract, as Reber claims, or the result of piecemeal fragmentary knowledge of bigram pairings (Perruchet & Pacteau, 1990), chunks (Servan-Schreiber & Anderson, 1990), or influenced by item specific knowledge (Vokey & Brooks, 1992). Evidence of item specific effects, however, need not contradict the position that the implicit knowledge base is abstract if one adheres to a distributive view of representation which claims memory for specific items is distributed across the entire representation, and that schemata or higher level generalizations are not stored separately, but are emergent on encoding (McClelland & Rumelhart, 1985), or are instantiated on retrieval (Hinzman, 1986).

The extent to which learners are unconscious of knowledge resulting from learning under implicit conditions is also debated (Brody, 1989; Dulany, Carlson & Dewey, 1984). In particular, Brody (1989) claims that subjects are not always able to verbalize their conscious knowledge of rules when asked to do so directly by an interviewer following the learning tasks, and as Mathews et al. (1989) have shown, altering the nature of this task by asking subjects to verbally instruct a second party on how to complete the learning tasks reveals subjects to be more consciously aware of rules than the verbalization procedure Reber adopts.

In summary, the implicit/explicit distinction refers to task conditions which manipulate degree of awareness at the level of cognitive function. Performance on such tasks can be the basis for inferring details of cognitive organization at the levels of representation and of neurophysiology. Claims that dissociations between performance on direct and indirect memory tasks are evidence for the operation of separate systems are thus inferences relating the level of cognitive function to the neurophysiological level of memory. With regard to learning, any objection to the claim about the abstractness of the knowledge based established during learning is an argument about preferences at the representational level. This is separable from criticisms of the assumed degree of awareness of rules, which is appropriate to the level of cognitive function, and addresses the nature of the information processing on the tasks.

In the following section I discuss the extent to which knowledge constructs, inferred from empirical evidence of performance under implicit and explicit task conditions, can be validly compared. I illustrate this by first specifying the relationship of task conditions to inferences at the levels of cognitive function, representation and neurophysiology in some currently influential theories of skill acquisition, automaticity and second language learning, and then examining the extent to which the levels of representation in these models can be compared.

IMPLICIT/EXPLICIT LEARNING, MEMORY AND KNOWLEDGE IN SLA THEORY CONSTRUCTION

Discussions of these distinctions in second language research have tended to focus on the issue of explicit versus implicit knowledge, and the domain of such knowledge has invariably been grammar rather than , for example, strategic, pragmatic or sociolinguistic information (Bialystok, 1979, 1982, 1990; Ellis, 1993a; Green & Hecht, 1991; Krashen, 1979, 1985; Sharwood Smith, 1981, 1991; Bialystok & Sharwood Smith, 1985). There is some discussion, at present increasing, of implicit versus explicit learning (N. Ellis 1993; Hulstijn, 1989, 1990; Nation & McLaughlin, 1986; McLaughlin, Rossman & McLeod, 1983; Schmidt, 1990, 1992a, 1993) , though little discussion of implicit versus explicit memory (Paradis, 1993; Schmidt, 1990, 1992a).

Often these distinctions are made in the course of elaborating theoretical models of second language learning (e.g., Bialystok, 1982; Ellis, 1993a; Krashen, 1985; Sharwood-Smith, 1981, 1991). In such cases the uses of the terms 'implicit' and 'explicit' are not used to refer to experimentally manipulated task conditions at the level of cognitive function, which can become the basis of inferences about organization at the representational and neurophysiological levels. Rather, they are independently invoked to describe distinctions at particular levels. Thus the common basis of the distinction in a specified set of task conditions is lost, and it is unclear how one use of the term, for example 'implicit knowledge', relates to another, or how they relate to constructs like 'implicit learning', which should be the basis on which they are inferred. These are critical problems for theory construction in SLA. Essentially, the vertical dimension of theory construction, which indicates the relationship between the operational construct implicit/explicit (at the level of

cognitive function and task condition) to inferences about the representational and neurophysiological levels, needs to be specified. Otherwise meaningful horizontal comparisons between the uses of these terms at separate levels cannot be made. This is rarely the case with the theoretical uses of the terms in the work of those researchers I have identified above. More experimentally grounded work, like that of Hulstijn (1990) and N Ellis (1993) avoids, to an extent, these problems.

Construct Comparison in SLA Theory Construction

The development of a theory of second language acquisition, on which to base recommendations for syllabus design, will necessarily involve reference to research findings and theoretical constructs from other, related, areas of inquiry, like psychology and linguistics. Theories may differ not only in source, but in scope (Long, 1993), with some attempting to integrate findings from a broad range of domains. The relative importance of the contributions of constitutive domains may result in indirect rivalry, not direct opposition (Berretta, 1991). Theories may also differ in their choice of format (Crookes, 1992). Care must be taken, of course, in constructing a theory on the basis of interdisciplinary findings. In particular, theorists must guard against identifying seemingly similar constructs, arising in different domains, as identical, in order to maintain a needed distinction in theories and against illegitimately comparing two constructs which do not, for a variety of reasons, share anything other than a notional similarity. Such is the case in Ellis's (1993a) attempts (discussed below) to construct a theoretical argument for the role of structural units of analysis in second language syllabus design on the basis, in part, of distinctions between types of knowledge; procedural versus declarative (Anderson, 1983), implicit versus explicit (Reber, 1989), automatic versus controlled (McLaughlin, 1987).

I have argued that claims about the representational level, and claims for a valid distinction between implicit and explicit knowledge can only clearly be made in relation to a fully specified model of relations between the level of cognitive function, (and a theory of how manipulations in task conditions affect this) and the levels of representation and neurophysiology (see Figure 2, Appendix 2). It is only possible to make valid comparisons

between knowledge constructs at the representational level in fully specified models— partially specified models, which do not specify the task conditions that give rise to the differential forms of representation, do not admit direct comparison (see Figure 4, Appendix 2).

Fully and Partially Specified Models

Fully specified models of vertical relations between the task condition, and the levels of cognitive function, representation and neurophysiology are given in Appendix 2. Figure 2 shows vertical relations for implicit learning tasks, where specified task conditions allow inferences to be made about the level of cognitive function, (learning) and the levels of representation (knowledge) and neurophysiology (memory). Figure 3 shows the vertical relations between inferences and levels for the implicit memory tasks discussed previously, and Figure 4 shows how, for example, anatomical evidence from magnetic resonance imaging (Squire & Zola-Morgan, 1991) would affect the nature of the relations between levels and allowable inferences. Figure 5 shows the relationship between two partially specified models. In these cases, task conditions are not specified (e.g., as in Krashen, 1985; see Figure 8 and discussion below) or are, of their nature incomparable, (e.g., as between Anderson, 1983, whose model was developed for the purposes of machine implementation and Reber, 1989, who has studied human learning under the specified task conditions: see Figures 6 & 7 and discussion below) and the description of the level of cognitive function is not derived by inference from empirical evidence of changes that occur as a consequence of manipulating the task conditions. The inferences about representation based on such hypothetical constructs, while they may bare notional similarity, cannot be equated, or each reduced to the other. Contrast this situation with the comparisons between inferences at the representational level that result from comparing fully specified models— as in the case of comparing implicit learning experiments that differ only slightly in their specifications of task conditions. As yet, evidence from implicit learning studies suggests that such slight alterations in task conditions can affect the level of cognitive function (Curran & Keele, 1993; Hartman, Knopman & Nissen, 1989; Mathews et al., 1989; Vokey & Brooks, 1992), and one would necessarily want to be able to

compare the inferences about representation based on evidence of cognitive function under these similar conditions.

Horizontal Comparisons of Forms of Knowledge

Discussion of distinctions between forms of knowledge have been a consistent feature of second language acquisition theory since the early theoretical work of Corder (1967), and Selinker (1972) which established the study of interlanguage as an area of inquiry involving both knowledge of the target language, the first language and the internally evolving, cognitively regulated 'approximative system' (Nemser, 1971) of the learner. The Chomskyan distinction which predates this era, between knowledge and performance (1959), is still current, in the form of i-knowledge and e-knowledge (Chomsky, 1986), and various models of information processing have contributed to the pool of available distinctions between types of knowledge from which second language theory has drawn. Ellis (1993a) is just one example of a researcher who has made use of these distinctions; others include Færch & Kasper (1983), Sharwood-Smith (1981), Bialystok (1982) and Tarone (1988). However, the current theoretical position is not a happy one in this respect, since comparisons abound between forms of knowledge identified as a consequence of one line of research, and one set of task conditions, and others set up and specified quite differently. The intention in referring to these distinctions has often been to support a distinction between two superordinate categories of knowledge which are differentially responsive to conscious introspection, and which are presumed to regulate language development in different ways. One such distinction is that of Krashen's (1985) between the knowledge base that is consequent upon 'acquisition', and that consequent upon 'learning' (1981, 1985). As a clarification of currently influential distinctions between forms of knowledge Appendix 3 (Figures 6–10) illustrates models of vertical relations appropriate to the work of Anderson (1983), Reber (1989), Krashen (1985), Logan (1988), Shiffrin & Schneider (1977), and McLaughlin (1987).

Anderson: Anderson's ACT theory (1983) (Figure 6) was developed to model expert–novice transitions in skilled behaviour using a machine implementable

production systems approach to knowledge compilation and retrieval. There are four stages in the model; i) inputs are stored in declarative memory; ii) general problem solving productions interpret declarative facts; iii) productions suited to specific tasks are entered into procedural memory, which are eventually iv) fine tuned to a specific class of problems (Greene, 1987; Schmidt, 1992b). Although Anderson speculates about the adequacy of this model in accounting for human learning it was developed to be machine implementable. It was not tested empirically using human subjects who performed under specified task conditions. To this extent it remains a theory at the level of cognitive function which assumes, rather than infers, two different knowledge bases, declarative and procedural knowledge, which interact during the transition from novice to expert behaviour and which are themselves asserted to relate to different memory systems.

Reber: It is not possible, therefore, to validly compare the inferences about knowledge representation in Anderson's partially specified model with those made by Reber (Figure 7) regarding the results of implicit learning experiments, where task conditions are specified, and evidence of performance under these conditions is adduced to support the distinctions made between forms of knowledge at the representational level. In addition, Anderson's hypothetical model explains a transition from one task condition to another, novice to expert. Reber's studies (e.g., Reber, 1976) compare differential performance on tasks specified as +/- conscious search for rules; +/- intention to learn, and such conditions are experimentally replicable (e.g., the conditions specified in Reber, 1976, are replicated by Reber & Allen, 1978; McAndrews & Moscovitch, 1985; Vokey & Brooks, 1992). In Reber's model, two knowledge systems are inferred to be differentially responsible for performance under the specified conditions; a complex, abstract, and fully developed implicit representation, and a simpler, imperfectly developed representation. Reber, unlike Anderson, makes no statements about the relationships of knowledge at the representational level to memory systems.

Krashen: In contrast to Reber, Krashen's model (Figure 8) is partially specified, and necessarily so, since the task conditions which Krashen asserts must be met for 'acquisition', or 'learning' to occur are impossible to manipulate experimentally. The main problem is that Krashen claims the

'affective filter' must be lowered in the acquisition condition; 'The affective filter is a mental block that prevents acquires from fully utilizing the comprehensible input they receive for language acquisition. When it is 'up' the acquirer may understand what he hears and reads, but the input will not reach the LAD. This occurs when the acquirer is unmotivated, lacking in self confidence or anxious'(1985: 3). While it is possible to manipulate variables like intention, or attention through task instructions, it difficult to ethically, and within an experimental setting, manipulate anxiety and other components of the 'affect' construct, even if the subtle differences Krashen assumes are causal i.e. between 'low' and 'moderate' anxiety (1985: 25) could be quantified.⁶ Krashen asserts that differences in representation arise as a consequence of functioning under these ideal conditions, i.e. acquired knowledge and learned knowledge, which, unlike Anderson's model, are non-interfaced. Krashen also makes no claims about the relationship of knowledge to memory, although his position (seemingly adopted by Paradis (1983) who does make the claim) would appear to imply a distinct systems approach, as in Anderson's model.

Logan: Like Reber, and unlike Anderson and Krashen, Logan fully specifies his model (Figure 9). There are clear, and operationalizable specifications of task conditions relating to the distinctions +/- practice; +/- early; +/- attentional effort +/- consistency of environment. However, like Anderson, and unlike Reber, Logan's tasks, since they are intended to examine the extent of the development of skilled behaviour within the individual, involve a transition from one task to the other. Like Reber, Anderson and Krashen, Logan associates the task conditions with two distinct forms of knowledge at the representational level– an abstract rule based representation, and an instance based representation of specific examples encountered during the tasks.

⁶It is true that there are constructs for measuring anxiety, for example the Taylor Manifest Anxiety Scale (see Krashen (1991: 30)), but although Krashen reports that anxiety, as measured by this scale, was positively correlated with achievement in Spanish as a second language (in a study by Chastain (1975)), no particular point on the scale is identified by him as distinguishing low from moderate anxiety. Also, as Larsen–Freeman & Long (1991: 243) point out, it isn't clear to what extent other factors supposedly regulating the lowering and raising of the affective filter, i.e. high motivation and high esteem, can offset the problem of high anxiety, and vice versa.

Shiffrin & Schneider, and McLaughlin: Shiffrin and Schneider's model of the development of automaticity (Figure 10), was adopted by McLaughlin as an explanation for the development of skilled behaviour in second language learners, (McLaughlin, 1987, 1990; McLaughlin, Rossman & McLeod, 1983). It differs from Logan's in not inferring two knowledge sources at the representational level. Automaticity is assumed to develop as a consequence of speed up of rule based representations. (The contrast between their model of the development of automaticity and Logan's is captured in Figure 1, Appendix 1.)

In summary, it can be seen that, despite making apparently similar claims for distinctions between forms of knowledge at the representational level, the various models differ from each other either in failing to specify operationalizable task conditions (e.g., Krashen v. Reber), or in specifying conditions for transitions between tasks, rather than for performance on separate tasks (e.g., Logan v. Reber), or in terms of the inferences made about the forms of knowledge at the representational level (Shiffrin & Schneider v. Loga). While the distinctions between forms of knowledge in these models may bare a notional similarity to each other, they are not identical, or instances of superordinate umbrella categories.

THE KNOWLEDGE BASE FOR SECOND LANGUAGE SYLLABUS DESIGN

Ellis (1993a) attempts to make a case for the role of a structural syllabus as a means to promote 'gradual mastery' of implicit second language knowledge and his is a recent case of the use of the distinctions considered above in the domain of second language acquisition theory. Like Bialystok (1982) Ellis proposes a two dimensional model of skill learning. In Bialystok's terms these are the dimensions of analysis and control. Ellis replaces her +/- analyzed distinction with a distinction between two types of knowledge, explicit and implicit. Here is an immediate problem. For Bialystok, this dimension represents a continuum of analysis, with early language being towards the unanalyzed end of the scale, and analyzed language characterizing the later, more developed system (for the debate about whether learning must begin with analyzed or unanalyzed knowledge see Bialystok, 1990; Hulstijn, 1990b).

For Ellis this is a dichotomy between interfaced, but distinct implicit and explicit 'types' of knowledge. Bialystok's dimension of control is termed the declarative to procedural dimension by Ellis, importing Anderson's (1983) distinction. Language development is characterized as the process whereby explicit declarative knowledge becomes implicit procedural knowledge. Ellis adopts a 'weak interface' position, which allows some seepage of explicit knowledge into implicit knowledge, but rejects the 'strong interface' position, which claims all explicit declarative knowledge can be directly converted into implicit procedural knowledge through practice. The role of the structural syllabus is to identify items which are candidates for the transition, and the role of methodology is to ensure that learners explicitly notice them, or notice the gap between their current representations and these features. This is necessary for the conversion of explicit into implicit knowledge.

There are problems with Ellis's position which stem largely from his basic assertion that an agreed upon distinction between explicit and implicit knowledge exists and is 'common in cognitive psychology' (1993a: 93), a claim he attributes to Bialystok (1982). It is true, as I have shown, that a number of distinctions are made between forms of representation in the models I have discussed, but these are not all inferences derived from performance on tasks under specified, and comparable implicit and explicit conditions. There are model-specific differences between these distinctions, as I have pointed out, yet Ellis ignores this. Ellis, to this extent, appears to conflate similar notions in order to maintain a supposedly needed superordinate distinction. However, his failure to justify the empirical basis of his distinction leaves him open to charges that the claims based on it are purely speculative and misrepresentative of current thinking.

It is true, as Ellis claims, that implicit and explicit knowledge need to be distinguished from procedural and declarative knowledge, and I gave some reasons for distinguishing Reber's model from Anderson's above (see Figures 6 and 7). However, Ellis, while rejecting the strong interface position that practice alone is sufficient for the conversion of explicit to implicit knowledge, does allow 'opportunities for formally practicing the new knowledge' (1993a: 95) a role in this process. The extent of the role of practice is problematic. The suggestion that practice is, to some degree, a condition for the process of converting explicit into implicit knowledge involves identifying, for example, the level of knowledge representation in Reber's

model, which distinguishes implicit from explicit knowledge (Figure 7) with that in Logan's (Figure 9) or Shiffrin & Schneider's (Figure 10), which relates two knowledge bases to each other via practice, and I have given reasons why this is not a valid comparison.

Practice, in Ellis's model, in fact has two senses, which are not fully articulated or differentiated. In one sense practice is a methodologically facilitated psycholinguistic operation responsible for effecting the transition from declarative to proceduralized representations, in the manner described by Anderson (1983) along the control dimension of his model. If practice, though, in this sense is not necessary for the conversion of explicit to implicit knowledge along the knowledge dimension then a single attention drawing activity should be enough to activate reorganizational links between explicit and implicit knowledge. This, it would seem, is the second sense of practice implied by Ellis's model, and relates to the explicit to implicit transition – methodologically facilitated 'consciousness-raising' activities which encourage 'guided self-discovery' of explicitly presented forms by the learner (see Sharwood-Smith 1981). It is not clear, though, what consciousness-raising involves, or why it would facilitate the integration of explicit knowledge into implicit knowledge, rather than the reverse process. What is needed in Ellis's account is a specification of the level of attention necessary to consciousness-raising, and how it might be manipulated, and discussion of whether the focussing of attention is, in some cases, the cumulative result of practice on consciousness-raising activities rather than the result of one-shot exposure to a form. Crucial to the consciousness-raising function of practice, I suggest, are the duration of the initial activation of a representation, and its degree of similarity to previously activated representations⁷, since these two factors have been shown to determine the

⁷Glass & Holyoak (1986: 273), discussing the attentional demands of concept learning (see also Hintzman 1974), claim that, for a concept to be learned on a single trial, following a single exposure to an input, the input must be sufficiently activated during encoding. The duration of the initial activation, and the similarity of the representation to previously processed representations will together determine the allocation of attention to the input. When the degree of similarity of a previously presented example to an immediately succeeding example is great there may be proactive inhibition, or a reduction in the attention allocated the repeated input. Repetitions of an input, or similar inputs, are more attention demanding, and therefore lead to greater levels of activation and learning, when distributed over periods of time, than when massed or successive repetitions are processed (Johnston & Uhl 1976).

extent of attention devoted to a stimulus (see Glass & Holyoak, 1986: 273). Experimental manipulation of these variables with regard to the input presented to learners, and the extent to which the targeted features of the input are 'noticed' (Schmidt, 1990) may help clarify the, at present ill-defined, 'consciousness-raising' construct which Ellis invokes.

Elsewhere Ellis (1993b: 6) has identified the role of practice in developing proceduralization as being one which encourages learner production of the target language. Consciousness-raising practice activities, which develop awareness of the form of input, on the other hand, encourage understanding but do not require the production of sentences manifesting the structures that are the focus of instruction. It is not clear, though, why production exercises cannot be used to develop awareness of the form of input; oral pattern practice using substitution tables focussed on past tense morphemes, for example, would seem to be one way to do this. Neither is it clear why consciousness raising activities should be developed which avoid the requirement that learners produce a structure, as, in principal, they must if the two senses of practice are not to be conflated⁸. It is unclear, too, how to justify the assertion that implicit knowledge consists of formulaic and rule-based knowledge (1993a: 93). How does this relate to Logan's distinction between the knowledge base drawn on in automatic behaviour, (memory for instances), and that drawn on in controlled behaviour, (rule-based representations), which seems to distinguish the two? Krashen (1981: 83-99) is clear about his position that formulaic knowledge can play no role in the development of the acquired system and the differentiation of its knowledge base. Prefabricated routines, or 'memorized whole utterances', Krashen claims 'are essentially and fundamentally different from creative language'(1981: 99). Reber also maintains that the knowledge base established under implicit learning conditions is 'abstract, and not dependent in any important way on the particular physical manifestations of the stimuli' (1989: 225).

The notion of the interface between implicit and explicit knowledge,

⁸At worst, the types of exercises that most clearly exemplify the two forms of practice Ellis distinguishes are choral drilling of exemplar patterns, and individual, discrete point grammar activities. Both of these are far from being communicative, group-work 'activities which will supply learners with comprehensible input and (which) therefore will enable them to acquire new linguistic features'(1993b: 8). However, it is motivating the use and design of such activities that Ellis cites as one of the main contributions of SLA research to second language pedagogy.

however, is the most problematic aspect of Ellis's model. None of the models I have described, apart from Anderson's, allow for interaction between two knowledge bases— they are simply consequences of cognitive function under different task conditions. One of the models Ellis cites to illustrate the strong interface position, which he rejects, that, 'explicit knowledge can change into implicit knowledge as a result of practice' (1993a: 96), that of McLaughlin, does not distinguish between two forms of knowledge at the representational level (see Schmidt, 1992b: 107 for discussion). Precisely what evidence is there for the claim, fundamental to the proposals Ellis makes, that explicit knowledge 'feeds into' (1993: 98) implicit knowledge, a term borrowed from Bialystok (1979) (who is guilty of similar obscurity in this matter; for discussion, see Odlin, 1986)? There is certainly no precedent for this in the work of Reber (1989), and although Mathews et al. (1989) have suggested that, under certain task conditions, and learning certain types of grammars, a mutually beneficial sequential relation between implicit and explicit modes of learning can be inferred this does not mean that the knowledge bases of these separate activities are interfaced. Ellis asserts, without ever explaining in terms of his constructs, that developmental data is evidence for the fact that explicit knowledge, at particular developmentally sensitive points, can trigger restructuring, or stagewise leaps in the complexity of the learners' implicit systems.

This is, in fact, the essence of Ellis's argument in favour of a role for the structural syllabus in pedagogy – there is development or restructuring which may be triggered by explicit instruction or focus on forms. As such his proposals need not invoke a distinction between implicit and explicit knowledge, which, I have argued, in the form Ellis presents it, is insufficiently motivated by empirical research into the nature of implicit and explicit processes. There are problems with this reduced position, as Ellis acknowledges, and I will briefly mention four. Sequencing a syllabus by structure implies assumptions about the order of learning, but i) we have insufficient developmental evidence to motivate decisions about all possible structures, ii) some structures may not be developmentally constrained, but variational (Pienemann, 1989), iii) there are variations in rate of progress through those developmental sequences that are assumed to be known, so groups of students cannot be treated homogeneously over time and iv) the precise point of learner development is difficult to identify from production

data since there is trailing, or recapitulation of developmental stages prior to the current one, and scouting, or initial excursions into a new developmental stage before the wholesale shift is made (Larsen–Freeman & Long, 1991).⁹

CONCLUSION

There is thus a danger of assuming the compatibility of the various definitions of knowledge I have considered without sufficiently addressing their differences. The working definitions of knowledge constructs needed for the purposes of second language theory construction should, I suggest, be clearly related to, and motivated by, empirical work in cognitive psychology and experimental second language research. If this is not done, the theory of second language learning based on such distinctions will be incoherent, and the resulting pedagogic proposals unclear, and I have argued that in Ellis's case this is so. Some reason therefore exists, I would argue, for definitional culling (see Long 1993; Berretta 1991) and for specifying the particular definition of 'implicit' knowledge one assumes if coherent theories, and clear proposals for pedagogy are to be based on the construct. My preference is for definitions based on fully specified models of the relationship of task conditions, (which may be labelled implicit and explicit, or direct and indirect) to inferences about knowledge at the representational level (see Appendix 2). Elsewhere I have proposed that implicit and explicit learning are 'fundamentally similar' processes in the adult, and close examination of the implicit learning and memory studies that have been done in cognitive psychology does not support the claim that different processing demands of implicit and explicit learning tasks result in distinct knowledge bases, or are supported by distinct memory systems (Robinson 1994). However, such conclusions are based largely on evidence of artificial grammar learning experiments (e.g. Reber 1989.; Matthews et al 1989) and there is a clear need for more second language studies which examine the acquisition of natural language under different experimental conditions, (e.g., Doughty, 1991;

⁹Given these considerations decisions about sequencing of structures are impossible to resolve. As Ellis admits, a linear syllabus in which structural items are presented one by one, according to some notion of learnability, is inadequate, particularly given point iii) above. A spiral syllabus, in which items are recycled more than once 'is still a hit-or-miss affair'(1993: 103), since it is impossible to motivate a decision about what structures to recycle and when.

N.Ellis, 1993; Hulstijn, 1990) which develop the paradigm initiated by Reber (1969).

Important questions such research could address are the extent to which changes in learning are consequent upon manipulations of assumed variables like degree of attention, and intention (Curran & Keele, 1993; Schmidt, 1990, 1992a). Other questions are prompted by the issue of learnability, or more properly, learnableness. What, given these conditions, can be learned? Are the conditions differentially sensitive to the degree of complexity of the stimulus domain (Reber, 1989) with more complex structures being learned faster, more robustly, and in a manner that permits of greater generalization to similar structures, under implicit but not explicit conditions? Is the notion of complexity to be motivated in terms of Universal Grammar (Sharwood-Smith, 1991; White, 1989), or in terms of processing models like those of Frazier (1985, 1988) and Smith (1988), or processing models supported by developmental evidence (Meisel, Clahsen, Pienemann, 1981; Pienemann, Johnston & Brindley, 1988)? Is learning under the two task conditions differentially sensitive to individual differences in cognitive capacities, with learning under implicit conditions being unaffected by such differences, in contrast to learning under explicit conditions (Reber, Walkenfield, Hernstadt, 1991)? In a second language context this could involve examining the contributions of individual differences in memory capacity or inductive language learning ability (see Skehan, 1989) as measured, for example, by subtests on aptitude batteries like the 'Modern Language Aptitude Test' (Carroll & Sapon, 1959). Such a research program would complement an approach to syllabus design that classifies and sequences tasks in a task-based syllabus (Long & Crookes, 1992) according to their assumed complexity at the level of cognitive function (Robinson, 1993). If complex tasks 'stretch' interlanguage (Long, 1989) it would be important to know whether such task driven complexifications can benefit from an explicit focus on form, and under what conditions, or whether some forms are better left to implicit processes. However, before we can specify a clear a role for implicit learning, or knowledge, in syllabus design, either structurally organized or task-based, it will be necessary to investigate such matters thoroughly, and with a clear idea of the relationship of the constructs we are using to those used elsewhere in cognitive psychology.

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APPENDIX 1.

A Model of Attention and Executive Control Processes

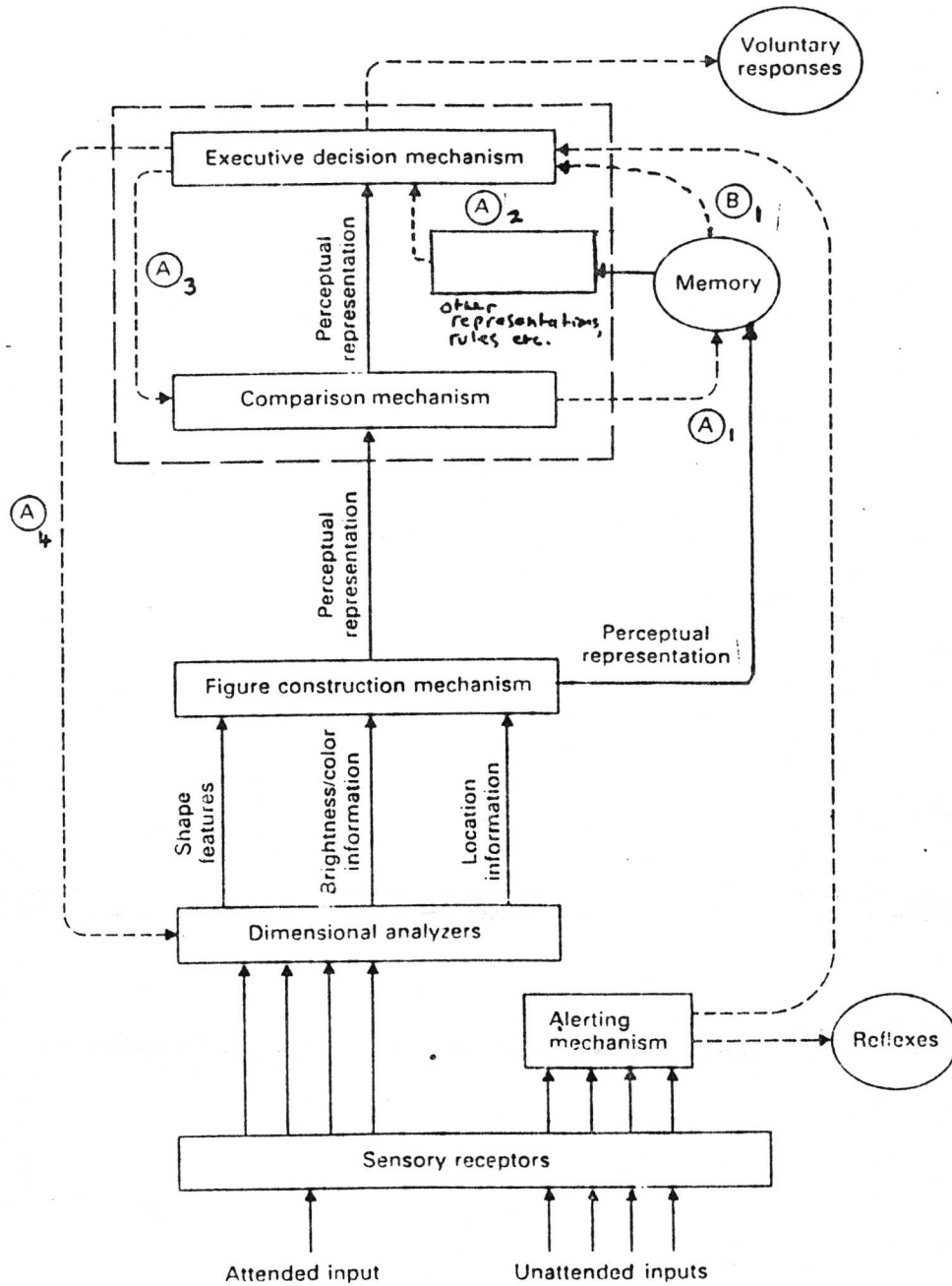


Figure 1.

APPENDIX 2

Fully And Partially Specified Models

Inferences are if then statements that relate levels. In Figure 2 inference 1 is an inference about learning which is based on differences in cognitive function as a consequence of behaviour under differently specified task conditions. This assumes a theory at the level of cognitive function. Inference 2 is an inference about knowledge which is motivated by phenomena explained at the level of cognitive function, and requires a theory at the representational level. Inference 3 is an inference about the memory which is motivated by the claim about knowledge and requires a theory at the neurophysiological level. Figure 3 shows the relation of inferences to levels when the task is a memory task, under specified direct or indirect conditions. Figure 4 shows how evidence at the neurophysiological level, for example from magnetic resonance imaging, can relate to inferences at the other levels. Figure 5 shows two partially specified models of relations between levels, and since these inferences are not related to specified task conditions, or are related to fundamentally differently specified task conditions, then direct horizontal comparisons between theoretical constructs at the representational level are not possible.

Implicit Learning Tasks

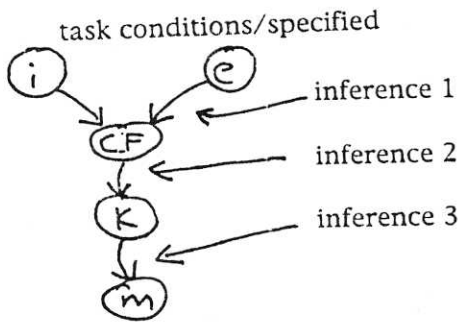


Figure 2.

Implicit Memory Tasks

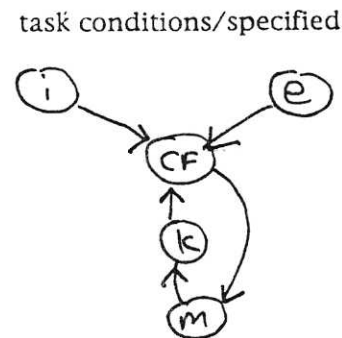


Figure 3.

Magnetic Resonance Imaging Experiments



Figure 4.

Partially Specified Models

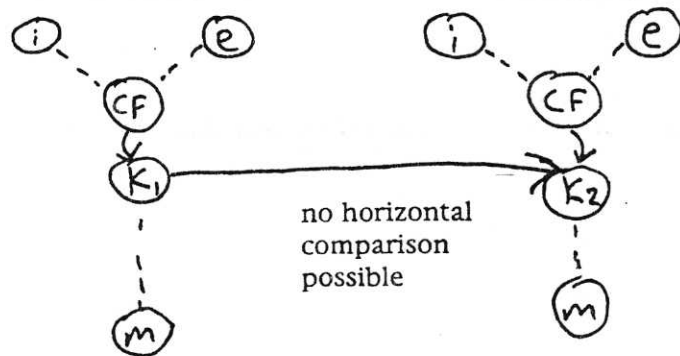


Figure 5.

APPENDIX 3

Cognitive Models of the Relationship between Task Conditions and Knowledge Representation

Anderson (1983)

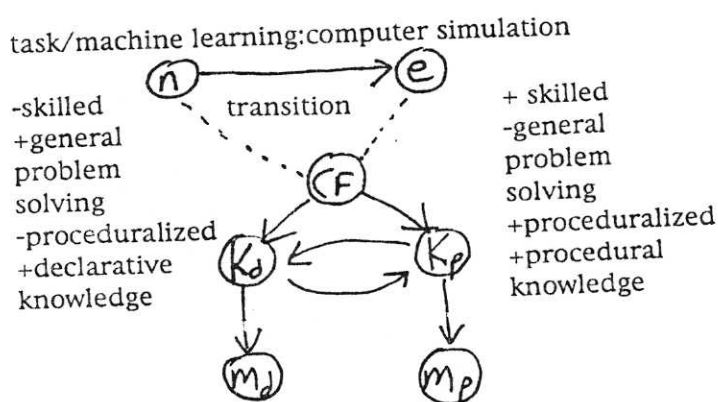


Figure 6

Reber (1989)

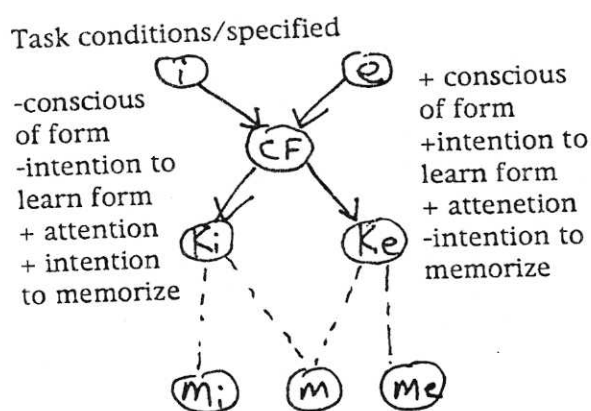


Figure 7

Krashen (1985)

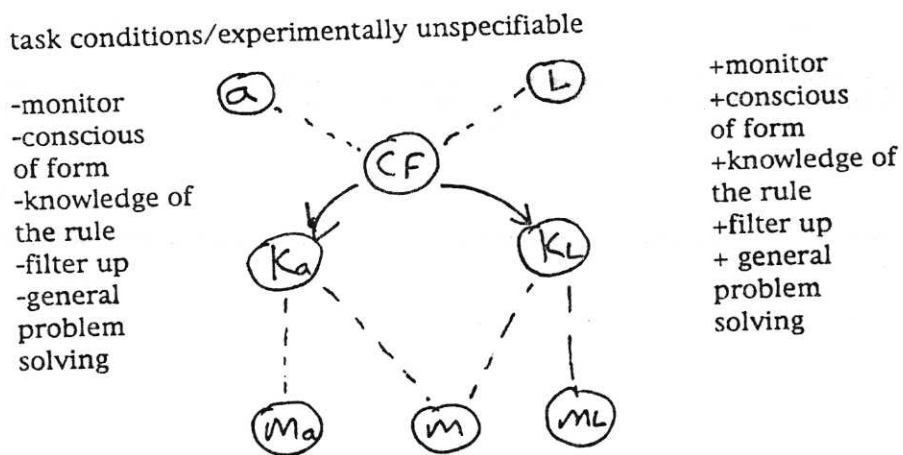


Figure 8

Logan (1988)

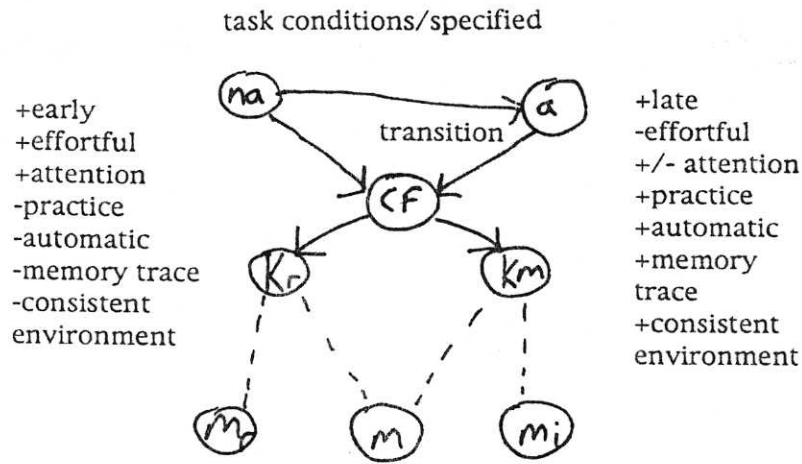


Figure 9.

Shiffrin & Schneider (1977): McLaughlin (1987)

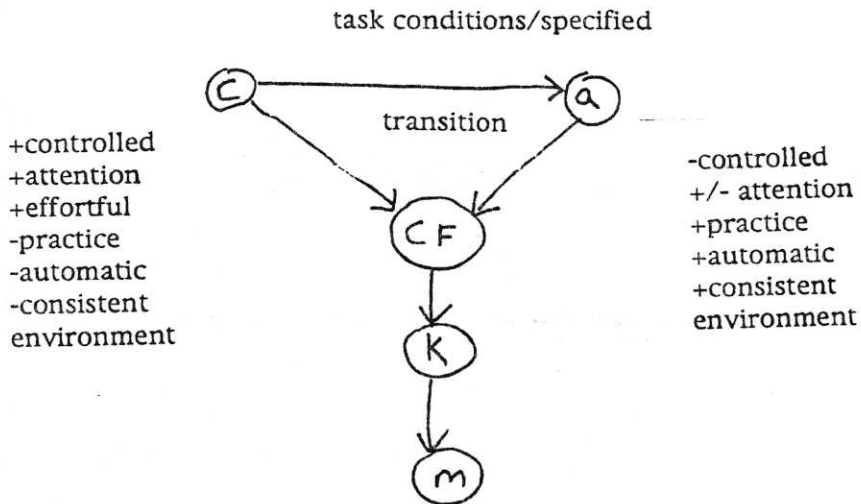


Figure 10