

INTRODUCTION Implicit and Explicit Language Learning - An Overview

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“Humans have devised ways of flying and accordingly discuss the mechanics. With swallows it is otherwise. And since swallows know nothing of technique, it never shows, never obtrudes upon their intent, joyous courses, from the day they leave their nest till their brightness falls from the air.” (Adams, 1980, p. 197).

INTRODUCTION Some things we just come to be able to do, like walking, recognising happiness in others, knowing that *th* is a more common than *tg* in written English, or making simple utterances in our native language. We have little insight into the nature of the processing involved - we learn to do them implicitly like swallows learn to fly. Other of our abilities depend on our knowing *how* to do them, like multiplication, playing chess, speaking pig Latin, or using a computer programming language. We learn these abilities explicitly like aircraft designers learn aerodynamics.

Implicit learning is acquisition of knowledge about the underlying structure of a complex stimulus environment by a process which takes place naturally, simply and without conscious operations. Explicit learning is a more conscious operation where the individual makes and tests hypotheses in a search for structure. Knowledge attainment can thus take place implicitly (a nonconscious and automatic abstraction of the structural nature of the material arrived at from experience of instances), explicitly through selective learning (the learner searching for information and building then testing hypotheses), or, because we can communicate using language, explicitly via given rules (assimilation of a rule following

explicit instruction). Two research questions naturally follow from these distinctions. What are the processes and resultant mental representations of implicit and explicit learning? Which of human cognitive capabilities are acquired implicitly and which learned explicitly? This second question is of both theoretical and practical pedagogic importance since teaching interventions are less relevant to implicitly learned skills but essential to explicitly learned ones.

Nowhere have these questions been more a matter of debate than in the realm of human language skills, both in native (L1) and second (L2) languages. Some people acquire languages automatically in the course of trying to communicate. Other people learn languages by studying vocabulary and grammar. And very many adults find second language acquisition (SLA) difficult or impossible.

L1

We acquire our first language (L1) by engaging in natural meaningful communication. From this 'evidence' and our innate capabilities of analysis, we automatically acquire complex knowledge of the syntactic and morphological structure of our language. Yet paradoxically we cannot describe this knowledge, the discovery of which forms the object of the entire discipline of theoretical linguistics. This is a difference between explicit and implicit knowledge - ask a young child how to form a plural and she says she does not know; ask her "here is a wug, here is another wug, what have you got?" and she is able to reply, "two wugs". The acquisition of L1 grammar is automatic and relies on instances rather than explicit rules - simple exposure to normal linguistic behaviour suffices and no explicit instruction or correction is needed.

But how do we come to have such rich and specific knowledge, or such intricate systems of belief and understanding, when the evidence available to us is so meagre? The target language made available to the learner is both underdetermined (information on whether an utterance is grammatical or not is missing) and degenerate (spoken language is full of noise and flaws). Since the early sixties, it has been argued that the gap between the "poverty of stimulus" and the complexity of the language knowledge accomplished by the mature adult

can only be explained under the assumption that much of the final state must already be present in the initial state, i.e., a very significant part of our linguistic competence must be innate. Thus it has been proposed that L1 acquisition depends on an input module specific to language (some form of ‘Language Acquisition Device’) whose workings are cognitively impenetrable to the language user. In these views we ‘learn’ our L1 like swallows ‘learn’ to fly - we are innately disposed to automatically and unconsciously acquire language.

Although there is general agreement that much of L1 acquisition reflects implicit learning, there is little accord concerning the details of the constituent processes. There is even, for example, continuing dispute over the high-level issue of linguistic nativism (a language-specific acquisition device) vs. empiricism (L1 acquisition by means of general implicit learning procedures).

L2

Some foreign language (FL) and second language (L2) teaching methods, like the ‘Audiolingual’ method which held sway between the Second World War and the early 60s and more recent ‘Natural’ and ‘Communicative’ approaches, maintain that the learning of second and other languages is just like L1 acquisition and as a result have renounced explicit grammar-based instruction. Such methods hold that acquired (implicit) knowledge and learned (explicit) knowledge of the type taught in traditional language courses are stored separately and that learned knowledge cannot be converted into acquired knowledge. Yet older children and adults can acquire and act upon rules and schemata; they can, for example, be taught grammatical rules for forming a plural. Traditional L2 teaching (Grammar Translation approaches) and the Cognitive Code method which was popular between the 60s and late 70s were heavily rule-based in that they held that perception and awareness of L2 rules precede the use of these rules. More recently, in the light of analyses of the disappointing abilities of graduates from ‘grammar-free’ foreign language programmes, there are again calls for a return to explicit methods. These pendulum-swings in educational practice suggest that there is no simple answer to which of these methods is ‘best’. Rather there is need for:

(i) a detailed theoretical analysis of the processes of explicit and implicit learning. What can be learned implicitly? If implicit learning is simply associationist learning and the induction of statistical regularities, what aspects of language can be so acquired? Just how modular and inaccessible are the implicit learning processes for language acquisition? What are the various mechanisms of explicit learning that are available to the language learner? If the provision of explicit rules facilitates, or is necessary for, the acquisition of certain forms, what are the appropriate nature of these rules? What are the developmental paths of implicit and explicit learning abilities? Are there sensitive periods for implicit language acquisition? What are the neural substrates of these processes?

(ii) an understanding of the representations and interrelations of explicit and implicit memory. There is considerable dispute over this question in linguistics. One view ('the non-interface position') is that metalingual rules can be learned for purposes of editing or self-correction, but they do not help acquisition: people can *describe* the rule which has been 'learned' but cannot apply it in conversation because they have not yet 'acquired' it (Krashen, 1982). Another ('the interface position') allows some 'seepage' from explicit metalinguistic to implicit knowledge whereby, as in the theories of development of automaticity in skills, practice under the guidance of explicit knowledge facilitates that acquisition of implicit knowledge. Others also allow for transfer in the reverse direction from implicit to explicit knowledge: implicit memory is primary but the development of self-awareness allows reflective examination, analysis and re-organisation of that knowledge resulting in a redescription at a higher level and the formation of new independent and explicit representations. These latter two possibilities are clearly not mutually exclusive.

(iii) applied linguistic analyses of which methods of instruction are better for which types of performance in which types of learner. The most comprehensive meta-analysis of exposure methods with those additionally involving instruction (Long, 1983) concluded that formal instruction does have a positive effect on L2 acquisition. But, as Long himself cautioned, such gross comparisons leave many questions unanswered. Which aspects of language acquisition are facilitated by instruction? What types of instruction are most beneficial? Are there individual differences in learner or learning-style which affect acquisition? Does type of

instruction interact with type of learner? If explicit instruction does facilitate acquisition, why? We need to understand the mechanisms, processes, and representations involved in L2 acquisition.

COGNITIVE SCIENCE

The motivation for this book is the belief that no one discipline can answer these questions: neither linguistics, psychology, philosophy, education, neuroscience nor connectionism. It is not that the questions are unanswerable, but rather that they are only tractable using the approach of cognitive science where all of these specialities collaborate in the quest. The chapters in this selection illustrate what each approach has to offer and how they might support and constrain the others. The authors' contributions to the grand inquiry are summarised below in, as they say in the movies when there are problems of priority of star status, 'order of appearance'.

DEFINITIONAL GROUND RULES

The role of conscious rules in language acquisition remains mysterious not only for want of further empirical investigation. Equally limiting are fundamental conceptual confusions in the very language which we use to address the question. SHARWOOD SMITH sets the stage by clarifying our notions of 'rules'. While we may all agree that (i) people's explicit knowledge is often stateable in terms of 'rules', (ii) fluent performance appears to be 'rule-governed', and (iii) languages, and especially grammars, can be usefully conceived as 'systems of rules', the meaning and implications of 'rule' is quite different in these three sentences. Analysing exactly what the concept of rule entails, particularly from a psychological point of view, focuses our attention on key issues such as (i) whether systematic, and thus apparently rule-governed, behaviour necessarily stems from rule-operated systems; (ii) whether rules as verbally explicated could properly reflect the underlying syntax of our mental mechanisms; (iii) whether implicit and explicit knowledge are mutually informed; and (iv) whether any kind of language acquisition is assisted by the learner's ability to analyse consciously aspects of the target grammar. He then examines various models of language acquisition and proficiency with particular reference to the role of metalinguistic knowledge, the distinction

between knowledge rules and rules of processing, and the types of evidence which can properly be brought to bear on these issues.

NO-, WEAK-, OR STRONG- INTERFACE?

During the 1970s and early 1980s KRASHEN undertook a thorough and systematic examination of the distinction between explicit learning and implicit acquisition of L2. His *Input Hypothesis* became both influential and controversial in applied linguistics, the combination of its radical nature and its clear and categorical polemics allowing ease of memorisation, application and attack. It is a strong non-interface position which posits that although adults can both subconsciously acquire languages and consciously learn about language, nevertheless (i) subconscious acquisition dominates in second language performance; (ii) learning cannot be converted into acquisition; and (iii) conscious learning can be used only as a Monitor, i.e. an editor to correct output after it has been initiated by the acquired system. In Krashen's theory, SLA comes naturally as a result of implicit processes occurring while the learner is receiving comprehensible L2 input. In the subsequent decade, four 'rival' explanations for L2 development have been proposed: Skill-Building, Simple Output, Output plus Correction, and the Comprehensible Output Hypothesis. All of these 'rival' hypotheses postulate that SLA accrues from practice in L2 production, some see a role for conscious learning, and one implicates negative evidence in tuning the learner's language representations. In Chapter 2 of this book, Krashen summarises his Input Hypothesis and illustrates these 'rivals'. He then evaluates the different positions against selected research findings from method-comparison designs. He argues that the Input Hypothesis is consistent with this research on SLA and literacy development, while strong versions of rival hypotheses are not consistent with the research. Specifically he asserts (i) that more comprehensible input consistently results in more second language competence and literacy development, while more correction, more conscious learning and more output practice do not (cf. chapters by R. Ellis, N. Ellis, and Kirsner for other views on the role of output practice); (ii) that methods containing more comprehensible input are consistent winners; (iii) that the system to be acquired is too complex to be consciously learned; (iv) that output and

correction do not exist in enough quantity to make a significant contribution to language development, and (v) that clear gains in competence can occur without conscious learning, output or correction, but not without comprehensible input. Krashen concludes by describing the affective advantages of the Natural Approach, the method which follows from the Input Hypothesis.

There is no denying that comprehension is the essential driving force of natural language development. It is learners' primary motivation and encourages their attention to the wealth of input data that they consequently expose themselves to. But it remains to be determined whether the gains in SLA accruing from the Natural Approach are a result of motivational, affective or cognitive factors. Classroom evaluations of the effectiveness of different teaching methods do not allow us easily to disentangle affect from cognitive effect, and we therefore require further controlled laboratory studies of the processes of instruction and acquisition, both from linguistics (see chapters by Schmidt; R. Ellis) and from psychology (Winter & Reber; Berry).

Furthermore, the demonstration that people acquire language from comprehensible input does not entail that acquisition is a result of unconscious or implicit learning processes. Consider the case of word acquisition: *contra* Krashen, it does not follow, from the fact that we have not been taught the vast majority of the words that we know, that vocabulary has been subconsciously acquired. That we have not been taught vocabulary does not entail that we have not taught ourselves. An implicit acquisition hypothesis would have to demonstrate (i) that acquirers really are unaware, (ii) that they fail to notice that the vocabulary item is novel, (iii) that they do not selectively attend to it, (iv) that they do not use a variety of conscious strategies to try to infer its meaning from the context and (v) that they do not apply metacognitive knowledge to guide application of appropriate mnemonic techniques to consolidate the new concept-label in memory. This is a tall order, but nonetheless necessary for the argument. The same is true for a theory of the implicit learning of syntax: acquirers' lack of conscious awareness has to be demonstrated, not supposed. And, more difficult still, for any particular grammatical pattern it is necessary to demonstrate that the learner has *never* consciously analysed it. The empirical rigour that this requires is not traditionally the stuff of

Applied Linguistics. As can be seen in the chapters by Winter and Reber, by Berry, and by McLaren, Green and Mackintosh, Psychology, which holds matters of consciousness to be firmly within its preserve, is having trouble enough investigating unconscious and implicit learning in the maximally controllable environment of the laboratory. But, as Schmidt argues, such operational rigour and conceptual clarity is as necessary for theories of language acquisition as it is for all domains of implicit learning.

Krashen acknowledges that, although a strong version of the Input Hypothesis provides the best account to date, in some cases acquisition does not do the entire job: in L1 there are rules of punctuation, grammar and spelling that even well-read people do not acquire, and adult L2 acquirers typically fall short of complete native speaker competence. He admits that conscious learning of such ‘late-acquired’ aspects of language can be used to supplement acquisition in these cases. But this spawns a host of responses. What are the aspects of language that might be implicitly acquired, and what is the role of explicit learning in the others? How do complexity of structure and salience of class-defining features affect the balance between implicit and explicit learnability? What patterns can be abstracted implicitly? What allows explicit learning capability - is it memory for particular episodes, or the ability to analyse a language string in working memory, or the fact that language itself allows statements of summary rules? What are the representations of language in implicit and explicit memory? What are the processes of implicit and explicit language learning and the role of attention in each? Are there developmental differences in general implicit learning potential? If not (some psychologists see implicit learning as being more developmentally invariant than explicit abilities - cf. Durkin’s chapter) why do there appear to be sensitive periods after which some aspects of language acquisition become less possible? Is there then a special implicit learning system particular to language acquisition, or is it a general learning potential? Is L2 acquisition the same as L1, or is Universal Grammar (UG) inaccessible to L2? There are many more such questions.

The *Input Hypothesis* is an important attempt after a general theory of SLA. It was a timely redress to educational practices which saw natural language as a subject of academic study rather than a medium for fluent communication. Audacious ‘General Theories’

commonly hold many truths as rough approximations and falsehoods in particulars. Their most valuable contribution lies in the ensuing debate and consequent enquiry. Many of the above-detailed questions are current in applied linguistics as a result of Krashen's statement of his *Input Hypothesis*. The chapters in this book review recent linguistics research addressing these matters but also demonstrate that other disciplines share these concerns and are necessary companions in their resolution.

In Chapter 3 R. ELLIS presents his theory of instructed second language (L2) acquisition. He analyses the L2 learning situation and describes the different aspects that any theory of L2 acquisition must address. His theory is also based on a general distinction between implicit and explicit L2 knowledge but, following Bialystok and McLaughlin, this is treated as a separate dimension from controlled and automatic processing. R. Ellis' theory addresses (i) how implicit knowledge is acquired and used; (ii) how explicit knowledge is acquired and used; (iii) the relationship between the two types of knowledge; (iv) the automatization of L2 knowledge; and (v) the role of other knowledge (world knowledge and first language knowledge). While Krashen's is a non-interface model, R. Ellis allows a weak interface between explicit and implicit knowledge: in this view explicit knowledge plays a significant role in L2 acquisition. The main loci of these effects are in the perception of, and selective attending to, linguistic form: (i) by facilitating the processes of 'noticing' (i.e. paying attention to specific linguistic features of the input) and (ii) by 'comparing' (i.e. comparing the noticed features with those the learner typically produces in output). Thus it is hypothesised that, under certain conditions (e.g. that the learner is 'developmentally ready' to acquire a new form), explicit knowledge can be converted into implicit knowledge, although this does not constitute the primary means for developing implicit knowledge. In contrast to Krashen's model, R. Ellis also sees benefit in output practice which allows both explicit and implicit knowledge to become automatized.

Krashen and R. Ellis agree that the majority of SLA comes about as a result of implicit learning. But what are the details of the processes involved and the resultant representations? The next section reviews relevant psychological enquiries. Krashen and R. Ellis disagree on a

number of key issues which are dealt with in later chapters: (i) the degree to which explicit knowledge affects the acquisition of fluent linguistic competence (both in grammar and lexis); (ii) the ways in which this is modulated by the complexity of the underlying structure (N. Ellis; Schmidt; Cook; Rutherford; Chamot & O'Malley; Paradis); and (iii) the role of output practice on L2 acquisition (N. Ellis; Kirsner).

THE PSYCHOLOGY OF IMPLICIT LEARNING - ARTIFICIAL GRAMMARS AND COMPLEX TASKS

Reber (1967) was the first to demonstrate people's ability to learn artificial grammars (AG) implicitly: information was abstracted out of the environment without learners' recourse to explicit strategies for responding and this implicitly-learned information could later be efficiently applied in transfer recognition tasks. Since that date there has been considerable progress in analysis of implicit and explicit learning of artificial languages in tightly-controlled empirical investigations, and Reber has proposed a theory of implicit learning which goes beyond the context of such experiments by claiming to reflect universal processes of human learning that are responsible for the development of tacit knowledge of all kinds. Implicit learning is the process by which knowledge about complex, structured environmental displays is acquired largely independently of awareness of both the processes and the products of acquisition. In their chapter, WINTER & REBER argue that the basic principles of implicit learning can, in principle, serve as a model for understanding the process of natural language learning. First they review the literature supporting the view that implicit induction routines yield a knowledge base that is both abstract and tacit - two requirements that any candidate theory of language acquisition must satisfy. Second, they take an evolutionary biological standpoint in order to show how implicit acquisition processes fit with the explicit, consciously modulated operations that are more often studied. Finally, they provide a critique of the nativist stance with respect to language acquisition. Rather than view the ontogeny of language as being the result of an innately given Universal Grammar (UG; cf. Roberts; Cook; Rutherford) whose essential epistemic content is innately specified, they argue for an empiricist model of language learning based on the basic

principles of implicit learning. In their view, then, the acquisition of natural language could occur as a result of general processes of implicit learning.

One major contribution of their chapter is the conceptual and operational clarity which it offers concerning the assessment of abstractness of representation and the degree of conscious involvement in learning and recall. Although assessment criteria for 'consciousness' are, and will remain, a matter of heated debate, Psychology has made considerable progress in their operationalisation. Of course this is much easier in the laboratory than the classroom or conversation-place; but, however exacting, the use of such detailed assessment criteria in studies of consciousness in L1 and L2 acquisition would considerably clarify the issue.

BERRY continues this theme by reviewing other psychological research concerning the distinction between implicit and explicit learning. Firstly, she describes a number of recent studies on human control of complex systems which suggest that dissociations between task performance and verbalisable knowledge, while still evident, may not be as complete as was at first thought. Although the majority of knowledge of such tasks is acquired implicitly, people clearly can develop some explicit knowledge as a result of such experience (in a way reminiscent of the natural development of metalinguistic knowledge during the course of essentially implicit early L1 acquisition). Secondly, she suggests that rather than simply demonstrating or denying dissociations, studies should focus on the conditions that lead to different types of learning and hence different forms of knowledge. In line with this, Berry re-examines the earlier distinction between explicit and implicit (or selective and unselective) learning modes and suggests that earlier characterisations may have been a little extreme. Of particular relevance to L2 learning is the conclusion, which replicates across AG and complex system control research, concerning the salience of underlying structures: adopting a more explicit hypothesis testing mode of learning is beneficial when key relationships are salient, but can be detrimental when key relationships are not salient or obvious. Finally, on the basis of this research on the control of complex tasks, Berry makes a number of

methodological, theoretical and practical recommendations for future research in the field of second language learning.

IMPLICIT LEARNING OF NATURAL LANGUAGE GRAMMAR

SCHMIDT is one of the few linguists who have adopted the conceptual and experimental rigours of experimental psychology in answering questions concerning the role of consciousness in L2 acquisition. He begins his comprehensive chapter with two cautions: (i) it cannot be automatically assumed that a theory derived from experiments with artificial grammars can legitimately be extended to encompass the learning of natural languages, and (ii) the concept of implicit learning contains within it a number of separable hypotheses, some of which are more controversial than others, but each of which has generated various methodological and theoretical objections in the literature. His chapter unravels the claims and counterclaims that have been made concerning the implicit learning of artificial and natural languages and assesses in parallel the evidence from psychology and applied linguistics with respect to the following questions: (i) the issue of unintentional (incidental) learning; (ii) the role of attention in learning; (iii) the links between implicit learning and both intuitive judgements and spontaneous performance; (iv) the core concept of unconscious induction; (v) the competing claims of symbolic processing and connectionist accounts of implicit learning; and (vi) the effects of instruction on implicit learning.

He concludes that (i) implicit learning occurs in laboratory experiments and SLA; (ii) attention to input is necessary for explicit learning and may be both necessary and sufficient for implicit learning, but there is no learning of unattended stimulus features; (iii) explicit learning may be necessary for learning some types of artificial grammar and some features of natural language. He agrees with Reber that the implicit learning operating here is of a very general type and has no peculiarities which necessitate the positing of a language-specific acquisition device. However, unlike Reber, he argues that much implicit learning is based on memory for particular instances, and that knowledge so gained is probably less abstract than is typically assumed (see also the chapter by McLaren et al. for a recurrence of this theme).

Finally he emphasises that research into the role of consciousness in SLA will not make substantial progress until the learner's degree of awareness is properly assessed.

IMPLICIT AND EXPLICIT PROCESSES OF VOCABULARY ACQUISITION

The chapters thus far have primarily concerned L2 grammar acquisition. But the bedrock of L2 is its vocabulary, and a focus on lexis allows the application of a variety of well-developed psycholinguistic techniques and increasingly rich neuropsychological evidence in addressing the involvement of consciousness in L2 vocabulary acquisition.

N. ELLIS reviews research related to L2 and L1 vocabulary acquisition in the areas of (i) incidental vocabulary learning, (ii) the associations between vocabulary and academic intelligence, (iii) priming studies of implicit memory, and (iv) neuropsychological evidence from human global amnesia. These diverse areas of research reveal that vocabulary acquisition neither depends solely on implicit learning, nor does it purely reflect explicit learning. Rather, there is a dissociation whereby the recognition and production aspects of vocabulary learning rely on implicit learning, but meaning and mediational aspects of vocabulary heavily involve explicit, conscious learning processes. The L2 or L1 learner must acquire the input/output mechanisms (I/O) of new vocabulary: namely the pronunciation elements and their compounds in the tongue, as well as the graphemes and their patterns of orthographic combination in the script. N. Ellis demonstrates that there are specialised modules, the input and output lexicons, which acquire the word forms and regularities of the surface form of language by implicit learning processes. Like other sensory or motor skill systems, these modules do so automatically and they are tuned by practice - by frequency, recency, and regularity. To the extent that vocabulary acquisition amounts to learning these surface forms of language, vocabulary acquisition is an implicitly acquired skill. Even amnesics who have very impaired explicit memory can acquire new vocabulary in this sense. However, the function of words is meaning and reference, and the mapping of I/O to semantic and conceptual representations is a cognitive mediation dependent upon explicit learning processes. It is heavily affected by depth of processing and elaborative integration with semantic and conceptual knowledge. Amnesic subjects have great difficulty in these aspects of vocabulary acquisition. But metacognitively sophisticated language learners excel because they have cognitive strategies for inferring the meanings of words, for enmeshing

them in the meaning networks of other words, concepts and imagery, and for mapping the surface forms to these rich meaning representations. To the extent that vocabulary acquisition is about meaning, it is an explicit learning process. N. Ellis describes the operating characteristics of the input and output lexical modules, and those of the explicit cognitive systems which mediate with semantics and conceptual systems. Finally he briefly summarises the pedagogic implications of acquiring different aspects of lexis by different learning processes.

KIRSNER presents a detailed psycholinguistic analysis of the critical role of implicit processes in the acquisition of vocabulary, focusing specifically on theoretical questions associated with role of exercise, morphology, modality and meaning in vocabulary acquisition. Two basic propositions are advanced in his chapter. The first of these is that the role of practice in *first* language vocabulary acquisition has been vastly under-estimated. The practice-counts for early words may be 100 or more times greater than 'comparable' words encountered at or after maturity. This body of highly practised lexical procedures, for use in pattern recognition and production, provide a basic pool of 'automated' examples. Kirsner argues that in the absence of an immersion programme, the second language learner will never enjoy the use of pattern recognition or production procedures which remotely approach the levels reached by first language users. The second proposition is that lexical performance in children and adults can be explained by reference to the power law of learning without recourse to specifically 'lexical' models, and that this model generalises to SLA, vocabulary items which are shared between languages, and modality and morphology effects which operate within and between languages (although he cautions, as N. Ellis suggests, that this proposition may not extend to semantic and associative processes). In brief, Kirsner contends that the lexical system is partitioned by modality, where: (i) separate systems of representation are developed to facilitate the communication of symbolic information for each modality (e.g., printed language, spoken language, signs, objects etc.), and (ii) classification of any one stimulus necessarily involves reference to representations defined by both: (a) input modality, for perceptual analysis, where this is defined by stimulus modality,

and (b) output modality, for pre-motor planning, where the latter is determined by the task and/or response demands as distinct from stimulus modality. Thus two serially organised information processing stages are involved in naming, word identification or lexical decision. The model therefore suggests that these tasks can be understood as the summation of one information processing principle which lies at the heart of implicit learning: the power law of practice governs performance in two otherwise independent information processing stages.

Kirsner additionally introduces an important methodological point. Much of the work which underpins the separation of implicit and explicit memories rests on findings from the application of a method which stemmed from experimental research in cognitive neuropsychology, namely the technique of double dissociation. This technique identifies tasks as separate when they involve at least one unique process. Thus if Task 1 involves processes [x,y,z] and Task 2 involves [x,y,w] then it is in principle possible to find evidence for their double dissociation - individuals with impaired process [z] will be able to do Task 2 but not Task 1; individuals with impaired process [w] will be able to do Task 1 but not Task 2. However, as the technique is increasingly applied, so we are discovering more and more double dissociations - not simply *between*, for example, implicit and explicit memory systems in clinical cases (or by inference after manipulation of variables such as depth of processing or retention interval which affect one system but not the other), but also dissociations *within* these domains as well. Kirsner warns: "the danger may be that it (double dissociation) can be used to demonstrate that any pair of tasks involve unique processes in some sense. The tool is too powerful, and it is committed to analysis or division. It does not indicate which things go together" (p. ***). Research must dissect and analyse differences with well-honed conceptual and methodological instruments. But it must also synthesise and put together correlated particulars. We must tease out the separate aspects of 'consciousness' and 'rules', the separable representational systems and processes of cognition, the divisions between implicit learning and memory, etc. But further we must note their likenesses and the ways in which they interact and influence each other. The progress of our enquiries depends upon a proper balance between 'splitting' and 'lumping'. We have not yet discovered the

‘basic level categories’ (Rosch et al, 1976) of cognition, but we can be sure that they lie at neither extreme.

INSIGHTS FROM ANIMAL LEARNING

MCLAREN, GREEN AND MACKINTOSH address this question of balance from the perspective of animal learning theory. They point out that the distinction between implicit and explicit learning and memory has been drawn in a variety of ways, not all of which coincide. By reference to work in animal learning, they illuminate the distinction between implicit learning as an automatically engaged, associative process and explicit learning as strategic and cognitive, resulting in beliefs and reasons for those beliefs. Using this distinction, and evidence from both real and hypothetical experiments with animals, they argue that several dissociations in performance thought to reflect a distinction between implicit and explicit processing should not be taken at face value. Learning characterised as explicit as a result of such dissociations is often more profitably regarded as implicit (i.e. as associative) and they demonstrate dissociations between different types of implicit learning task in animals and in humans. They analyse what types of learning are possible using associative mechanisms, and how working memory (in the short term) and episodic memory (in the long term) is necessary for explicit, cognitive learning.

In their chapter Winter and Reber earlier emphasised the primacy of the implicit; similarly McLaren et al. argue that, in the tasks which they consider, the first stages of learning are associative, and cognitive learning only occurs when people start to notice certain particularly salient or simple patterns and thence form hypotheses about them. This is the same ‘noticing’ which psychologists Berry and Reber hold to be important for explicit learning generally, and which linguists Schmidt and R. Ellis hold important for SLA. Schmidt’s definitions are illustrative: (i) “the subjective experience of ‘noticing’ is the necessary and sufficient condition for the conversion of input to intake in SLA. A further extension of the noticing hypothesis is that what must be attended to and noticed is not just the input in a global sense but whatever features of the input are relevant for the target system, i.e. that in order to acquire phonology one must attend to phonology; in order to acquire pragmatics, one must

notice both linguistic forms and the relevant contextual features; etc.”; (ii) “Noticing is used here as a technical term to refer only to registration of the occurrence of a stimulus event in conscious awareness and subsequent storage in long term memory, not the detection of form/meaning relationships or inductive formation of hypotheses or other processes that may lead to the organisation of stored knowledge into a linguistic system” (p. ***).

INTERIM SUMMARY: A SKETCH MAP OF LANGUAGE-LEARNING MECHANISMS

It is appropriate at this point to try to state a working synopsis of the views outlined thus far.

- Animals and humans alike share abilities of implicit, associative learning.
- These processes of detection of environmental pattern will occur only in attended input domains.
 - Much of implicit learning is based on memory for particular instances. However, sufficient frequency and regularity of intake will tune implicit input systems to preferentially perceive and chunk recurrent patterns. Simple and salient features are most readily acquired, but the correlation detectors of implicit systems and connectionist models are also capable of identifying numerous, varied, multi-levelled and non-linear combinations of features in complex and even internally-contradictory stimulus domains. Input processing works on the surface form of stimuli, and any regularities extracted by input systems are at a relatively superficial level of structure. They do not seem to be as profound in their transferability as symbolic representations which allow for metaphors and analogies spanning large conceptual distances. In contrast, the abstractions of implicit systems are relatively inflexible and do not readily afford transfer to other feature domains.
- Humans additionally are capable of explicit learning dependent on a working memory (WM) system which employs sequential symbol processing. Working memory has various sources of input: it is fed by the highest, most patterned level of output from implicit input systems (it is this level that can be ‘noticed’); it has access to long-term explicit memories of

discrete events; it has access to declarative information comprising statements of rules and facts in long-term memory.

- Anything that has been ‘noticed’ in WM can potentially be stored as an explicit, episodic long-term memory (LTM).

- Anything that has been ‘noticed’ in WM can potentially be described verbally. Such verbal descriptions can be stored in declarative memory. The richness of potential symbolic descriptions for any particular content of WM ensures that such verbalisable rules are maximally potentially abstract and have the greatest capacity for transfer across feature domains, modalities and semantic space.

- Pattern detection also occurs in WM, but this is of very different types from that occurring in input modules: (i) because WM is not tied to one particular modality of input it can identify covariance across input modalities; (ii) it can identify a match between an input pattern and pre-existing episodic memories - particular input patterns can remind, causing the accessing of episodic memories and declarative knowledge; (iii) because it can cause the explicit recall of episodic memories it can identify regularities between them; (iv) it can identify whether an episode of input or memory agrees with or contradicts a declarative summary or rule.

- Identification of patterns in working memory allows subjects to give verbal descriptions of their awareness, and to summarise and store this awareness as further declarative rules in LTM.

- Because language is also a medium of inter-personal communication, declarative statements of ‘rules’ can be transmitted from one person to another once these have been discovered. The language learner can be taught pedagogical rules; the linguistics student formal grammars; the psychology student models of human information processing.

- Such verbal rules, whether discovered or instructed, must be succinctly stateable and readily accessible if they are to guide on-line processing and performance. Language as a whole is a very complex system, but only simple and salient structures are governable by explicit on-line control.

- Declarative rules can be used for conscious, attentive, usually slow, regulation of output. Sufficient practice under such guidance can result in the tuning of output modules (which themselves learn according to implicit associative principles) so that eventually these sequences can be performed automatically, without further attentional demand.
- Declarative rules can also have ‘top-down’ influences on perception. They can influence the ‘Central Executive’ of working memory (Baddeley, 1986) or ‘Supervisory Attentional System’ (Norman & Shallice, 1986) to guide input to working memory in a variety of ways¹: (i) they can focus attention on the relevant modality, representation and level of processing (e.g. to concentrate on the phonology, or the morphology, or the stress, etc.); (ii) they can make salient the relevant features (e.g. concentrating on the end of the word or the phrase boundaries), (iii) by making active particular units in working memory this in turn may reinforce corresponding output patterns of the input systems, thus allowing learning mechanisms to tune the operation of input modules in a fashion analogous to ‘teacher’ signals propagating through connectionist networks to optimally tune the weights (see chapter by Broeder & Plunkett) - i.e. conscious awareness of a pattern or chunk in WM may reinforce the input systems’ implicit learning and increase the likelihood of it perceiving that pattern in future.

This short summary leaves much to be desired. There is far too much waving of hands and far too little specification of computational detail. But perhaps it may usefully serve at least to apprise (or remind) us that the human cognitive system is multifaceted and versatile. If language is cut from the same cloth as other cognitive processes and can be understood in terms of the same underlying architecture and skill-acquisition processes, then the human learner has a repertoire of different learning processes that may be brought to bear in the acquisition of language. Our continuing enterprise lies in the determination of the particular involvements of these, their products, and their interactions.

VERBAL METALINGUISTIC RULES- INDUCTION, INSTRUCTION AND CONTROL

¹ (‘and here a miracle occurs’ - while this is undoubtably true, we have as yet little idea about the mechanisms and processes that are involved).

How might having language affect language acquisition? What are the ways in which declarative rules about language might be induced? How could they control language acquisition and production? What do good language learners know about language as an object and about themselves as language-learners? Can language learners be helped by being taught pedagogical grammar rules? This section concerns these issues of verbal descriptions of language itself.

Like McLaren et al., BENTALL AND DICKINS emphasise that, in order to understand the phylogeny, ontogeny and the different mechanisms of learning and memory, there is a need for greater communication between cognitive researchers and those working in the experimental analysis of behaviour. They exploit evidence from learning theory which is directly relevant to the distinction drawn by cognitive psychologists between implicit and explicit learning, and they point to some similarities between the work of modern cognitive psychologists and that of the founders of the behaviourist movement, particularly Pavlov, Watson and Skinner. Research with human adult subjects has generally shown that responding in both Pavlovian and operant conditioning experiments is qualitatively and quantitatively different from that of other species. In contrast, the performance of preverbal infants is much more similar to that of nonhuman organisms. Available evidence indicates that human adult responding in conditioning experiments is a function of the subjects' ability explicitly to formulate the experimental contingencies, and that the development of explicit learning skills is closely related to the emergence of language. In the final part of their chapter they review recent research on equivalence learning, a type of learning which appears to be implicated in various aspects of symbolic behaviour such as naming and using syntactic relations, and which has been extensively studied by learning theorists. Whereas verbal humans readily form equivalence relations, nonhuman animals do not readily show evidence of emergent relations, nor do learning-disabled children who lack functional speech or language skills. Such parallels between the phenomena of equivalence learning and language suggest either that equivalence class formation is a by-product of linguistic processes, which may be explicit, or that the capacity to form equivalence classes is a more fundamental attribute, probably implicit, which underlies language itself. Another possibility is that

language and equivalence are simply parallel consequences, not necessarily interdependent in any way, of the same neural/cognitive system which appears to be unique to humankind. They argue that further research into equivalence phenomena, employing both cognitive and learning theory methodologies, is crucial in order to disentangle these consequential alternatives and thus to provide important evidence about the relationship between implicit and explicit learning processes.

Bentall and Dickens demonstrate that the ability to form verbal 'rules' allows humans to go beyond implicit learning, to transcend animal behaviour patterns by forming and testing hypotheses and to regulate their behaviour in accordance with their verbally stateable beliefs or strategies. Such 'rules' can be culturally transmitted and thus we can investigate their role in the acquisition of language itself. Language-specific explicit knowledge is termed 'metalinguistic knowledge' and it is this that CHAMOT AND O'MALLEY address in their chapter. They begin with an account of early research on the strategies of language learners which sought to identify the characteristics of the good language learner and to classify learner strategies. Learners are mentally active during the learning process as they select information from their environment, organise it, relate it to their prior knowledge, decide what needs to be remembered, use the information appropriately and reflect on the level of success of their learning efforts. Chamot and O'Malley provide cognitive accounts of the descriptions of explicit techniques for language learning reported by good language-learners, and argue that differences in the learning approaches of effective and less effective language learners indicate that metacognition, rather than frequency of learning-strategy use, may be the major factor in determining the effectiveness of individuals' attempts to learn another language. The benefits of instruction in strategies for assisting less effective language learners to become more effective are explored, and their chapter concludes with a discussion of the contributions of learner and learning strategies to second language acquisition, and how these relate to explicit and implicit notions of language learning.

It is hard to understand the mechanisms and processes of fluent skill. Paradoxically we can often learn more about normal functioning by studying abnormal cases where, as a result of accidental ‘natural experiments’ involving brain lesion, fluency is compromised. Thus neuropsychology has become an essential sub-discipline of cognitive science. Indeed language processing has been the paradigm case in the history of neuropsychology because brain lesion does not typically result in total language loss, but instead particular dissociable components of language are damaged. Thus we can identify the disparate modules and processes which cooperate in the total activity of understanding and producing language. The dissociation between productive and receptive L1 processes in Broca’s and Wernicke’s aphasias was perhaps the first double dissociation in neuropsychology. It is only relatively recently that clinical cases relevant to L2 and bilingualism have been studied. In his chapter, PARADIS points out that Krashen’s distinction between implicit linguistic competence (acquisition) and metalinguistic knowledge (learning) is realised in neuroanatomy - they rely on different underlying cerebral systems, their contents are of a different nature and consequently metalinguistic knowledge cannot *directly* become linguistic competence through gradual automatization. Patients with Korsakoff’s syndrome, or amnesia, have impaired explicit memory but intact implicit memory; patients with aphasia have impaired implicit memory for language (or of the automatic use thereof) without loss of explicit knowledge. Normal speakers have two different sources of knowledge that can be used alternately but not concurrently to produce utterances. Furthermore, these two types of knowledge stem from different sources: essentially, grammatical competence is acquired in school and communicative competence is acquired on the street. Different teaching methods allow for varying degrees of conscious learning and incidental acquisition. Paradis claims that the involvement of the emotional/motivational components of the limbic system at the onset of the microgenesis of utterances during the period of language acquisition may, as a consequence, focus the individual’s attention on the message to be understood or communicated and hence away from the form, and thus facilitate the development of procedural memory for language. Thus failure to integrate the language system into the phylogenetically and ontogenically prior communication system through lack of limbic

participation during L2 formal learning may be one factor that reduces incidental acquisition in the classroom. He next considers the relationships, both in processing and neuroanatomical terms, between L1 and L2. He argues that L2 is learned, represented, and processed in ways qualitatively similar to L1, but that it varies quantitatively in the degree of necessary reliance on metalinguistic knowledge and/or pragmatic aspects of language use, as a function of the extent of linguistic competence achieved. Like N. Ellis, he shows that the lexicon is at least in part subserved by declarative memory whilst morphosyntax is subserved by procedural memory. He claims further that, since lexicon and morphosyntax are subject to different maturational constraints imposed on procedural memory, then patterns of cortical organisation associated with the processing of morphosyntax are altered to a greater extent as a function of age of first exposure than those associated with the processing of vocabulary. Finally he considers the apparent paradox that some bilingual aphasic patients regain better access to the language they spoke the least well before insult, suggesting that this may reflect their ability to use their intact metalinguistic knowledge for their formally learned L2 as a compensatory strategy, in the context of an impaired linguistic competence in both languages.

CONNECTIONISM

Since the early 1960s it has been argued that the gap between the “poverty of the stimulus” and the complexity of language knowledge accomplished by the mature language user can only be explained under the assumption that human beings are equipped with an innate mental system for language acquisition. Understanding the mechanisms of language acquisition at algorithmic and implementational levels thence became a major goal of Cognitive Science. Initially this mental system was described in terms of symbolically and categorically defined principles or rules. But recently a promising alternative to symbolic accounts of language acquisition has been offered by Connectionism which has claimed that artificial neural networks, using simple learning algorithms, can exhibit behaviour previously assumed to be characteristic of rule-governed systems, even though the connectionist nets do not contain explicit rules. Connectionism attempts to develop computationally explicit

parallel distributed processing (PDP) models of “implicit learning” in well-understood, constrained and controllable experimental learning environments.

We need to assess just how much of language acquisition *can* be done by extraction of probabilistic patterns of grammatical and morphological regularities. Since the only relation in connectionist models is strength of association between nodes, they are excellent modelling media in which to investigate the formation of associations as a result of exposure to language.

There have been a number of compelling demonstrations for L1 acquisition. The pioneers were Rumelhart and McClelland (1986; 1987) who showed that a simple learning model reproduced, to a remarkable degree, the characteristics of young children learning the morphology of the past tense in English - the model generated the so-called U-shaped learning curve for irregular forms; it exhibited a tendency to overgeneralize, and, in the model as in children, different past-tense forms for the same word could co-exist at the same time. Yet there was no “rule” - “it is possible to imagine that the system simply stores a set of rote-associations between base and past-tense forms with novel responses generated by ‘on-line’ generalisations from the stored exemplars.” (Rumelhart and McClelland, 1986, p.267). More recently, with the development of network architectures which integrate time as a dynamic dimension in the representations embodied within a network (e.g. simple recurrent networks, SRNs), temporal aspects of language processing such as word order have been investigated to demonstrate, for example, that grammatical class information can be extracted simply from the analysis of sequential word probabilities in utterances (Elman, 1990).

Only in the last five years has the connectionist approach been applied to the particular issues of SLA. In their chapter BROEDER AND PLUNKET first explain the basic assumptions of Connectionism by describing different kinds of neural network model. The advantages of connectionist models over traditional symbolic models are that (i) they are neurally inspired, (ii) they incorporate distributed representation and control of information, (iii) they are data-driven with prototypical representations emerging as a natural outcome of the learning process rather than being pre-specified and innately given by the modellers as in more nativist cognitive accounts, (iv) they show graceful degradation as do humans with language

disorder and (v) they are in essence models of learning and acquisition rather than static descriptions. Broeder and Plunkett next demonstrate how recent Connectionist studies have addressed various issues specific to SLA: (i) the determining role of type/token frequency of units in the input, (ii) the role of interference and transfer from L1 both in SLA lexis and word order properties and (iii) the effects of memory-size restrictions, learning rate differences, and prior knowledge on individual differences in SLA, particularly the ‘adult language-learning paradox’.

It is clear that connectionist models are already playing a vital role in our understanding of SLA. At least we can use them to assess just how much of SLA can result from the extraction of regularities of input by simple learning algorithms. The delimiting of these extents will allow us to determine whether simple implicit learning mechanisms could in principle show the full properties of a recursive, structured-symbolic rule system (a true linguistic grammar). Some Cognitivists have expressed doubt whether connectionist systems will be able to deal with the full compositionality and systematicity of language and thought (e.g., Fodor & Pylyshyn, 1988; Pinker, 1988). We await further tests of the extent of applicability of connectionist language acquisition before we can decide if implicit learning in such systems is sufficient to account for SLA or whether it is necessary to additionally posit higher levels of symbol manipulating devices which operate according to the language of thought.

The testing of these limits will also have profound implications for the debate concerning linguistic nativism vs. empiricism. Most connectionist accounts of language acquisition use generic PDP architectures - for example one class of SRN is as likely to be used for modelling strings of language as it is sequences of motor programme in the basal ganglia or short-term memory lists in the articulatory loop; what differs between these models is the nature of the input data. Each success of generic PDP models in learning language restricts the degree to which it is necessary to invoke a Language Acquisition Device, a genetically pre-programmed mechanism whose specific capability is to impose structure upon the linguistic environment, and in turn further extends the involvement of general implicit learning mechanisms that are simply responsive to structure in the environment.

UNIVERSAL GRAMMAR THEORY

The Chomskyan view of language posits that L1 acquisition represents the extreme of implicit learning - (i) the language acquisition mechanism is innate; (ii) exposure to noisy and incomplete language results in immensely rich and complex L1 knowledge of which most speakers (with the exception of a handful of professional linguists) are blissfully consciously unaware and (iii) explicit learning plays no real role, at least as far as grammar is concerned.

ROBERTS present an introductory overview of Chomsky's theory of first-language acquisition and language universals. He illustrates the detailed and intricate complexity of the implicit knowledge which is the final state of adult language and then presents in detail the so-called "argument from the poverty of the stimulus": (i) children are exposed to ill-formed sentences yet they are rarely given feedback concerning which parts of the input are ungrammatical; (ii) even when ungrammaticality is flagged, children appear to pay it little heed or misinterpret it (Chomsky (1980) likened this situation to attempting to induce the rules of chess by observing players who occasionally break those rules without giving any indication that they are so doing). The rich and subtle knowledge state that adults have induced from input alone thus leads linguists to attribute a great deal of linguistic competence to an innately-given initial state. Roberts next describes the "Principles-and-Parameters" approach to language universals and language acquisition and the variation that can be seen among the world's languages. As a consequence of the "poverty of the stimulus argument", this posits a very rich Universal Grammar (UG). In this view there is a rich, innately specified language faculty which is specific to, and uniform within, the human species. Universal Grammar is the linguist's account of what is common to all possible human languages. The contemporary conception is that there is a very limited number of general rule schemata which generate structures. These are subject to a range of well-formedness conditions which are themselves simple and mainly atomic in nature. These rule schemata and well-formedness conditions in combination constitute the principles of UG. Cross-linguistic variation is explained by principles being able to instantiate themselves in slightly different ways, i.e. along minimally different parameters with a given association of

principles with parametric values giving rise to a speaker's particular grammatical system. In this view, like the empiricist views of language learning discussed, for example, by Winter & Reber, L1 acquisition is implicit. But unlike the empiricists, linguists are more influenced by the complexity of the final knowledge state given the poverty of the input experience. Thus they claim that much of human knowledge of language is innately given (e.g. principles such as structure-dependency or binding which are not acquirable from the input as they could not be deduced from the observation of sentences), and that much less is therefore left to be acquired from the input by simpler implicit learning procedures. Roberts concludes by outlining current research within UG theory concerning the starting state of the innate language endowment - are parameter settings initially open and filled in by acquisition, are they randomly set and corrected by exposure to data or are they preset to a default (or unmarked) value with deviations from the maximally unmarked system being tuned by experience? Although UG research has still to resolve these issues, it is clear that the UG perspective posits that L1 acquisition comes as a result of implicit learning and implicit learning alone.

COOK describes in further detail the principles and parameters of UG before concentrating on the implications of UG theory for L2 acquisition. The most salient differences compared to L1 acquisition lie (i) in the nature of the final state: L2 acquirers often fail to reach the target of acquisition, remaining in some "interlanguage" state of "imperfect" acquisition; (ii) L2 acquisition occurs after L1 acquisition which itself will have set UG parameters and perhaps additionally affected the learner's explicit knowledge of language; and (iii) L2 acquisition often occurs in older children and adults who are more capable at conscious formal hypothesis testing and explicit learning. SLA research has tried to examine whether L2 grammars consist of principles and parameters and whether L2 learning has 'access' to the UG. This question, which mostly concerned UG researchers in the late 1980s, was a variant of the traditional issue of whether L2 learning is the same as L1 acquisition, rephrased as whether UG is 'accessible' in L2 learning: the possibilities are direct access, indirect access, and no access. The first two of these options again posit that L2 acquisition is

implicit. They differ in the nature of the implicit learning: the ‘direct access’ position holds that L2 acquisition is just like L1 acquisition; the ‘indirect access’ position that there is implicit learning of the L2 from evidence of examples of the language, but that this is mediated by a pre-existing implicit knowledge of the L1. In contrast the ‘no access’ view holds that the innate knowledge of UG is unavailable to L2 acquisition, the grammar of L2 is learned by some other means than UG and that L2 must derive from other faculties of the mind than language such as general problem-solving capabilities and explicit learning mechanisms. Cook surveys two bodies of evidence relevant to the question of L2 access to UG: (i) whether L2 grammars are describable in terms of principles and parameters, and (ii) whether L2 grammars show L1 influence. He concludes that the fairest position on access is not to adopt an either/or approach but to combine the positions into one complex model, the compound position. This includes three routes from input to the L2 grammar. The *direct access* route applies to principles such as subadjacency which seem to occur in L2 grammars, regardless of L1 and despite not being learnable from the input. The *indirect influence* route applies to parameters such as pro-drop where the L1 setting makes a difference to the L2 grammar even at advanced stages. The *other influences* route takes care both of the possibility that some aspects of L2 grammars are learnable by means such as grammatical explanation and of the cases where L2 seems to incorporate elements that breach the principles and parameters model. The *direct access* route takes an implicit view of learning as it relies on sources within the mind of which people are largely unaware and uses data from outside simply as a way of triggering settings; it is the same as the L1 version. The *indirect influence* route is also largely implicit in that differences between the L1 and the L2 in terms of principles and parameters are not usually available to the L2 learner’s conscious attention. Finally, aspects of language acquired under *other influences* may undoubtedly be explicitly learned as a result of a diversity of explicit methods of language teaching.

Finally, Cook considers an alternative metaphor where language acquisition is viewed as the initial state of the mind changing into the final state, denying separate status to the LAD and to UG. In this case there are not two ‘products’ of LAD in SLA, but one: a changed state of the mind containing two grammars, called ‘multi-competence’. Consequently the mind of

the L2 user has to contain two values for a parameter simultaneously. The differences that occur in the L2 forms of principles and parameters are due, not to lack of access, but to the problem of simultaneously storing two versions alongside each other; for a French/English speaker the way that structure-dependency is used in English has to be stored alongside the way that it is used in French. Some accommodation might be expected between the two forms of knowledge. Hence the knowledge of the L2 user is unlikely to be quite the same as that of a monolingual; it is not the lack of access to UG that is at stake, it is the possession of two versions of UG instantiated in the same mind and influencing each other - the compound state of a mind with two grammars. Yet why does this mutual influence of bilingual grammars not result in a resting average which is neither the grammar of L1 or L2? Cook answers this, following Chomsky (1989), by pushing the parameters and their settings away from syntax and towards the lexicon - there is no single overall setting for any particular parameter, but rather a setting for each lexical item. In this view we cannot study syntax in isolation from lexical items - the permissible operations of syntax are determined by the symbols operated upon, by 'lexical idiosyncracies' (Chomsky, 1989) - the processes and the objects are inextricably linked.

RUTHERFORD concludes this section on UG and language acquisition with an historical analysis of research into UG in SLA. He shows how a clear understanding of the *language* in SLA - of whether L2 interlanguage grammars satisfy the criterion of explanatory adequacy in that they are learnable grammars within UG- was necessary before it was possible to understand development, i.e. *SLAcquisition*. He concludes that interlanguage grammars are learnable within UG and that this in turn provides opportunity to explore in a principled way the very question of "UG in SLA" itself. He next provides a detailed methodological analysis of the types of evidence which might properly support and the types of evidence which might logically challenge an influence of UG in SLA. In so doing he also clarifies the non-arguments both for support and for denial of UG-in-SLA. The clear statement of these methodological guidelines will be of great value to future claims about language universals in SLA research which can now range themselves within a network of principled

argumentation. Although his focus is primarily methodological, Rutherford does briefly apply these principles to the analysis of UG research to date. Like Cook he concludes that there is at least some UG access in SLA as evidenced by the research programme of Lydia White demonstrating a number of situations where L2 criteria are attained notwithstanding their underdetermination in the input data and their non-instantiation in L1. In the second part of his chapter Rutherford applies Learnability Theory to SLA. The learnability model that has received the most attention thus far is that founded upon the Subset Principle which again arose out of a need to address the problem of how learning can take place in the absence of both robust input and negative evidence. The Subset Principle holds that where the input data are compatible with two possible grammars in a nested relationship, the learner must guess the narrower one first in order not to be trapped in an overgeneralization from which retreat without disconfirming evidence would theoretically not be possible. Although strong claims have been made for the viability of the Subset Principle in L1 acquisition, similarly strong claims have been made against it, some recent ones from an L2 perspective. Rutherford concludes that as a driving force for SLA research in Linguistics, concern for the mechanisms of language acquisition stands at the beginning of this decade where UG stood at the beginning of the eighties. He suggests that likely avenues for further research include (i) psycholinguistic questions of language learnability - a widening of preoccupation with syntactic competence to include whatever learning mechanisms serve that competence in SLA; (ii) for both L1 and L2, what elements of language learning occur on-line, what ones off-line, and why and (iii), perhaps the most important question for L2 alone, what it is cognitively that *holds back* adults, where implicit and explicit learning procedures have little or no effect, and where failure to change leads, for example, to fossilisation. Such a research agenda can only be achieved from the breadth of Cognitive Science, from a collaborative approach involving linguists, psycholinguists, psychologists, neuroscientists and computational scientists.

A DEVELOPMENTAL VIEW: L1 AND IMPLICIT MEMORY

DURKIN reviews work on the developmental interrelations of implicit memory and language: to what extent could implicit memory subserve aspects of language development, and, in turn, could the development of increasingly sophisticated linguistic knowledge and abilities have any consequences for the ontogenesis of implicit memory? He demonstrates that, despite their similar concerns, research into child language development and that concerning implicit memory have traditionally failed to inform and learn from each other. His chapter outlines several areas of useful interconnection. First, he suggests that, notwithstanding the current research boom into implicit memory, its understanding is clearly limited by its elusiveness - even this term, apparently simple in comparison with concerns like “consciousness”, “awareness”, and the like, eludes clear definition - for example, (i) should the defining criteria focus on facilitation in the absence of conscious recollection, or the user’s intentionality of the retrieval process; (ii) are there any hygienic tasks which cleanly tap implicit memory, and, if so, why is it even possible to show dissociations between performance on different implicit memory tests; (iii) why do so many implicit memory tests involve linguistic materials and yet so little theory of implicit memory concern language? He gathers insights from research on the development of reading where, over the twenty years since LaBerge and Samuels (1975), “automatic processes” have become equated with “unconscious processes”, “fast, spontaneous processes”, and “capacity free processes”. Yet, as Stanovich (1990) attests, automatic, obligatory processes do use some cognitive resources, they are not necessarily capacity-free. We drift into such equations from observing correlations. But they are not identities. Stanovich recommended that we ban ‘folk’ terms like “conscious” and “awareness” from reading research. Should we do the same for language acquisition research? If not, at least we should be very careful about our use of terms.

Durkin next reviews findings from recent studies of implicit memory in children which have been interpreted as indicating that implicit memory is developmentally invariant. He argues that it may not be, and that one of the reasons why is that it often involves language. Some areas of linkage and overlap between language development and implicit memory are then outlined, in particular Karmiloff-Smith’s (1992) emphasis on representational redescription where implicit information *in* the mind subsequently becomes explicit

knowledge *to* the mind, first within a domain and then sometimes across domains. This model is important in that it emphasises the recurrent interactions between implicit and explicit processes and also because it so strongly reminds us that what is learned (either implicitly or explicitly) at any point is so overwhelmingly determined by what is already known - we cannot study learning divorced from the learner, nor knowledge devoid of development. It is clear that developmental psycholinguistics will also be a key player in our future understanding of the interrelations of implicit and explicit learning processes.

REPRESENTATION AS THE KEY

The final chapter is more sanguine than Durkin's concerning our current grasp of these issues and their promise for the future. BIALYSTOK suggests that current theories of implicit and explicit knowledge of language help us to resolve three central issues of SLA: sensitive periods for learning, multilingual representation and universal grammar. She examines the different mental representations underlying implicit and explicit knowledge of language, differences which extend to the source of the knowledge, the learner's accessibility to it, and the nature of the information it comprises. Unlike others in this field, Bialystok has never been open to the criticism like that of Stanovich (above) that she confuses these dimensions, indeed automatic vs. controlled processing and analysed (explicit) vs. unanalysed knowledge have been orthogonal dimensions in her models since the early 1980s (e.g. Bialystok, 1982). Her approach to L2 strives to encompass the richness of interactions between these dimensions (e.g. How does knowledge alter its representational form? What determines which knowledge is eligible for this transformation? Why does only some knowledge undergo the transformation?) in the same way that Karmiloff-Smith's does for L1. The distinction between explicit and implicit defined in this way is used as the basis for analysis of the issues: sensitive period for learning, multilingual representation and universal grammar. Both sides in each of these debates have compelling evidence and convincing arguments. Bialystok argues that the competing views can be distinguished in part by their emphasis on assuming that linguistic knowledge is represented *either* implicitly or explicitly.

However, if we consider instead that language is represented in both of these ways, then both of the competing views become partially correct (this same assumption underlies the analyses presented in the chapters of Paradis and N. Ellis). A resolution to each debate requires determining the role both types of knowledge play and the nature of their interaction. Bialystok argues that language must be regarded as being comprised of at least two distinct parts. One part is characterised as universal, incorporating all the languages known by the speaker, and developing more fully if the opportunity occurs in early childhood. The other part is characterised as language specific, distinctly stored for each language, and developing limitlessly irrespective of the age of the learner. These two aspects of language representation are fundamentally different from each other. By treating them separately and allowing them different patterns of development, different functional profiles and different representational forms, it is possible to accommodate the research supporting both positions for the three issues discussed above.

Bialystok's starting point is that "knowledge that is known differently has been learned differently and can be used differently in thought and action". Her review clearly demonstrates that the implicit/explicit debate is not just one of the concerns of research into first and second language. Rather the diversity of different forms and representations of language and their differential accessibility and mutual influence are at the core of all issues of language acquisition.

CLOSURE

For the case of L1 acquisition, Pinker (1987) argues that, on their own, neither *correlational information* (e.g. as in connectionist networks analysing distributional properties of absolute or relative serial positions of words), *prosodic information* (phrase structure inferred from intonation, stress and timing), *syntactic information* (high innate constraints on possible grammars), nor *semantic information* (using presence of *semantic* entities such as 'thing', 'causal agent', 'true in past', etc. to infer that the input contains tokens of the corresponding *syntactic* substantive universals such as 'noun', 'subject',

‘auxiliary’, etc.) is sufficient for the child to bootstrap into a knowledge of syntax. Rather each of these sources of information has some contribution, with decisions about rules consequent on competition of these different sources of information. In this type of *constraint satisfaction model* the child’s parser sets up incomplete representations of the input that serve as boundary conditions, Universal Grammar provides a set of constraints that the analysis of input sentences and the acquired rules of grammar must satisfy and processes of pattern matching and parameter adjustment enforce consistency between the input, universal grammar and the developing language-particular grammar.

The readings in this book give testament to the centrality in all issues of language acquisition of questions concerning the multiform learning processes, the distinct representational systems that result from them, their differing accessibilities, and the relative degrees of their mutual influence. The relevance of the diverse research marshalled here indicates that future progress in these concerns will require the collaborative enquiry of Cognitive Science. Each of the parts of the problem is extremely complicated: the clarification of the conceptual issues; animal and human learning; information processing and representation in symbolic systems and connectionist networks; neural substrates of cognition; the nature of language and multilingualism; the evidence from which language is learned; the natural and pedagogical acquisition environments; fundamental processes of human cognitive, social, and neural development. Each of these enquiries will make some progress on its own. But a complete understanding of language acquisition will only come from a synergy of these different knowledge sources with each nourishing but also constraining the others. In much the same way that language acquisition itself stems from bootstrapping from different knowledge sources, so also does language acquisition research.

REFERENCES

- Adams, R. (1980). *The Girl in a Swing*. Harmondsworth: Penguin.
- Baddeley, A.D. (1986). *Working Memory*. Oxford: Oxford University Press.

- Bialystok, E. (1982). On the relationship between knowing and using forms. *Applied Linguistics*, **3**, 181-206.
- Chomsky, N. (1980). *Rules and Representations*. Oxford: Blackwell.
- Chomsky, N. (1989). Some notes on economy of derivation and representation. *MIT Working Papers in Linguistics*, **10**, 43-74.
- Elman, J. L. (1990). Finding structure in time. *Cognitive Science*, **14**, 179-211.
- Fodor, J.A., & Pylyshyn, Z.W. (1988). Connectionism and cognitive architecture: A critical analysis. *Cognition*, **28**, 3-72
- Karmiloff-Smith, A. (1992). *Beyond Modularity. A Developmental Perspective on Cognitive Science*. Cambridge, MA: MIT Press.
- Krashen, S. (1982). *Principles and Practice in Second Language Acquisition*. Oxford: Pergamon.
- LaBerge, D., & Samuels, S. (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology*, **6**, 293 - 323.
- Long, M. (1983). Does second language instruction make a difference? A review of the research. *TESOL Quarterly*, **17**, 359-82.
- Norman, D.A., & Shallice, T. (1986). Attention to action: Willed and automatic control of behaviour. In R.J. Davidson, G.E. Schwartz, & D. Shapiro (Eds.), *Consciousness and Self-Regulation. Advances in Research and Theory*, Vol. 4 (pp. 1-18). New York: Plenum Press.
- Pinker, S. (1987). The bootstrapping problem in language acquisition. In B. MacWhinney (Ed.), *Mechanisms of Language Acquisition*. Hillsdale, N.J.: Erlbaum.
- Pinker, S. (1988). On language and connectionism: Analysis of a parallel distributed processing model of language acquisition. *Cognition*, **28**, 73-194.
- Reber, A.S. (1967). Implicit learning of artificial grammars. *Journal of Verbal Learning and Verbal Behavior*, **77**, 317-327.
- Rosch, E., Mervis, C.B., Gray, W.D., Johnson, D.M. & Boyes-Braem, P. (1976). Basic objects in natural categories. *Cognitive Psychology*, **8**, 382-439.

Rumelhart, D., & McClelland, J. (Eds.) (1986). *Parallel Distributed Processing: Explorations in the Microstructure of Cognition*. Cambridge, Mass.: MIT Press.

Stanovich, K. E. (1990). Concepts in developmental theories of reading skill: Cognitive resources, automaticity, and modularity. *Developmental Review*, **10**, 72 - 100.