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# The weak interface, consciousness, and form-focused instruction: mind the doors

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If the doors of perception were cleansed every thing would  
appear to man as it is, infinite. For man has closed himself up,  
till he sees all things thru' narrow chinks of his cavern.

(William Blake 1790: plate 14)

THIS CHAPTER examines the theoretical backgrounds of form-focused instruction (FFI) in language education, applied linguistics, psychology, and cognitive science, these disciplines all being concerned with the differences between implicit and explicit knowledge and the ways in which these might interact. It argues that although much of first language (L1) acquisition involves implicit learning, these mechanisms do not suffice for second language acquisition (SLA) because of learnt attention and transfer from the L1. SLA must therefore overcome the processing habits of the L1 by recruiting additional resources of explicit learning. The interface is dynamic: it happens transiently during conscious processing, but the influence upon implicit cognition endures thereafter. The various roles of consciousness in SLA include: learners noticing negative evidence; their attending to language, their perception focused by social scaffolding or explicit instruction; their voluntary use of pedagogical grammatical descriptions and analogical reasoning; their reflective induction of meta-linguistic insights about language; and their consciously guided practice which results, eventually, in unconscious, automatized skill. Consciousness creates access: its contents are broadcast throughout the brain to the vast array of our unconscious sources of knowledge, and by these means, consciousness is the interface (N. Ellis 2005). Current cognitive theories of the role of consciousness in learning (Baars 1997; Baars and Franklin 2003) correspond

well with the weak interface theory of second language (L2) instruction proposed by Rod Ellis (R. Ellis 1994b) whereby explicit knowledge plays a role in SLA by facilitating the processes of ‘noticing’, of ‘noticing the gap’, and of consciously guided output practice form. (See Chapter 1.)

## Implicit and explicit language learning and knowledge

Children acquire their L1 by engaging with their caretakers in natural meaningful communication. From this ‘evidence’ they automatically acquire complex knowledge of the structure of their language. Yet paradoxically they cannot describe this knowledge, the discovery of which forms the object of the disciplines of theoretical linguistics, psycholinguistics, and child language acquisition. 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 implicit and is extracted from experience of usage rather than from explicit rules—simple exposure to normal linguistic input suffices and no explicit instruction is needed. Adult acquisition of an L2 is a different matter in that what can be acquired implicitly from communicative contexts is typically quite limited in comparison to native speaker norms, and adult attainment of L2 accuracy usually requires additional resources of consciousness and explicit learning.

Theoretical dissociations between implicit and explicit knowledge of language evolved relatively independently in language education and applied linguistics and in psychology and cognitive neuroscience.<sup>1</sup> From various divisions of cognitive science and education we know that implicit and explicit learning are distinct processes, that humans have separate implicit and explicit memory systems, that there are different types of knowledge of and about language, that these are stored in different areas of the brain, and that different educational experiences generate different types of knowledge.

## The history of the interface in language education and applied linguistics

Differing assumptions about the nature of language representation and its promotion motivated different teaching traditions (Kelly 1969). Traditional grammar translation foreign language (FL) instruction and the cognitive code method popular in the 1960s and 1970s capitalized on the formal operational abilities of older children and adults to think and act in a rule-

governed way. This allowed their instruction, through the medium of language, in pedagogical grammar rules, with lessons focusing on language forms such as, for example, particular tenses and inflectional patterns. These explicit methods were motivated by the belief that perception and awareness of L2 rules necessarily precedes their use. In contrast, FL and L2 teaching methods like ‘audiolingualism’ which held sway during the Second World War, and more recent ‘natural’ and ‘communicative’ approaches, maintained that adult language learning is, like L1 acquisition, implicit. Since language skill is very different from knowledge about language, they consequently renounced explicit grammar-based instruction. The defining distinction between implicit acquisition and explicit learning of L2 was that of Krashen (1982). He argued that adult L2 students of grammar-translation methods, who can tell more about a language than a native speaker, yet whose technical knowledge of grammar leaves them totally in the lurch in conversation, testify that conscious learning about language and subconscious acquisition of language are different things, and that any notion of a ‘strong interface’ between the two must be rejected. Krashen’s Input Hypothesis, an extreme ‘non-interface’ position, thus countered that (1) subconscious acquisition dominates in L2 performance; (2) learning cannot be converted into acquisition; and (3) 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, just like L1 acquisition, comes naturally as a result of implicit processes occurring while the learner is receiving comprehensible L2 input. The Input Hypothesis was the theoretical motivation behind natural and communicative approaches to instruction.

These foundations suggest that language learning can take place implicitly, explicitly, or, because we can communicate using language, it can be influenced by declarative statements of pedagogical rules (explicit instruction). There are at least some mutual influences in their development too. Consider, for example, that from implicit to explicit knowledge: although in native language acquisition implicit learning is primary, the development of self-awareness allows reflective examination, analysis, and re-organization of the products of implicit learning, resulting in redescription at a higher level and the formation of new independent and explicit representations. Thus an older child can make a good stab at explaining how to form a plural in English because they have realized the relevant metalinguistic insight of ‘add -s’ from observing themselves forming plurals in this way (Bialystok 1982). But what about the other direction? The central issue of the ‘interface question’ is just how much do explicit learning and explicit instruction

influence implicit learning, and how can their symbiosis be optimized? Subsequent research took up this theme.

Empirical analyses of learners in 'grammar-free' communicative, natural, or immersion L2 and FL programmes demonstrated significant shortcomings in the accuracy of their language (Lightbown *et al.* 1993). Critical theoretical reactions to Krashen's Input Hypothesis (for example, McLaughlin 1987), together with demonstrations that it is those language forms which are attended that are subsequently learnt, prompted Schmidt (1990) to propose that conscious cognitive effort involving the subjective experience of noticing is a necessary and sufficient condition for the conversion of input to intake in SLA. Schmidt's Noticing Hypothesis was the theoretical motivation for subsequent research efforts, both in laboratory experiments (Hulstijn and DeKeyser 1997) and in the classroom (Doughty and Williams 1998a), into the role of consciousness in SLA. Together, the shortcomings in uptake, the consequently limited endstate of naturalistic learners, and the demonstrable role of noticing in SLA, obliged in turn the rejection of the extreme 'no interface' position.

Applied linguistics was thus left with something in-between, some form of a weak interface position (Long 1991; R. Ellis 1994b) whereby explicit knowledge plays various roles (1) in the perception of, and selective attending to, L2 form by facilitating the processes of 'noticing' (i.e. paying attention to specific linguistic features of the input), (2) by 'noticing the gap' (i.e. comparing the noticed features with those the learner typically produces in output), and (3) in output, with explicit knowledge coaching practice, particularly in initial stages, with this controlled use of declarative knowledge guiding the proceduralization and eventual automatization of language processing, as it does in the acquisition of other cognitive skills.

As this volume attests, the weak interface position motivated renewed interest in explicit instruction, but the pendulum didn't swing back all the way to the decontextualized and often meaningless grammar drills of traditional grammar translation instruction, which Long (1991) termed 'focus on forms'. Instead, instruction was to be integrated into the meaningful communication afforded by more naturalistic approaches: learner errors should be picked up by a conversation partner and corrected in the course of meaningful, often task-based, communication by means of negative evidence which offers some type of explicit focus on linguistic form (R. Ellis 1990, 1994a, 2000, 2001a, 2002a; Doughty and Williams 1998a). The period from 1980–2000 was a time of concerted research to assess the effectiveness of different types of explicit and implicit L2 instruction. Reviews of these investigations (Lightbown *et al.* 1993; Long 1983; N. Ellis and Laporte 1997; Hulstijn and DeKeyser 1997; Spada 1997; Doughty and Williams 1998a),

particularly the comprehensive meta-analysis of Norris and Ortega (2000) that summarized the findings from 49 unique sample studies of experimental and quasi-experimental investigations into the effectiveness of L2 instruction, demonstrate that focused L2 instruction results in large target-oriented gains, that explicit types of instruction are more effective than implicit types, and that the effectiveness of L2 instruction is durable.

## Implicit and explicit knowledge and their interface in psychological research

These developments ran in parallel to research in psychology demonstrating the dissociations of implicit and explicit memory, and of implicit and explicit learning (N. Ellis 1994). The separation between explicit and implicit memory was evidenced in anterograde amnesic patients who, as a result of brain damage, lost the ability to consolidate new explicit memories (those where recall involves a conscious process of remembering a prior episodic experience) to update their autobiographical record with their daily activities, to learn new concepts, or to learn to recognize new people or places. Nevertheless, amnesiacs maintained implicit memories (those evidenced by the facilitation of the processing of a stimulus as a function of a recent encounter with an identical or related stimulus but where the person at no point has to consciously recall the prior event) and were able to learn new perceptual skills (such as mirror reading) and new motor skills (Schacter 1987; Squire and Kandel 1999). They also showed normal classic conditioning—hence the famous anecdote of the amnesic patient who, having once been pricked by a pin hidden in the hand of her consultant, refused thereafter to shake him by his hand while at the same time denying ever having met him before.

The dissociation between explicit and implicit learning was made by Reber (1976) who had people learn complex letter strings (for example, MXRMXT, VMTRRR) generated by an artificial grammar. In the course of studying these for later recognition, they unconsciously abstracted knowledge of the underlying regularities, so to be able to later distinguish between novel strings which either accorded or broke the rules of the underlying grammar. However, like young children who can pass ‘wug tests’ in their native language, these adult participants too were unable to explain their reasoning. Such research illustrated quite different styles of learning, varying in the degree to which acquisition is driven by conscious beliefs, as well as in the extent to which they give rise to explicit verbalizable knowledge: 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 attends to particular aspects of the stimulus array and volunteers and tests hypotheses in a search for structure.

In brain science, neuropsychological investigations of the results of brain damage demonstrated that different areas of the brain are specialized in their function and that there are clear separations between areas involved in explicit learning and memory and those involved in implicit learning and memory (A. Ellis and Young 1988). Explicit learning is supported by neural systems in the prefrontal cortex involved in attention, the conscious apperception of stimuli, and working memory; the consolidation of explicit memories involves neural systems in the hippocampus and related limbic structures. In contrast, implicit learning and memory are localized, among other places, in various areas of perceptual and motor cortex.

In psychology, subsequent research in implicit and explicit learning of artificial languages, finite-state systems, and complex control systems showed: (1) When the material to be learnt is simple, or where it is relatively complex but there is only a limited number of variables and the critical features are salient, then learners gain from being told to adopt an explicit mode of learning where hypotheses are to be explicitly generated and tested and the model of the system updated accordingly. As a result they are also able to verbalize this knowledge and transfer to novel situations. (2) When the material to be learnt is more randomly structured with a large number of variables and when the important relationships are not obvious, then explicit instructions only interfere and an implicit mode of learning is more effective. This learning is instance-based but, with sufficient exemplars, an implicit understanding of the structure will be achieved. Although this knowledge may not be explicitly available, the learner may none the less be able to transfer to conceptually or perceptually similar tasks and to provide default cases on generalization ('wug') tasks. (3) Whatever the domain, learning the patterns, regularities, or underlying concepts of a complex problem space or stimulus environment with explicit instruction, direction, and advanced clues, heuristics, or organizers is always better than learning without any cues at all (Reber *et al.* 1980; MacWhinney 1997a). (4) Although Reber had emphasized that the results of implicit learning were abstract, unconscious, and rule-like representations, subsequent research showed that there was a very large contribution of concrete memorized knowledge of chunks and sequences of perceptual input and motor output that unconscious processes tally and identify to be frequent across the exemplars experienced in the learning set (Stadler and Frensch 1998).

On the broader stage of cognitive science, the period from 1980–2000 showed a parallel shift away from an almost exclusively symbolic view of

human cognition to one which emphasized the overwhelming importance of implicit inductive processes in the statistical reasoning which sums prior experience and results in our generalizations of this knowledge as schema, prototypes, and conceptual categories. Everything is connected, resonating to a lesser or greater degree, in the spreading activation of the cognitive unconscious, and categories emerge as attractor states in the conspiracy of related exemplars in implicit memory. These are the aspects of cognition that are readily simulated in connectionist models (Rumelhart and McClelland 1986; Elman *et al.* 1996) and which subsequently have had considerable influence upon our understanding of implicit knowledge of language and its acquisition (Christiansen and Chater 2001).

In cognitive neuroscience technological advances in functional brain imaging using electro-encephalographic (EEG) and functional Magnetic Resonance Imaging (fMRI) triangulated the findings of earlier cognitive neuropsychological studies of brain areas involved in implicit and explicit memory. Subsequent improvements in the temporal and spatial resolution of these techniques afforded much more detailed descriptions of the dynamics of brain activity, promoting a shift of emphasis from knowledge as static representation stored in particular locations to knowledge as processing involving the dynamic mutual influence of inter-related types of information as they activate and inhibit each other over time (Eichenbaum 2002; Frackowiak *et al.* 2004)—as Charles Sherrington had put it 60 years previously, ‘an enchanted loom, where millions of flashing shuttles weave a dissolving pattern, always a meaningful pattern though never an abiding one; a shifting harmony of subpatterns’ (Sherrington 1941: 225).

Thus, in the latter part of the twentieth century, research in these various disciplines converged on the conclusion that explicit and implicit knowledge of language are distinct and dissociated—they involve different types of representation, they are substantiated in separate parts of the brain, and yet they can come into mutual influence in processing.

## Implicit and explicit knowledge and their interface in SLA

What is the nature of the implicit knowledge which allows fluency in phonology, reading, spelling, lexis, morphosyntax, formulaic language, language comprehension, grammaticality, sentence production, syntax, and pragmatics? How are these representations formed? How are their strengths updated so to statistically represent the nature of language, and how do linguistic prototypes and rule-like processing emerge from usage? These difficult and complex issues are certainly not resolved and they remain the

focus of the disciplines of linguistics, psycholinguistics, and child language acquisition. Nevertheless, there has been a growing consensus over the last 20 or 30 years that the vast majority of our linguistic processing is unconscious, its operations tuned by the products of our implicit learning which has supplied a distributional analysis of the linguistic problem space, that is, a statistical sampling of language over our entire history of prior usage. Frequency of usage determines availability of representation and tallies the likelihoods of occurrence of constructions and the relative probabilities of their mappings between aspects of form and their relevant interpretations. Generalizations arise from conspiracies of memorized utterances collaborating in productive schematic linguistic constructions (Rumelhart and McClelland 1986; Bybee and Hopper 2001; Christiansen and Chater 2001; N. Ellis 2002a; Bod *et al.* 2003). Implicit learning collates the evidence of language, and the results of this tallying provide an optimal solution to the problem space of form-function mappings and their contextualized use, with representational systems modularizing over thousands of hours on task (N. Ellis 2002a).

But if these implicit learning processes are sufficient for L1 acquisition, why not for second? One part of the answer must be transfer. Transfer phenomena pervade SLA (Weinreich 1953; Lado 1957; C. James 1980; Odlin 1989; MacWhinney 1997b). Our neural apparatus is highly plastic in its initial state. It is not entirely an empty slate, since there are broad genetic constraints upon the usual networks of system-level connections and upon the broad timetable of maturation and myelination, but nevertheless the cortex of the brain is broadly equipotent in terms of the types of information it can represent (Elman *et al.* 1996; Kandel *et al.* 2000). In contrast to the newborn infant, the L2 learner's neocortex has already been tuned to the L1, incremental learning has slowly committed it to a particular configuration, and it has reached a point of entrenchment where the L2 is perceived through mechanisms optimized for the L1. Thus L1 implicit representations conspire in a 'learnt attention' to language and in the automatized processing of L2 in non-optimal ways. In this view, the limitations of SLA result from psychodynamic tensions in the unconscious mind of the L2 speaker—not the psychodynamics of Freudian psychology, but those of a more psycholinguistic kind. It is basic principles of associative and connectionist learning which yield the limited endstate, whereby features in the L2 input, however available as a result of frequency, recency, or context, fall short of intake because their processing is shaped by the L1. Further details of these constituent processes of contingency, cue competition, salience, interference, overshadowing, blocking, and perceptual learning can be found in N. Ellis (2006a, b).



Gathering these strands together, we can conclude:

- 1 Implicit and explicit learning are distinct processes.
- 2 Implicit and explicit memory are distinguished in their content, their form, and their brain localizations.
- 3 There are different types of knowledge of and about language, stored in different areas of the brain, and engendered by different types of educational experience.
- 4 A large part of acquisition involves the implicit learning of language from usage.
- 5 L1 transfer, learnt attention, and automatization all contribute to the more limited achievements of exclusive implicit learning in SLA than in L1 acquisition.
- 6 Pedagogical responses to these shortcomings involve explicit instruction, recruiting consciousness to overcome the implicit routines that are non-optimal for L2.
- 7 Evaluation research in language education demonstrates that such FoF instruction can be effective.

What then are the detailed mechanisms of interface? How do the explanations of weak interface as proposed over a decade ago (Long 1991; R. Ellis 1994b) stand up in the light of subsequent research? What are the various psychological and neurobiological processes by which explicit knowledge of form-meaning associations impacts upon implicit language learning? In the remainder of this chapter, I will bring to bear current research in cognitive neuroscience as it relates to this question. I believe that this research broadly supports the weak interface position and that additionally it provides an important emphasis for our understanding of language learning and instruction, namely that we must concentrate on dynamic processes (Larsen-Freeman and N. Ellis 2006a, b) rather than on static conceptualizations of language, representation and physical interface. The interface, like consciousness, is dynamic, situated, and contextualized: it happens transiently during conscious processing, but the influence upon implicit cognition endures thereafter (N. Ellis 2005).

## Consciousness provides the weak interface

Learning is a dynamic process; it takes place during processing, as Hebb (1949), Craik and Lockhart (1972), Pienemann (1998), and O'Grady (2003) have all reminded us from their neural, cognitive, and linguistic aspects on learning. In fluency in our native language, both language processing and language tallying (N. Ellis 2002a) are typically unconscious; our implicit

systems automatically process the input, allowing our conscious selves to concentrate on the meaning rather than the form. Implicit, habitual processes are highly adaptive in predictable situations. But the more novelty we encounter, the more the involvement of consciousness is needed for successful learning and problem-solving (Baars 1997). As with other implicit modules, when automatic capabilities fail, there follows a call recruiting additional collaborative conscious support (Baars and Franklin 2003): We only think about walking when we stumble, about driving when a child runs into the road, and about language when communication breaks down. In unpredictable conditions, the capacity of consciousness to organize existing knowledge in new ways is indispensable. ‘The particulars of the distribution of consciousness, so far as we know them, point to them being efficacious ...’ (W. James 1890/1983 Vol. 1: 141–2).

The psychological processes of interface are exactly that—they are dynamic processes, synchronous with consciousness (N. Ellis 2005). The last 10 years have seen significant advances in our scientific study of consciousness and its roles in learning and memory<sup>2</sup> (Baars *et al.* 2003). There have been three major strands of development: (1) cognitive neuroscientific investigation of the neural correlates of consciousness (NCC) (see Koch 2004 for review); (2) cognitive analysis of consciousness (particularly Global Workspace Theory: Baars 1988, 1997); and (3) computational modeling of the events underlying the emergence of self-amplifying resonances across a global network of neuronal coalitions, the dynamic competition among the massively parallel constituency of the unconscious mind that elects (Koch 2004: 24, 173) the current oneness of the fleeting stream of conscious experience (Dehaene *et al.* 2003; Dehaene and Changeux 2004). These developments inform three issues relating to the Weak Interface: the neurobiology of implicit tallying, NCC, and the role of consciousness in learning.

### *The neurobiology of implicit tallying*

For the first time, it is now possible, using fMRI and ERP techniques, to image the implicit processing of words which, despite being presented below the threshold for conscious noticing, nevertheless result in subsequent implicit memory effects. The implicit statistical tallying that underlies subsequent priming effects can be seen to take place in various local regions of primary and secondary sensory and motor cortex (Dehaene and Changeux 2004; Dehaene *et al.* 2004).

## *The NCC*

The NCC is a huge, difficult, and fascinating question, and it is generating a correspondingly massive collaborative research effort. A lot more will have been discovered in another 10 years. But what is already known is potent enough in its implications for the interface: implicit learning occurs largely within modality and involves the priming or chunking of representations or routines within a module; it is the means of tuning our *zombie agents*, the menagerie of specialized sensori-motor processors, such as those identified in Dehaene's research, that carry out routine operations in the absence of direct conscious sensation or control (Koch 2004: Chapter 12). In contrast, conscious processing is spread wide over the brain and unifies otherwise disparate areas in a synchronized focus of activity. Conscious activity affords much more scope for focused long-range association and influence than does implicit learning. It brings about a whole new level of potential associations.

## *Consciousness and learning: the collaborative mind*

Compared to the vast number of unconscious neural processes happening in any given moment, conscious capacity evidences a very narrow bottleneck. But the narrow limits of consciousness have a compensating advantage: consciousness seems to act as a gateway, creating access to essentially any part of the nervous system. Consciousness creates global access (Baars 1997).

Baars (1988, 1997) introduced 'Global Workspace Theory' by describing the likenesses between our cognitive architecture and a working theatre. The entire stage of the theatre corresponds to working memory, the immediate memory system in which we talk to ourselves, visualize places and people, and plan actions. In the working theatre, focal consciousness acts as a 'bright spot' on the stage. Conscious events hang around, monopolizing time 'in the limelight'. The bright spot is further surrounded by a 'fringe' (Mangan 1993) or 'penumbra' (W. James 1890; Koch 2004: Chapter 14) of associated, vaguely conscious events. Information from the bright spot is globally distributed to the vast audience of all of the unconscious modules we use to adapt to the world. A theatre combines very limited events taking place on stage with a vast audience, just as consciousness involves limited information that creates access to a vast number of unconscious sources of knowledge. Consciousness is the publicity organ of the brain. It is a facility for accessing, disseminating, and exchanging information and for exercising global coordination and control: conscious-

ness is the interface. ‘Paying attention—becoming conscious of some material—seems to be the sovereign remedy for learning anything, applicable to many very different kinds of information. It is the universal solvent of the mind’ (Baars 1997, Section 5: 304).

Note that in this view, consciousness is not the director, neither is it the author of the play. The contents of consciousness are hugely constrained by top-down processes. But the stream of consciousness is the reflection of thoughts, not the thoughts themselves. Consciousness has no more access to the implicit workings of the prefrontal cortex and other regions involved in the evaluation of different courses of action, decision making, and planning than it does to the implicit workings of the lower perceptual levels of primary perceptual cortex. The theatre in Global Workspace Theory is all of our unconscious modules; there is no one place in the brain to which the unconscious modules send their results for ultimate conscious appreciation by the audience, as in a Cartesian theatre (Dennett 2001). In Freud’s (1966) terms, the id and the super-ego are both unconscious. In Koch’s (2004: Chapter 18), the homunculus is nonconscious. In Jackendoff’s (1987), consciousness is an intermediate level: Thinking—the manipulation of sensory data, concepts, and more abstract patterns—is largely unconscious; what is conscious about thoughts are images, tones, silent speech, and other feelings associated with intermediate-level sensory representations. And at any one time, our state of mind reflects complex dynamic interactions of implicit and explicit knowledge:

In the human brain information (as a marginally coupled, phase-locked state) is created and destroyed in the metastable regime of the coordination dynamics, where tendencies for apartness and togetherness, individual and collective, segregation and integration, phase synchrony and phase scattering coexist. New information is created because the system operates in a special regime where the slightest nudge will put it into a new coordinated state. In this way, the (essentially nonlinear) coordination dynamics creates new, informationally meaningful coordination states that can be stabilized over time. The stability of information over time is guaranteed by the coupling between component parts and processes and constitutes a dynamic kind of (nonhereditary) memory.

(Scott Kelso 2002: 369)

Global Workspace Theory and parallel research into NCC illuminates the mechanisms by which the brain interfaces functionally and anatomically independent implicit and explicit memory systems involved variously in

motoric, auditory, emotive, or visual processing and in declarative, analogue, perceptual, or procedural memories, despite their different modes of processing, which bear upon representations and entities of very different natures. Biological adaptations tend to be accretive (Gould 1982). The speech system, for example, is overlaid on a set of organs that in earlier mammals supports breathing, eating, and simple vocalization. Language is overlaid upon systems for the visual representation of the world. Yet, however different the symbolic representations of language and the analogue representations of vision are, they interact so that through language, we create mental images in our listeners that might normally be produced only by the memory of events as recorded and integrated by the sensory and perceptual systems of the brain (Jerison 1976). Likewise, it may be that the global broadcasting property of the consciousness system is overlaid on earlier functions that are primarily sensori-motor. In his major review culminating a lifetime's pioneering work in human neuropsychology, Luria (1973), having separately analysed the workings of the three principal functional units of the brain (the unit for regulating tone or waking, the unit for obtaining, processing, and storing information, and the unit for programming, regulating, and verifying mental activity), emphasized that it would be a mistake to imagine that each of these units carry out their activity independently:

Each form of conscious activity is always a *complex functional system* and takes place through the *combined working of all three brain units*, each of which makes its own contribution ... *all three principal functional brain units work concertedly*, and it is only by studying their interactions when each unit makes its own specific contribution, that an insight can be obtained into the nature of the cerebral mechanisms of mental activity.

(Luria 1973: 99–101, italics in original)

### Some component processes of the weak interface

This, then, is the broad framework: language representation in the brain involves specialized localized modules, largely implicit in their operation, collaborating via long-range associations in dynamic coalitions of cell assemblies representing—among others—the phonological forms of words and constructions and their sensory and motor groundings (Barsalou 1999; Pulvermüller 1999, 2003). L1 uses tunes and automatizes them to perform in particular ways, resulting in our highly specialized L1 processing modules.

To break out of these routines, to consolidate the new connections, networks and routines necessary for L2 processing, consciousness is necessary.

The weak interface theory of L2 instruction proposed that explicit processing plays a role in SLA by means of ‘noticing’, ‘noticing the gap’, and guided output practice. The remainder of this chapter outlines relevant research on each in turn.

### *Noticing*

The primary conscious involvement in SLA is the explicit learning involved in the initial registration of pattern recognizers for constructions that are then tuned and integrated into the system by implicit learning during subsequent input processing. Neural systems in the prefrontal cortex involved in working memory provide attentional selection, perceptual integration, and the unification of consciousness. Neural systems in the hippocampus then bind these disparate cortical representations into unitary episodic representations. ERP and fMRI imaging confirm these NCC, a surge of widespread activity in a coalition of forebrain and parietal areas interconnected via widespread cortico-cortico and cortico-thalamic feedback loops with sets of neurons in sensory and motor regions that code for particular features, and the subsequent hippocampal activity involved in the consolidation of novel explicit memories. These are the mechanisms by which Schmidt’s noticing helps solve Quine’s problem of referential indeterminacy (N. Ellis 2005).

This means is most relevant where the language form is of low salience and where L1 experience has tuned the learner’s attention elsewhere: ‘since many features of L2 input are likely to be infrequent, non-salient, and communicatively redundant, intentionally focused attention may be a practical (though not a theoretical) necessity for successful language learning’ (Schmidt 2001: 23). Instruction is thus targeted at increasing the salience of commonly ignored features by firstly pointing them out and explaining their structure, and secondly by providing meaningful input that contains many instances of the same grammatical meaning-form relationship (Terrell 1991). Once consolidated into the construction, it is this new cue to interpretation of the input whose strengths are incremented on each subsequent processing episode. The cue does not have to be repeatedly noticed thereafter; once consolidated, mere use in processing for meaning is enough for implicit tallying. A natural corollary is that if explicit knowledge is to be effective, it must be provided before relevant input that exemplifies it (Reber *et al.* 1980) if it is to affect the processing of the cue in question and

become sufficiently associated with its relevant interpretation to become entrenched enough to influence implicit processing thereafter (as with the ‘RuleandInstances’ learners of N. Ellis 1993).

A meta-analysis of Norris and Ortega (2000) of 25 explicit form-focused treatments from a wide variety of studies with interventions including consciousness raising, input processing, compound FoF, metalinguistic task essentialness, and rule-oriented FoF, demonstrated an average effect size of these various treatments in excess of 1.2. More generally still, the same meta-analysis demonstrated average effect sizes in excess of 1.0 for 69 different explicit instructional treatments, whether they involved FoF or more traditional FoFs. It is true that explicit instruction evidences greater effect on outcome measures that are themselves more explicit and metalinguistic in content (Norris and Ortega 2000), but FFI results in a medium-sized effect on free constructed production measures too (Norris and Ortega 2000), with further studies reviewed by R. Ellis (2002a) confirming this route of influence of explicit knowledge on implicit learning. We need more studies to look at the effects of explicit instruction using outcome measures that particularly focus on different aspects of implicit knowledge and processing (Doughty 2004), but the weight of the evidence to date is in favour of significant interface by the means of attention being focused upon relevant form-meaning connections in the limelight of conscious processing.

### *Noticing the gap*

A learner’s flawed output can prompt negative feedback in the form of a ‘corrective recast’, that is, a reformulation of their immediately preceding erroneous utterance, replacing non-target-like (lexical, grammatical, etc.) items by the corresponding target-language forms. Recasts arguably present the learner with psycholinguistic data that is optimized for acquisition because they make the gap apparent—in the contrast between their own erroneous utterance and the recast they highlight the relevant element of form at the same time as the desired meaning-to-be-expressed is still active, and the language learner can engage in focused input analysis (Doughty 2001). Long (2006a) reviews over 40 descriptive, quasi-experimental, and experimental studies of the occurrence, usability, and use of recasts in classrooms, laboratory settings, and non-instructional conversation, showing that these techniques are generally effective in the promotion of uptake. There is some debate, however, concerning the degree to which attention should be focused upon the meaning or the message in the negotiations of

recasting. Long holds that the focus of both interlocutors should always be on meaning so that any learning of form is implicit, whereas the review of Nicholas, Lightbown, and Spada (2001) raised questions as to the potential non-salience and/or ambiguity of recasts, concluding that recasts appear to be most effective in contexts where it is clear to the learner that the recast is a reaction to the accuracy of the form, not the content, of the original utterance. This is particularly so where the error is committed on a low salience form where the learner is unlikely to notice the variance between their production and the appropriate element in the form of the recast. More research is needed into the generality of the claim that, the less salient the gap, the more learners have to be made aware of it. As Long (2006: 41) concludes: 'Knowing which classes of problematic TL features can be addressed successfully via implicit negative feedback, and which, if any, require more explicit treatment would be both theoretically important, as it could help explain how recasts work, and pedagogically useful'.

### *Output practice*

Explicit memories can guide the conscious building of novel linguistic utterances through processes of analogy. Formulas, slot-and-frame patterns, drills, and declarative pedagogical grammar rules can all contribute to the conscious creation of utterances whose subsequent usage promotes implicit learning and proceduralization. Thus, by various means, the learner can use explicit knowledge to consciously construct an utterance in working memory. 'Practice makes perfect' applies here as it does with other skills. Anderson's (1983, 1992, 1996) ACT model described the move from declarative to procedural knowledge as three broad stages: a cognitive stage, where a declarative description of the procedure is learnt; an associative stage, where the learner works on productions for performing the process; and an autonomous stage, where execution of the skill becomes rapid and automatic. McLaughlin (1987) described processes of L2 automatization, from the novice's slow and halting production by means of attentive control of construction in working memory to fluent automatic processing with the relevant programs and routines being executed swiftly and without reflection. Segalowitz and Segalowitz (1993), and DeKeyser (2001) provide more recent reviews of automatization and the ways that this conscious processing can result in the training of unconscious, automatic, zombie sensorimotor agents for L2 processing (Koch 2004: Chapter 14).

The balance of experimental findings supports the effectiveness for SLA of encouraging learners to produce output. Norris and Ortega (2000)



summarized the results of six studies from before 1999 that involved explicit FoFs followed by output practice and that demonstrated a substantial average effect size of 1.39. DeKeyser *et al.* (2002) pulled together the results of five more recent studies, all of which substantiated that output-based treatments promoted learners to significant improvement on uses of the Spanish subjunctive, acquisition of Spanish copulas, interpretation and production of the Italian future tense, and acquisition of the French causative. Keck, Iberri-Shea, Tracy, and Wa-Mbaleka (2006) reported a quantitative meta-analysis of studies of the effects of interaction upon acquisition. Eight of the unique sample studies in this meta-analysis involved *pushed output*, where participants were required to attempt production of target features, often because they played the role of information-holders in jigsaw, information-gap, or narrative tasks. The effects of these treatments were compared with six other interaction studies that did not provide opportunities for pushed output. Tasks involving opportunities for pushed output ( $d = 1.05$ ) produced larger effect sizes than tasks without pushed output ( $d = 0.61$ ) on immediate post-tests. A lot more research is needed to get at the individual components, but taken together, these studies provide good reason to consider an interface of explicit knowledge upon implicit learning during output too.

## Conclusion

Much of the problem of SLA stems from transfer, from the automatized habits of the L1 being inappropriately applied to the L2. The first step of FFI is, in the words of the London Underground, to ‘mind the gap’ and to realize this. The second step is for the learner to FoF again. In their songs of experience, the doors of perception can never be so clean as they were in their songs of innocence, but, through appropriately guided consciousness, the L2 learner can be usefully minded of language again, thus to allow an interface of explicit upon implicit knowledge.

## Notes

- 1 In 1991, as I came to the issue of implicit and explicit SLA from a background in psycholinguistics, I searched out applied linguists who were of a more psychological and empirical persuasion. They were few enough that I resolved to try to visit them on an upcoming sabbatical, and to recruit them into an edited book on this topic (N. Ellis 1994). I was happy that Rod responded so quickly and positively and that I was able to visit him at Temple University in Japan in 1992. The few months I spent

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there were an important part of my education in applied linguistics. I am grateful to Rod both for his enduring scholarship and his friendship.

- 2 The Association for the Scientific Study of Consciousness was established in 1996 and held its inaugural conference in 1997.