Attention and awareness in second language acquisition

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Historical discussion

Attention and awareness in cognitive science and SLA

Issues of attention “bear on every area of cognitive science” (Allport, 1989, p. 631). Attention, however, is not a unitary construct; many mechanisms have been proposed to explain how it affects different aspects of behavior and learning. Attentional mechanisms have been invoked to explain such diverse phenomena in second language acquisition (SLA) as variation in the accuracy, fluency and complexity of second language (L2) use in different social environments, and the effects of pedagogic task demands on learners’ spoken and written performance in experimental, and classroom language learning settings. Availability of attentional resources has also been argued to predict the extent to which instructional conditions manipulating the focus of learners’ attention affect the quality of perception, and, as a consequence, memory for targeted aspects of input. Explaining variational phenomena implicates mechanisms of attention which are used to control action while using the L2. Explaining perceptual, learning and memory phenomena implicates mechanisms of attention which are used to select (or inhibit) and mentally rehearse information in the L2 input. These two broad classes of attentional mechanisms interact to affect SLA in ways that researchers have explored in both experimental and classroom settings.

Attentional mechanisms regulating the use and learning of L2s can be studied at a number of different levels. For example, at the neurobiological level (Schumann, 2004), research using functional magnetic resonance imaging (fMRI) shows changes in areas of neural activation during stages of behaviorally induced visual orienting (overt head and eye movement toward visual stimuli), as well as in subsequent stages of accurate discrimination between and in response to visual targets (Posner & Peterson, 1990). One aim of research at this level is to show how attentional networks in the brain give rise to awareness—the subjective, contentful “feel” of experience that can be reported to others, to varying extents. For example, Beck et al. (2001) found that the ability to successfully detect and report awareness of changes in a visual scene was associated not only with visual cortex activity related to the changing object, but also with additional activity in regions of the frontoparietal cortex commonly associated with directed attention. Neurobiological research has identified a number of these types of attentional networks (Raz and Buhle, 2006), and has begun to influence accounts of the neural components of attention to language (Arabski and Woltaszek, 2010; Chee, 2009; Green, 2003; Green et al.,...
2006; Indefrey et al., 2001) and how they interact with phonological working memory to affect such processes as rule-learning and fossilization (de Diego-Balaguer and Lopez-Barroso, 2010; Schuchert, 2004); language selection and control in bilinguals (Fabbro, 1999; Rodriguez-Fornells et al., 2006), and the influence of selection and control on the attainment of varying levels of bilingual proficiency (Chee, 2005).

Attention can also be studied at the information processing level, in which performance on cognitively demanding tasks, rather than less demanding tasks, is thought to implicate mechanisms for attention allocation (e.g., automatic versus controlled responding) that differentiate performance on each of them. At this level, attention is conceptualized as having functions that regulate our actions in and facilitate our learning about the environment. These functions include selecting information for processing, focusing on it and inhibiting distractions, activating concepts in long-term memory, and coordinating participation in multiple simultaneous activities. Many of the models of attention that have guided SLA research have their origins in areas of cognitive science addressing one of these information-processing functions. These include models proposed for the study of selective attention in visual processing (Posner & Peterson, 1990); the study of mental workload and divided attention (Kahneman, 1973; Wickens, 1984, 2007); the relationship of focal attention to rehearsal in working memory (Cowan, 1995); conditioned attention and associative learning (Rescorla and Wagner, 1972); and the withdrawal of attention during the development of automaticity and skilled responding (Anderson, 1993; Logan, 1988; Shiffrin and Schneider, 1977). In order to address specific issues in SLA theory, some models of attention have been adapted from the form in which they were originally proposed (see Chaudron, 1985; Gass, 1997; McLaughlin et al., 1988; Robinson, 1995). Debate continues about which models are most effective in their explanations of aspects of information processing during SLA, such as the allocation of attention to competing task demands and the resulting effects on second language (L2) production. In addition, there is disagreement regarding how detailed or “fine-grained” attentional models should be for explaining the effects of L2 instruction (Leow, 2002; Robinson, 2003; Simard and Wong, 2001).

#### Historical issues in SLA Research into attention and awareness

**Input and intake.** The distinction between what is available to be learned (input), and what is cognitively registered through learners’ perceptions and further processing (intake), is one of the earliest psycholinguistic distinctions made in SLA theory:

The simple fact of presenting a certain linguistic form to a learner in the classroom does not necessarily qualify it for the status of input, for the reason that input is ‘what goes in’ not what is available for going in, and we may reasonably suppose that it is the learner who controls this input, or more properly his intake. This may well be determined by the characteristics of his language acquisition mechanism

(Chaudron, 1985, p. 165).

Discussing the “psychological variables that make up the learner’s mechanisms for perception and learning,” Chaudron (1985) further distinguished between an initial stage involving perception of input, or “preliminary intake,” from a later stage involved in the “recoding and encoding of the semantic (communicated) information into long term memory” (1985, p. 2), leading to “final intake.” Two issues much SLA research and theory has subsequently addressed are the attentional mechanisms responsible for learners’ selective perception at the early stage of preliminary intake, and whether and to what extent, it is accompanied by awareness.
Implicit and explicit learning and knowledge. Throughout the 1970s and 1980s, research and theory in cognitive psychology increasingly addressed the role of awareness in learning. These early efforts aimed to reveal the extent that “consciousness” and the “cognitive unconscious” contribute to learning, and were highly influential on SLA research. This seminal work included research and theorizing about implicit, unaware learning of complex artificial grammars (Reber, 1967, 1993) and the relationship of conscious, “explicit” memory to “implicit” memory, which (in contrast to explicit memory) involves no deliberate conscious attempt at recall (Schacter, 1987). Reber and Schacter argued that there were two functionally independent learning and memory systems, since both implicit and explicit learning as well as implicit and explicit memory, could be dissociated from each other. Furthermore, Reber claimed that where a stimulus domain was complex, as in the case of natural language, it could only be learned implicitly, that is, without participants knowing what they learned or how they learned it. Implicit learning was operationalized by asking learners to memorize strings of letters, such as XVVXXZ, generated from the rules regulating a complex finite-state grammar. Learners’ above chance accurate performance on post exposure grammaticality judgments, accompanied by the learners’ inability to describe the knowledge guiding their judgments, led Reber to conclude that participants had unconsciously abstracted the underlying structural rules (for reviews of this research see Perruchet, 2008; Pothos, 2007; Shanks and St. John, 1994; Williams, 2009).

At the same time as these early publications on implicit learning and memory in cognitive psychology were appearing, Krashen (1982) put forward a similar proposal for a distinction between two dissociated language learning systems responsible for unconscious knowledge, or “acquisition”, and conscious knowledge or “learning”. Successful SLA, he claimed, was largely the result of unconscious “acquisition”, since only simple aspects of an L2 can be consciously learned, and since access to what has been consciously learned is only possible under stringent conditions, i.e., when learners have time to reflect, know the rule, and are focused on accuracy, or form. Krashen’s “Monitor Model”, and claims about the superiority of acquisition processes over conscious learning processes, prompted well over a decade of empirical research into the role of awareness in SLA. Bialystok (1978) proposed a model similar to Krashen’s, distinguishing between an Explicit Linguistic Knowledge source, containing all the “conscious” facts the learner has about the L2, and an Implicit Linguistic Knowledge source, containing “intuitive information” that cannot be verbally described. The Explicit Knowledge source stores simple rules while the Implicit Knowledge source stores the complex ones. The implicit knowledge is drawn on in spontaneous language production, in the same way that acquired knowledge is used in spontaneous production in Krashen’s model.

Consciousness raising and input enhancement. Sharwood Smith (1981) argued that “consciousness raising” activities could be potentially helpful for instructed L2 learners, distinguishing four types of intervention that could be used to direct learners’ attention to language form. These activities ranged from the provision of pedagogic rules to “brief indirect clues” to the L2 target structure such as visually enhancing a particular structure in the input during language learning activities. A great deal of SLA research has investigated the effectiveness of what Sharwood Smith (1991) later called “input enhancement” techniques and the extent to which they influence learners’ selective attention to forms. In addition, research has examined the effects of these interventions on learners’ subsequent knowledge and performance. Two particularly interesting issues in this research are how explicit or attention-demanding the input enhancement techniques should be, as in Doughty and Williams’ (1998) investigations of “focus on form” (Long, 1991), and whether input enhancement should be presented reactively (immediately following evidence that a learner has problems producing or comprehending the forms) or proactively, in anticipation of the problems learners are likely to have in selectively attending to form (R. Ellis, 2001).
Apperception. The late 1980s and early 1990s saw a great deal of theoretical debate about the role of attention and awareness in SLA, much of it reacting to Krashen’s claim that unconscious acquisition processes are most influential on the levels of success learners reach. Gass (1988) proposed a framework for research which identified five levels, or processing stages, in the conversion of ambient speech (input) to output. The first of these stages, apperception, concerns attention to and selection of input: “the apperceived input is that bit of language which is noticed by the learner because of some particular features” (p. 202)—and apperception is “the process of understanding by which newly observed qualities of an object are related to past experiences … the selection of what we might call noticed (apperceived) material” (p. 201). It is clear that by apperception Gass means attention to and awareness of input. However, it is “not equivalent to perception” (p. 201), defined as a stimulus-driven process. Apperception involves “noticing” a form and consciously relating it to “some prior knowledge which has been stored in our experience” (p. 201).

For Krashen all that was necessary for acquisition processes to operate was comprehensible input, but Gass (1988) makes the distinction between this and comprehended input, which is controlled by the learner and is the processing stage preceded by apperception. Gass therefore suggests that consciousness is necessary for acquisition to take place. The extent of prior knowledge is one of the factors that determines whether apperception will select input for further processing, and which aspects of the input will be selected. Three other factors are frequency (both highly frequent, and highly infrequent input may result in apperception), affect, and attention, which is “what allows a learner to notice a mismatch between what he or she produces/knows and what is produced by speakers of the second language” (p. 203).

The “Noticing Hypothesis”. At about the same time, Schmidt and Frota (1986) published the results of a diary study in which Schmidt argued for a close relationship between what he had “noticed” (operationalized as testimony to the occurrence of L2 forms, in written diary entries) about a language he was learning (Portuguese), and the subsequent appearance of some of those forms in his own production. Further pursuing the notion of noticing, Schmidt (1990) pointed out that the term “unconscious” (the defining feature of Krashen’s “acquisition” process) is commonly used in three distinct senses: to describe learning without “intention”, learning without metalinguistic “understanding”, and learning without attention and “awareness”. Schmidt argued that while L2 learning without intention or metalinguistic understanding is clearly possible, there can be no learning without attention, accompanied by the subjective experience of “noticing”, or being aware of aspects of the “surface structure” of input. All L2 learning is conscious in this sense, since input does not become intake for learning unless it is noticed. Schmidt (1995) assumed that focal attention and the contents of awareness are essentially isomorphic. The “Noticing Hypothesis” continues to promote much research into the role of awareness in second language learning in instructed and experimental settings, using an increasingly sophisticated and sensitive range of measures of awareness, as will be described in the third section of this chapter.

Detection, noticing and working memory. In another widely cited paper, however, Tomlin and Villa (1994) argued that while attention was necessary for L2 learning, awareness was not. They argued that a more fine-grained analysis of the role of attention in SLA was necessary, and drew on Posner and Peterson’s (1990) neurocognitive model of three interrelated networks, which function not only to detect stimuli (cognitive registration of them), but also to alert (prepare to attend) and orient (commit attentional resources) to stimuli. “None of the central components of attention—alertness, orientation or detection—require awareness” (p. 193), they claimed, and further, that detection was the initial, prerequisite level of processing needed for input selection and second language acquisition. Robinson (1995) described a model of attention and memory
complementary to Schmidt’s Noticing Hypothesis, which accommodated some details of Tomlin and Villa’s proposal. In that model, noticing was defined as “detection plus rehearsal in short-term memory, prior to encoding in long-term memory” (1995, p. 296). Drawing on Cowan’s (1988, 1995) embedded process model of attention and memory he argued that only a subset of input that is detected is focally attended, and noticed. Detected input, which is in peripheral attention, enters into short-term memory. Focally attended input enters working memory, which is that part of long-term memory in a currently heightened state of activation. Further, the nature of the rehearsal processes operating on the contents of working memory help to differentiate the contents of what is noticed and, following rehearsal, permanently encoded in long-term memory—thus accommodating Gass’s (1988) claim that prior knowledge and attention together help determine what is noticed and available for learning. Since there are differences between learners in the abilities drawn on in focusing (and inhibiting) attention, and maintaining and rehearsing information in short term and working memory, Robinson argued that these differences should correspond to differences in learning under implicit, incidental and explicit conditions of exposure. Those higher in these abilities should be more successful at noticing, and learning than those lower in these abilities, whatever the condition of instructional exposure. To this extent, he argued (1997a), learning under any condition of exposure is fundamentally similar.

Selective attention and frequency effects. In a series of influential papers, first appearing in the mid 1990s, N. Ellis addressed the issue of selective attention in the context of “emergentism” (N. Ellis, 1998), and the role of frequency effects in second language learning and processing (N. Ellis, 1996, 2002, 2006a, 2006b). As has been previously shown (Rescorla and Wagner, 1972), human memory is sensitive to recency, the time since past occurrence of a stimulus, and frequency, the number of times it has previously occurred, with both of these positively affecting the “associative learning of representations that reflect the probabilities of occurrence of form–function mappings” (2006a, p. 8). Ellis interprets Goldschneider and DeKeyser’s (2001) findings that perceptual salience, frequency, and morphophonological regularity of morphemes were the strongest predictors of their rank in morpheme acquisition orders as evidence that these are the factors contributing the most to the intensity with which learners attended to, and associatively learned, these forms. This work on associative, statistical learning, has been influential in research into child language acquisition (Conway and Christiansen, 2006; Gomez and Gerken, 1999; Saffran et al., 1999), and is currently being drawn on in studies of implicit and explicit learning during adult SLA (Rebuschat, 2008; Williams, 2010).

Core issues

In this section, we deal with three issues related to attention and awareness in L2 research: (1) interface between implicit and explicit knowledge, (2) objects of attention (i.e., which aspects of language can or cannot be attended to), and (3) the role of attention to and awareness of output.

Interface between implicit and explicit knowledge

Within SLA research, the study of implicit and explicit learning, as well as the distinctions between implicit and explicit knowledge, is firmly rooted in cognitive psychology (as we discussed earlier in the section entitled Historical Issues in SLA Research into Attention and Awareness). Disagreement regarding a number of factors, including the role of awareness, and the nature of knowledge acquired through different types of learning, became a source of debate in both SLA and cognitive psychology. Central to the implicit/explicit discussion is the question of whether or not implicit and explicit learning, and implicit and explicit knowledge, are two dissociated and distinct systems.
If in fact two independent systems exist, what is the relationship, or interface, between these two learning and knowledge systems? Krashen (1982) has claimed that grammatical competence is acquired only through exposure and cannot be explicitly taught, that is, it is essentially implicit. Because learners rely on implicit knowledge for both comprehension and production, and explicit knowledge is used only for monitoring the accuracy of output, explicit instruction and the explicit knowledge gained through it are useful when responding to discrete items on tests, but play no real role when language is being used for real communication. Krashen also argued that these two types of language knowledge are stored and used differently by learners, and that explicit knowledge cannot become implicit knowledge. This position, that implicit knowledge is informationally encapsulated and unaffected by conscious knowledge, is referred to as the non-interface position.

Recent research in neuroscience and neurolinguistics has demonstrated the existence of two distinct and separate processes for developing and storing implicit and explicit knowledge (as described in the chapter in the current volume by Ullman & Morgan-Short), but the influence of explicit knowledge on the development of implicit knowledge remains a source of debate in the field of second language acquisition. DeKeyser (1997, 2003, 2009) argued that explicit declarative knowledge can provide a basis for repeated practice, which, if sufficient, leads to proceduralized and eventually automatized knowledge. Over time, proceduralized knowledge allows the learner to become faster and more consistent in their production and comprehension, thus devoting fewer attentional resources to form. This strong interface position claims that declarative knowledge resulting from explicit learning can directly result in the development of procedural knowledge that learners can subconsciously access in the same way as implicit competence. However, this position depends on excluding awareness as a crucial part of the definition of acquired knowledge, because learners do not become unaware of the rules through practice. Rather, DeKeyser argues that they can develop knowledge that is “functionally equivalent” (2003) to knowledge that is learned implicitly and suggests, moreover, that after automatization of the rules, learners may in fact forget previously known metalinguistic rules, since they are no longer needed.

Another perspective is the weak interface position, which holds that explicit knowledge can become implicit knowledge under the right conditions. R. Ellis (1993) has argued that the transformation of explicit to implicit knowledge through practice can only occur if the learner is developmentally ready to advance (see, for example, the developmental constraints on readiness proposed by Pienemann in his Processability Theory described in Chapter 14). Another possibility is that explicit knowledge can facilitate the growth of implicit knowledge by alerting learners to what they need to attend to when processing input. Indeed, explicit knowledge (whether gained through instruction or through conscious induction) should have mostly positive influences on learning through exposure and interaction, since “learning with advance organizers and clues is always better than learning without cues” (MacWhinney, 1997, p. 278). N. Ellis (2005, 2008) has argued for still another version of the weak interface position, stating that although explicit and implicit knowledge are distinct and dissociated systems, representing different types of knowledge supported in different areas of the brain, there is interaction between them. According to N. Ellis, explicit knowledge is developed through learners’ conscious efforts to construct meaning, while implicit knowledge is developed during fluent language production and comprehension. Relying on implicit and automatized knowledge in predictable situations, we only draw on additional conscious resources, such as explicit knowledge, when these automatic abilities fail. Ellis provides the example of walking to illustrate his point. We do not think about walking until we take a misstep, at which point we use explicit knowledge to subsidize the failure of our implicit knowledge. These implicit and explicit processes connect in what Ellis refers to as a dynamic interface
(p. 325), which is established during conscious processing in working memory. Thus consciousness plays a crucial role in enabling this interface, which then allows conscious and unconscious processes to operate in parallel in language learning as in any other cognitive performance task.

Paradis (2009) has argued that these various scenarios do not constitute an interface between two systems, but rather the replacement of one system with another. Paradis suggests that when instructed learners first begin to acquire a language, metalinguistic knowledge may be used almost exclusively. However, as learners progress, they begin to rely more on the implicit knowledge that has been developed and internalized through continued and extensive practice, with this knowledge eventually becoming automatized as implicit competence. Paradis provides the metaphor of someone recovering from blindness. As this person learns to read visually, he will gradually replace reading with Braille to reading with his eyes. The two systems, tactile and visual, are independent of each other, and although the knowledge of Braille still exists, it does not become visual reading. Within SLA, this can be interpreted to mean that metalinguistic knowledge remains available to language learners, even as they gradually develop automatic implicit competence as a separate and independent system. For instance, learners can use their explicit knowledge to produce monitored output, which then serves as the input for the development of the implicit knowledge system (as also argued by Gass & Mackey, 2006, Schmidt and Frota, 1986). As learners progress, they devote more attention to creating meaning while the structural processes become more automatic (Schmidt, 1995), gradually replacing reliance on the explicit system with implicit knowledge acquired through repetition and exposure to the form in context.

Objects of attention

So far, we have been referring to attention as if it were uniformly involved in all language learning and processing, but research suggests that learners pay more attention to some aspects of language than to others. It is well-established, for example, that learners are less sensitive to syntactic cues to grammatical gender than they are to morphophonological cues (noun endings) during processing. In particular, Bordag and Pechmann (2007); Bordag et al. (2006); Carroll (1999); Franceschina (2005); Holmes and de la Batie (1999) provided evidence to demonstrate that learners are sensitive to noun endings and make use of them in their determination of gender. On the other end of the spectrum, Lew-Williams (2009) and Guillelmon and Grosjean (2001) have shown that learners are insensitive to syntactic indicators of gender, such as agreement on determiners and adjectives. Most of this research has been examined through processing measures such as speed or accuracy of noun production or production using priming experiments, preferential looking tasks, and word recognition tasks. Diversity in cue sensitivity may be considered an indication of where attention is focused when processing a second language.

Mackey, Gass, and McDonough (2000) indirectly investigated attention to different parts of language by looking at learners’ perceptions of oral feedback. In this study, learners were given feedback on their production of target forms, and then were asked through retrospective interviews to comment on the feedback that they received. These learner-produced comments provide a way of examining learners’ attentional focus on a particular area of production, in this case, a form that deviated from target language norms. Results indicated that feedback intended to correct lexical, semantic, and phonological errors was perceived more accurately than feedback intended form orphosyntactic errors. Related to these results is Jiang’s (2004) study of Chinese ESL learners, and his finding that learners are not sensitive to morphology when processing L2 sentences. One possible explanation for this observed differential sensitivity to certain aspects of language is the phenomena of attentional blocking and learned attention (N. Ellis, 2006, 2007). According to N. Ellis, when linguistic cues are redundant (e.g., in the sentence He goes to the store,
both _He_ and _-s_ indicate the third person singular) the learning of later experienced cues is blocked by earlier learned cues. For example, N. Ellis (2007) found that for redundant cues, when learners were exposed to adverbial cues, the acquisition of verbal tense morphology was blocked, whereas earlier exposure to verbal tense morphology blocked the later acquisition of adverbs. In the case of L2 acquisition, speakers who do not have a certain linguistic cue in their L1 may fail to pay attention to, and subsequently learn, that cue in their L2. Indeed, N. Ellis (2007) also found that L1 speakers of Chinese languages, which do not have verb tense morphology, were unable to acquire inflectional morphology in the presence of redundant adverbial and verbal cues. Other theoretical approaches to L2 learning (e.g., Lardiere, 1998; Prévost and White, 2000; Sprouse, 1998) also support the view of differential learning. However, in these studies, the explanations take a more formal direction with rare discussion devoted to the role or influence of attention.

Gass _et al._ (2003) investigated the role of focused attention on the learning of three areas of language: syntax, lexicon, and morphosyntax. The focus of attention was manipulated by underlining words, phrases and sentences in stories that participants read on a computer screen and telling participants to pay attention to the underlined material. Findings indicated that although learners’ attention was focused on all three parts of language, the greatest amount of learning took place in syntax. However, without focused attention, the greatest amount of learning took place in the lexicon, followed by morphosyntax, and then by syntax. In addition, the authors discussed the role of proficiency in relation to attention, finding a diminished impact of directed attention as a function of proficiency and in all language areas. However, “focused attention” in that study refers only to externally manipulated attention, and does not necessarily correspond to internal attentional processes, which the authors cite as a limitation.

The role of attention to and awareness of output

Many of the issues we have described concern the role of attention and awareness in processing input, and the extent to which levels of attention and awareness are necessary for retention of input and further learning. Recently, however, there have been an increasing number of studies examining attention to and awareness of form in L2 production, or output, and the extent to which attention to and awareness of output can facilitate SLA. Swain (1995) argued that attention to output has a facilitating role, since “in producing the target language … learners may notice a gap between what they want to say and what they can say, leading them to recognize what they do not know, or know only partially” (pp. 125–126). Producing language also offers opportunities for testing hypotheses about well-formedness, and for metalinguistic reflection on L2 form. Izumi (2003) and Kormos (2006) have described the stages of L2 speech production at which attention can operate to promote the three kinds of awareness that Swain described, and current research is concerned with the extent to which the attentional demands of pedagogic tasks promote these kinds of awareness, and so affect performance and learning.

The theoretical question of interest here is the notion of attention as “capacity”. Clearly, the human information processing system is limited in its ability to process and respond to information in the environment; but are breakdowns in performance caused by limits on attentional capacity? Skehan (1998, 2009) argues for this position, claiming that capacity limits on a single pool of attentional resources will, in general, lead to decrements in the fluency, accuracy and complexity of L2 speech when tasks are high in their attentional, memory and other cognitive demands. Skehan argues that certain task characteristics may “predispose learners to channel their attention in predictable ways, such as clear macrostructure towards accuracy, the need to impose order on ideas towards complexity, and so on” (Skehan, 1998, p. 112). However, tasks can lead either to increased complexity, or accuracy of production, but not to both. In Skehan’s account, due to
scarcity of attentional resources, attention to accuracy of speech takes place at the expense of attention to complexity of speech. A contrasting position has been proposed by Robinson (2003, 2007), who argues that attentional capacity limits are an unsatisfactory, post-hoc explanation for breakdowns in attention to speech. Following Neuman (1987) and Sanders (1998), Robinson suggests that breakdowns in “action-control”, not capacity limits, lead to decrements in speech production, and learners’ failure to benefit from the learning opportunities that attention directing provides. Consequently, increasing complexity along various dimensions of tasks, such as increasing the amount of reasoning the task requires or increasing the memory load of the task, promotes greater effort at controlling production and more vigilant monitoring of output. This increased task complexity leads to greater accuracy and complexity of L2 production when compared to performance on simpler task versions that require little or no reasoning. Furthermore, greater task complexity leads to increased noticing and improved uptake of task relevant input. Research into Skehan’s and Robinson’s contrasting predictions, and their theoretical underpinnings in models of attention and speech production, can be expected to continue in current SLA research.

**Data and common elicitation measures**

**First-Person verbal reports**

First-person reports of experience, collected in the form of speech or writing, have been the major source of information on the contribution of attention and awareness to SLA, and have been elicited via a range of methodologies. These include diary entries, in which learners reflect on their experience over weeks or months (Schmidt and Frota, 1986; Warden et al., 1995); on-line “think-aloud” protocols, in which learners verbalize the contents of their experience while directly engaged in learning activities (Bowles, 2010; Leow, 1997, 2000; Leow and Morgan-Short, 2004), immediate off-line response prompts to recall experience (Philp, 2003); or somewhat more delayed responses to written questionnaires (Bell and Collins, 2009; Robinson, 1996, 2010a), stimulated recall, in which learners are prompted to report the thoughts they had while performing a task (Gass & Mackey, 2000; Mackey et al., 2000) or oral interview questions (Leow, 2000; Williams, 2004, 2005).

As Baars (2003) notes, the standard behavioral index for consciousness is the ability people have to report their experience (see also Weiskrantz, 1997). Conscious processes “can be operationally defined as events that: (1) can be reported and acted upon, (2) with verifiable accuracy, (3) under optimal reporting conditions, and (4) which are reported as conscious” (2003, p. 4). Optimal reporting conditions involve, for example, factors such as a minimum delay between the event and the report, and freedom from distraction. Because of the need for optimal conditions, immediate off-line measures, such as those collected by Philp (2003) and Mackey et al. (2000), have advantages over first-person reports collected after some period of delay, as in diary studies or during oral interviews, where learners may have simply forgotten what they were aware of during learning. Think-aloud protocols have been argued to be concurrent measures of awareness and, possibly, learning, and have the advantage of immediacy over all other methods for first-person reporting, but it has been argued that learning activities may distract attention from attempts to verbalize experience while thinking aloud, thereby reducing their faithfulness as records of what learners were aware of. On the other hand, the effort to verbalize thoughts may distract learners’ attention from the learning activity, negatively affecting performance. This potential effect that the effort of verbalization may have on the cognitive processes of interest is referred to as the risk of “negative reactivity”. Sachs and Polio (2007) found just such an effect, since a group instructed to think aloud while processing feedback in the form of reformulations provided on the drafts of
essays they had written made a lower percentage of corrections to their revised essays than a group not instructed to think aloud while processing the feedback. On the other hand, Sanz et al. (2009) found that a group of English speaking students instructed to think aloud while participating in a computerized lesson on the Latin case system, in which they received explicit feedback about responses to the semantic functions of case markers, performed significantly better on post-test measures of grammaticality judgment and sentence production than a group not instructed to think aloud, but had no effect on the latency of response to grammaticality judgment items. Thus the observed reactivity was “positive” in this case (see Bowles, 2010 for extensive discussion of this issue of “reactivity”).

Overall, although they differ in the optimality of the conditions they require for eliciting awareness, the first-person reports of experience described above are valuable sources of information about the facilitating effect (or not) of more versus less reported awareness on learning morphosyntactic, lexical or phonological form (Mackey et al., 2000) or pragmatic form (Felix-Brasdefer, 2008). In the classroom and laboratory studies referred to above, first-person reports are used to assess the relative “extent” of awareness of forms made salient through some instructional intervention intended to guide attention to them, such as input enhancement (Alanen, 1995; Jourdenais et al., 1995; Robinson, 1997b), or recasting (Mackey, 2006; Philp, 2003), and the extent to which these “greater” levels of awareness did (more explicit learning) or did not (more implicit learning) accompany pre-to post-test gains in knowledge.

**Subjective and objective behavioral tests of learning**

First-person verbal reports, however, clearly may fail to include all of the information learners were aware of during learning (cf. Allport, 1988; Godfroid et al., 2010; Jourdenais, 2001; Rosa and O’Neill, 1999). This lack of information may be due to some of the reasons provided above, such as the possibility of forgetting after a delay between experience and reporting, as well as for other reasons described below. In studies of implicit learning in cognitive psychology, first-person verbal reports have been criticized for failing to meet what Shanks and St. John (1994) have called the information criterion, and also the sensitivity criterion.

In the early studies of implicit learning conducted by Reber (see Reber, 1989), during training he asked participants to attend to, and copy down a series of letter strings they were presented with (e.g., XXVZ). He then told them the strings they had seen followed certain rules, regulating permissible sequences, and asked them to judge which of a further series followed, or did not follow the same rules. Participants performed with above chance accuracy, but without being able to respond to requests to verbalize the rules they were following in making judgments. However, as Perruchet and Pacteau (1990) and Shanks and St. John (1994) argued, these results were not evidence that unconscious learning had taken place. Participants were asked to provide information in the verbal reports about their knowledge of rules, but even those who were completely unaware of and unable to verbalize rules could have been aware of and used other information (e.g., co-occurring bigrams and trigrams) to guide their performance. These verbal reports therefore violated the information criterion necessary in measures of implicit learning because they did not necessarily measure the knowledge responsible for guiding behavior.

The sensitivity criterion states that a measure of awareness should be sensitive to all of the conscious knowledge that could have guided learning. First-person verbal reports may fail to meet this criterion since participants may be insufficiently motivated to report knowledge which they have, but which they feel unsure of or lack confidence in. In short, when learners are asked to report first-person experiences, they may not be asked about the information they were
aware of and which led to learning, or they may intentionally withhold knowledge they were aware of and which led to learning. For these reasons, researchers argue (e.g., Dienes and Scott, 2005; Merickle and Reingold, 1991; Tunney and Shanks, 1993) that both subjective and objective “behavioral tests” need to be employed as markers of awareness. These tests are necessary supplements to first-person reports of experience, such as protocols, in order to probe whether awareness is actually implicated in learning, even in the absence of learner failures to voluntarily self-report it.

An objective test of learning encourages learners to respond by consciously accessing the knowledge they need to perform the test or task. For example, after being trained on an artificial grammar in implicit or explicit learning conditions, learners are often asked to complete a grammaticality judgment task (i.e., indicate whether the new string follows the grammar of the strings encountered during training). When learners are required to underline or otherwise identify the information that guided their decisions, they are guided to consciously indicate the knowledge on which their judgments are based. Where the above chance accuracy of grammaticality judgments matches learners’ underlining or other identification of the information that did occur during training, it is taken to be evidence that learning was the result of awareness. However, asking participants to engage in such a task may increase awareness of the target forms during testing, and does not necessarily reflect the level of awareness during the learning phase. Objective measures may also require learners to generate a sequence of letter strings or words based on learners’ explicitly accessible knowledge and memory of their occurrence during trained exposure. Again, where the explicitly accessed knowledge used to generate strings or sentences in these tests matches the occurrence of those strings and sentences in training, then learning is judged to be the result of awareness. All of the direct measures for assessing reflective memory for prior exposure to grammatical strings during training described by Merikle and Reingold (1991) (and summarized in Robinson, 1995) are therefore objective tests. These measures include forced choice recognition tests of information presented during training, or responses to instructions to recall whether information in the test occurred during training.

In contrast, a subjective test of learning does not encourage learners to consciously reflect on their prior experience with—and so their explicit memory for—the stimulus during training, but rather requires them to respond on the basis of the degree of “feel,” or certainty about intuitions guiding their responses during actual test performance. These subjective tests include those eliciting estimates of the “confidence” which learners have in making responses to a post-training exposure test of knowledge gained (Rebuschat and Williams, 2010; Shanks and Johnstone, 1998; cf. Krashen, 1982). Where learners report themselves to have no confidence in their responses, and so to be “guessing” versus “not guessing” (a dichotomous scale), and where there is also above chance accuracy in responding to the test of what was learned (another dichotomous scale), the knowledge guiding responding is then judged to be outside of awareness. According to Dienes et al. (1995), tests of implicit, unaware learning should meet this “guessing criterion,” which can be calculated using the chi-square statistic. This guessing criterion demonstrates the absence of awareness by showing a greater than expected proportion of guessing/above chance accurate responses compared to other responses in a 2 x 2 guessing/not guessing, above/below chance matrix. Similarly, when there is no significant positive correlation between learners’ confidence ratings on the accuracy of their decisions, measured along some interval scale from “no confidence” to “absolute confidence”, and their percentage of accurate decision-making on test items, the knowledge that guides performance on the tests is also judged to be outside of awareness. This is what Dienes et al. (1995) call the “zero correlation criterion” for demonstrating implicit learning.
Instructional relevance

Input enhancement

Many subfields of second language research are relevant to the instructional context (see Chapter 33). Significant amounts of research have investigated what Sharwood Smith (1991) referred to as input enhancement, or induced input salience (p. 121) and the extent to which it in fact induces selective attention. Polio (2007) provides a clear review of the input enhancement literature, including definitions, similarities, and correspondences with the term “focus on form” (see Chapter 33) as well as empirical evidence. She points to narrow definitions of input enhancement, in which instructors or materials developers visually enhance materials (e.g., colors, bold letters), as having been shown to have little effect. On the other hand, if a broader definition is taken, such as one that includes any effort to draw learners’ attention to certain language features, then the impact on acquisition is broader (see also Han, Park, & Combs, 2008; Huang, 2008; Leow, 2007).

As was noted in section 2, the significance of attention-drawing activities varies according to the structure involved. For example, Jeon (2007) designed communicative activities that were focused on lexical items (nouns and verbs) and morphosyntactic features (relative clauses and Korean honorifics). In the short-term, relative clauses, verbs, and nouns were impacted more than honorifics; in the long-term, attention-drawing activities had a greater impact on relative clauses than on honorifics within the category of morphosyntax. Comparing morphosyntax and the lexicon, verbs were more impacted than nouns and honorifics. Jeon’s explanation for the differential effects of attention-focusing activities centers on the salience of form.

Individual differences and attention

Aptitude. Considered a strong indicator of academic success, aptitude has generally been regarded as a key factor in predicting learners’ rate of development in second language learning contexts (DeKeyser, 2000; Dörnyei, 2005) and is discussed in full in Chapter X in this volume. Early aptitude research (Carroll, 1973, 1981) identified four cognitive components related to predicting language learning potential: phonemic coding ability, grammatical sensitivity, associative memory ability, and inductive language learning ability. Recent research has also suggested that these aptitude components play an important role in learners’ individual processing abilities (Dörnyei and Skehan, 2003; Robinson, 1996, 1997a). For instance, earlier sections of this chapter have addressed the importance of focusing learners’ attention on form in order to facilitate acquisition. However, the success of focusing learners’ attention is likely affected by learners’ individual abilities to focus on form, abilities which are grounded in the aptitude components of grammatical sensitivity and inductive language learning ability.

Empirical research (de Graaff, 1997; Robinson, 1997a; Williams, 1999) has also demonstrated that individual differences in aptitude influence learning in both implicit and explicit conditions. For instance, in Robinson’s studies examining the effects of varying learner / learning conditions (rule-search, instructed, incidental, and implicit) on acquisition (1996, 1997a), learners in the implicit group who demonstrated greater grammatical sensitivity were more likely to deduce and be able to verbalize explicit knowledge from language stimuli than those lower in grammatical sensitivity. Robinson (2002) also suggests that learning conditions that promote attention to and noticing of target forms (such as explicit conditions in which a pedagogic rule is presented to guide input processing, or in which learners are encouraged to search the input for grammatical rules) draw on different aptitude resources, or aptitude complexes, than learning that takes place during
incidental (i.e., a comprehension activity) or implicit conditions (i.e., memorizing sentences and answering questions about the location of words in the sentences).

These differential relationships between aptitude complexes and psycholinguistic processing conditions, such as pedagogical tasks or instructional treatments, have significant implications for the language learning classroom (Robinson, 2002). For example, by profiling the strengths and weaknesses learners have in the abilities that contribute to language learning aptitude it should then be possible to match these profiles to tasks and input processing conditions that draw on the abilities learners are strong in, thereby optimizing their chances of success in L2 instructional programs.

Working memory. Another individual difference closely linked to attention, working memory is usually described as the processes used to temporarily store and manipulate information needed for both known and novel cognitive tasks and is discussed in full in Chapter X of the current volume. Working memory is often considered to be a central component of language aptitude (Miyake and Friedman, 1998; Robinson, 2001, 2002, 2005a; Skehan, 2002), and the relationship between working memory and attention has been a key area of research in SLA, with working memory capacity closely related to comprehension and processing skills. Although there are a number of working memory models (Baddeley and Hitch, 1974; Conway et al., 2005; Engle, 2001; Miyake and Shah, 1999) defining the construct in variable ways, each model identifies a form of executive attention or coordination. This executive component supervises the distribution of attentional resources when more than one cognitive task or task dimension requires attention, maintaining access to relevant information and blocking access to irrelevant information (Kane et al., 2007).

Considering the complexity and cognitive demands involved in second language learning, the link between working memory capacity and attention is an important one, and a number of empirical studies have demonstrated a connection between them. In an exploratory small-scale study, Mackey et al. (2002) examined the relationship between both phonological and verbal working memory and noticing, finding that learners who reported lower levels of noticing of questions during task performance also had low working memory capacities. Learners with high working memory capacities were more likely to have noticed more questions. Mackey et al. (2010) investigated the relationship between working memory and modified output during interaction. Because modified output can occur following corrective feedback on an utterance in interaction, the idea is that the learner must have, at some point, attended to the corrective feedback and in this study, working memory scores significantly predicted the production of modified output by learners (see also Mackey and Sachs, 2011, for similar working memory-learning patterns with older adults). Within instructional contexts, learners’ individual capabilities to store and manipulate information, as well as manage and devote attentional resources to competing cognitive demands and suppress irrelevant information, are likely to be significant factors affecting learner success.

Tasks in language learning

Tasks are central to language learning in communicative classrooms. Arguments for their validity as a pedagogical tool come partially from the interactionist literature (see Mackey and Gass, 2006; Gass and Mackey, 2007; for reviews) which, in turn, relies heavily on the construct of attention and attention-drawing activities. As Schmidt noted, in summarizing conclusions drawn by Ericsson and Simon (1984), and others, “Task demands are a powerful determinant of what is noticed” in experimental settings, “and provide one of the basic arguments that what is learned is what is noticed … the information committed to memory is essentially the information that must be heeded in order to carry out a task” (1990, p. 143). The extent to which this is true of second
language learning tasks in classrooms is an important issue for materials and instructional design. Space limitations prevent us from a thorough discussion of tasks, and findings from research into their effects on learning, but, suffice it to say, proposals concerning task characteristics, task complexity and task sequencing (see e.g., Candlin, 1987; Robinson, 2001, 2007; Skehan, 1996, 1998) have proven to be central in discussions of classroom instruction. For example, are there certain task types or even feedback types that might result in implicit or explicit knowledge? In what way is it useful to manipulate the conceptual demands of tasks so as to direct attention to one part of language as opposed to another? What task characteristics promote output and noticing of forms in the input, and to what extent do attestations of noticing lead to greater retention and learning of those forms?

Feedback in interactive settings is an important factor that may guide attention since, in principle, feedback may focus attention on problematic parts of an utterance. Thirty years ago, Schachter (1981) engaged in a discussion of the role of feedback types and proposed hand signals that focused on specific error types. The underlying principle is similar to today’s activities which focus on the extent to which learners can be trained to understand the intent of feedback and understand the function of feedback. Connecting task demands and attention to feedback, Robinson (2005b) has argued that complex tasks (compared to simpler counterpart tasks) lead learners to attend more closely to information provided in task input (such as corrective feedback), with the consequence that complex tasks will result in more uptake and retention of attended input than simple task versions. A final issue of instructional relevance is the extent to which preparatory attention, provided during planning time, facilitates task-based learning, and whether it is better to provide this before (pre-task) or during (within-task) task performance. Ellis (2009), provides a comprehensive summary of findings for this research to date.

Future directions

The area of attention and awareness in second language acquisition is growing in importance in second language research. Many of the areas discussed in this section are continuations and outgrowths of current research. Below we provide some suggestions for new research directions to continue to move the field forward.

(1) Do different techniques for focusing attention on form draw on different sets of cognitive abilities? The contribution of individual differences in cognitive abilities to attend to, be aware of, and successfully learn forms and meaning is an on-going and important area of research, particularly regarding instructional attempts to make forms and meanings salient to learners. A research area of particular interest is whether different techniques for focusing attention on form (Doughty and Williams, 1998; Long and Robinson, 1998) draw on different sets of cognitive abilities. For example, do different sets of abilities promote successful attention to and noticing of recasts of problematic learner utterances, compared to the abilities that are involved in understanding metalinguistic explanations of the error? Research has shown that working memory capacity is related to the ability to notice and use the negative feedback provided in interaction (Mackey et al., 2002, Mackey & Sachs, 2011). Learners with greater working memory capacity profit more from this feedback technique, and are also better able to attend to, notice and learn aspects of grammar while processing input for meaning. Findings such as these (see e.g., Sagarra, 2007; Trofimovich et al., 2007) are prompting new proposals for comprehensive aptitude batteries (Robinson, 2002, 2005a, 2007) that sample the cognitive abilities learners draw on under a range of input processing conditions, and in response to a range of focus on form techniques, which aim to promote attention to and
noticing of instructionally targeted forms. For example, some learners may be more “primeable” than others, such that previous recasts more successfully prompt later recollection, use and so longer-term retention of the recast forms in subsequent episodes inviting their use (McDonough and Trofimovitch, 2008; Robinson, 2005a). The prospect that this research offers, is that—if identified—the cognitive abilities that promote attention to, noticing and retention of form–meaning connections under differing task and processing conditions can be profiled in populations of learners, and instructional options can subsequently be matched to these profiles in order to optimize the probability of more successful allocation of attention to, noticing and elaborative processing of forms and their meanings (cf. Robinson, 2010b; Snow, 1994).

(2) How do we increase the sensitivity of behavioral tests of the role of attention and awareness in learning? Future research will likely adopt increasingly sensitive measures of the contents of awareness, and explore new methodologies for operationalizing this complex and multi-faceted construct. For example, Rebuschat (2008) has used, for the first time, subjective behavioral tests, such as confidence estimates and source attributions, described in section 3.2, to examine the extent of implicit versus explicit L2 learning. Neurophysiological measures of physical changes in brain states will also be used increasingly to complement the behavioral and introspective methods for studying the relationship of attention and awareness to learning. Studies such as that of Godfroid et al., reported in section 5.4 below, provide an example of how such converging behavioral and neurophysiological evidence for the influence of attention and awareness on L2 learning may be gathered in future studies.

(3) How do we research situated and distributed cognition perspectives on the roles of attention and awareness? Cognition, learning, and attention are always situated processes, occurring in sociocultural contexts which can be analyzed at different levels of granularity in instructional settings (Snow, 1994). This raises the question of the extent to which these contexts can be consistently reproduced (for purposes of instructional accountability, planning and management) and matched to the abilities learners bring to them. One option is to reproduce instructional contexts by delivering tasks having the same or similar characteristics, and research the ways these task characteristics make demands on the abilities learners bring to them, and the consequences of these task characteristic—ability determinant coordinates for success or failure in learning (Ackerman and Ciancolo, 2002). Another option is to research how attention and noticing are deployed across sequences of such tasks, such that the distribution of attention and learning opportunities across task “affordances” is maximized. Sequences of tasks, appropriately distributed across timescales, have the capacity to afford opportunities to prime and prompt recollection of previously experienced language related episodes, thus strengthening memory for them. The theoretical constructs adopted in research into the role of “remindings” in other areas of instructional design (see Ross and Bradshaw, 1994) will be important to consider in SLA research into these issues.

(4) Combining first person verbal reports and physiological measures to study attention and awareness during second language acquisition. A final issue for research that we raise here is important for operationally evaluating the results of future research into all the other issues raised above into the roles of attention and awareness in instructed SLA. We described the limitations of verbal reports as measures of attention to and awareness of learning targets above. Verbal reports are unlikely to faithfully reflect everything that learners are attending to and aware of. Consequently, supplementing these reports with physiological indices of on-line attention to learning targets such as eye movements (Scheiter and Van Gog, 2009), is a valuable way of attempting to establish more reliable, converging evidence for the roles of attention and
awareness in learning. Eye-tracking lines of research provide one such example of a converging physiological index of learning processes in what follows.

One might assume that longer length of eye gaze fixation indicates greater effort, and awareness of the fixated content (the eye–mind assumption; e.g. Reichle et al., 2006). Godfroid et al. (2010) report the first SLA research to explore this procedure in the context of noticing. In their study of incidental learning of vocabulary, participants read short 9–11 line paragraphs on a computer screen for comprehension purposes (participants were told the aim of the exercise was to compare how people read on a computer screen and read on paper). Eight pseudo word target forms were embedded in the paragraphs. Following a post–exposure recognition test of knowledge of the pseudo words, Godfroid et al. used a stimulated recall procedure (Gass and Mackey, 2000) to elicit comments from learners about the words in the post-tests, and memories of their occurrence while reading. Accurate scores on the multiple choice post-test showed some learners recognized words they had been exposed to, and understood their meaning. The stimulated recall data also indicated that some learners remembered reading the target words, and provided information about how they dealt with them during the reading task. Godfroid et al. also collected information about four different measures of eye fixation time for the pseudo words and the immediately following words (the spillover region). Statistical analyses (reported in Godfroid, 2010, and Godfroid et al., forthcoming) revealed that the total amount of time learners spent reading a pseudo word predicted the recognition of that pseudo word on the post-test, thereby lending support to the view that attention plays a crucial role in encoding stimuli in memory. However, some participants recognized words they had been exposed to (performing accurately on the post-test), even though fixation times were quite low (indicating lack of increased awareness). These findings led to the conclusion that the “mere perception of the target words sufficed to create a memory trace that enabled participants to discriminate them”. This suggests that detection, not noticing, led to learning, as measured by post-test recognition of the words. The problem here, however, is in establishing a boundary of eye fixation time above which one can conclude attention was accompanied by awareness, and below which it was not. Although it might be possible to establish such a boundary for an individual by using a combination of the verbal reports, test performance, and eye tracking data, such an eye fixation threshold would likely differ across individuals. Furthermore, this type of threshold could possibly vary within individuals, given the levels of variation in the complexity of processing they are engaged in on any two tasks. As Godfroid et al. suggest, these remain important issues for future research.

Note
* Authors’ note: This chapter benefited significantly from a great deal of insightful feedback and helpful suggestions provided by Aline Godfroid. Any errors that remain are the sole responsibility of the authors.

References
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