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*Daisuke Nakamura**

Methodological considerations in studying awareness during learning. Part 2: Second Language Acquisition

Abstract: *This paper considers methodological issues of awareness during adult second language acquisition (SLA). Specifically, the paper deals with (a) the issue of instructional orientations, (b) the issue of biases in knowledge measurement, and (c) the issue of reactivity in the online think-aloud protocol. Detailed reviews of prominent SLA research that has investigated the possibility of implicit SLA reveal (1) that the instruction on implicit learning does not guarantee that learners engage in the implicit learning mode, (2) that the majority of SLA research has employed only tests of "explicit learning" such as untimed grammaticality judgment, and (3) that there is some evidence that the online think-aloud protocol causes negative reactivity particularly when it is metalinguistic in nature.*

Key words: *awareness, retrospective verbal report, think-aloud protocol, second language acquisition*

Children's first language acquisition (FLA) differs from adult second language acquisition (SLA) in fundamental ways (Bley-Vroman, 1990, 2008). Children develop adult-like first language (L1) constructions with the aid of, or with concurrent development of cognitive abilities such as theory of mind (Cook, 2010; Cromer, 1974; Ellis, 2003). Outcomes of learning also differ: children somehow arrive at mastery of adult-like L1 constructions (in Bley-Vroman's term, convergence). Adult second language (L2) learners, on the other hand, already possess matured cognitive abilities as well as knowledge of L1 (Ellis, 2003), which helps and/or hinders their learning of additional languages. Outcomes of adult L2 learning are divergent: some develop near native-like L2 proficiency (Abrahamsson & Hyltenstam, 2008) while others remain at a lower level of L2 proficiency.

Most controversially, some researchers argue that the existence of awareness during learning is also different between FLA and SLA. Children acquire their L1s implicitly - without awareness of the learning processes and/or outcomes (Ellis, 2007; Goldberg, 2006; VanPatten, 1994; Winter & Reber, 1994) - by focusing on understanding the meaning of utterances without intention to learn (Krashen, 1981, 1985, 1994, 2003). On the other hand, in order to learn L2, adults need attention and awareness at the level of noticing - subjective experience of knowing surface structures of input (Ellis, 2005; Robinson, 1995a, 2003, 2007; Schmidt, 1990, 1994a, b, 1995a, b, 2001, 2010, see also Robinson, Gass, Mackey, & Schmidt, 2011, for a summary of this issue). The issue of implicit SLA has been widely discussed and empirically tested in the SLA literature (DeKeyser 2003; Dornyei 2009; N. Ellis 1994; Hustijn & DeKeyser,1997; Hustijn & R. Ellis 2005; Hulstijn & Schmidt 1994; Robinson 2010; Sanz & Leow 2011; Williams 2009, 2010). However, methodological problems in measuring awareness pose serious questions about evidence for/against learning without awareness. The aim of this paper is therefore to consider each methodological issue of awareness revealed by the findings in laboratory SLA. In so doing, the paper firstly describes the issues of awareness during learning in the context of a) neurophysiological and philosophical classifications of awareness, b) implicit learning in cognitive psychology, c) implicit and explicit SLA in the context of general linguistic traditions (UG approaches vs. usage-based approaches), d) implicit and explicit learning in the context of FLA vs. SLA. The paper then raises the possibility of differential contributions of awareness to the learning of different aspects of L2 (e.g., vocabulary, pragmatics) before providing methodological considerations for the claim that all adult SLA needs

*** Contact author at: hamuhamuhamihami@yahoo.co.jp; Aoyama Gakuin University, 4-4-25, Shibuya, Shibuya-ku, Tokyo. JAPAN150-8366**

awareness at the level of noticing. The paper addresses 1) whether differences in learners' states of minds reflect differences in instructional orientations, 2) whether laboratory research is biased against implicit learning, and 3) whether awareness should be measured concurrently or retrospectively.

Neurophysiological and Philosophical Classifications of Awareness

Awareness has often been equated with another term, *consciousness* (Schmidt, 1990; Velman, 2009). Although both could denote subjective qualities of mental "states", the term consciousness also refers to the subjective qualities of mental "processes", as reflected in usages such as conscious perception. Consciousness, therefore, has a wider scope in applicability than awareness. However, since most researchers in philosophy and neurophysiology equate consciousness with awareness, the paper follows this tradition unless that distinction becomes relevant.

Awareness, as Edelman (2003) believed, is revealed by diverse phenomena, and thus various "types" of consciousness have been identified in the literature. The most fundamental broad distinction is consciousness of an organism as a whole (e.g., sleep, coma, and vegetative) vs. conscious of (contents of) their mental state.

Rosenthal (2002) distinguished three types of consciousness; creature, state, and transitive consciousness. *Creature consciousness* refers to waking states of minds concerned with "the biological matter" (p. 406). Animals have creature consciousness but plants do not. Or, a person does not have creature consciousness when they are in a coma (although levels of consciousness or arousal differ in degrees; in sleep, in anaesthesia, in vegetative states, and in seizures, see Tononi & Koch, 2008). *State consciousness* is concerned with the conscious/ unconscious mental states, that is, awareness of the contents of mental states. Note that the self is not contained within the scope of awareness. A third type, *transitive consciousness* is self-awareness of the mental states: "I" am aware of those things. Transitive consciousness is defined independently of awareness of the contents of mental states.

Edelman (2003) distinguished primary consciousness from higher-order consciousness. *Primary consciousness* refers to "the remembered present" (p.5521), the multimodal scene constructed by binding perceptual and motor events so as to retrieve past memories. Importantly, primary consciousness does not involve "the narrative capability" and thus animals with primary consciousness can sometimes adapt to the environment by planning action, but cannot verbalize or reflect on the events. Verbalization is made possible by *higher-order consciousness*. Humans possess the richest form of higher-order consciousness evidenced by possession of language, which results in the capacity to remember the remote past, to plan the future, and to develop self-awareness. In other words, the higher-order consciousness is consciousness beyond the remembered present.

In addition to these rather primitive distinctions, further distinctions concerning conscious mental states have also been developed. The term "fringe" consciousness is one example of this, and was originally developed by William James (1890). He considered that consciousness located at the periphery of focal attention evokes "vague feelings" which provide contexts about conscious contents brought by focal attention (Reber, Wurtz, & Zimmermann, 2004). Block (2005) developed the most prominent distinction, phenomenal vs. access consciousness. *Phenomenal consciousness* is awareness of, but not access to contents of mental states developed by "recurrent interaction or processing" (Lamme, 2003) between the V1 (the primary visual cortex) and the MT/V5 (Block, 2005). Access consciousness is developed by amplification of such recurrent interactions and by spreading them into the areas of frontal, prefrontal, and temporal cortex (Lamme, 2003), and is thus modulated by working memory (WM) processes. *Access consciousness* is not to be necessarily feasible to report the contents of access consciousness (Block, 2007 referred to such access consciousness which can be verbalized as *reflective consciousness*).

Implicit Learning in Cognitive Psychology

Awareness with relation to learning has been extensively studied in cognitive psychology since the seminal demonstration by Reber (1967; see Folia, Udden, de Vries, Forkstam, & Petersson, 2010, Perruchet, 2008, Pothos, 2007, Shanks, 2005, for recent reviews). Reber (1993: 12) defines implicit learning as:

> A situation-neutral induction process whereby complex information about any stimulus environment may be acquired largely independently of the subjects' awareness of either the process of acquisition or the knowledge base ultimately acquired.

This definition claims that both (1) the learning processes and (2) the resultant knowledge are implicit, with the special concession "largely independently", suggesting that both implicit learning processes and implicit knowledge can interact with the explicit learning processes and knowledge.

However, there have been a wide variety of definitions of implicit learning and thus the term implicit learning is polysemous (Frensch, 1998). Researchers differ in whether implicitness refers only to the learning processes (Shanks & St. John, 1994) or includes both the processes and the resultant knowledge (Reber, 1993). To complicate matters further, some include intentionality (Cleermans & Jimenz, 1996; Perruchet & Vinter, 1998; Segar, 1998; Stadler & Frensch, 1994) or/and automaticity (Frensch, 1998; Mathews et al., 1989) of the learning processes as definitions of implicit learning. These conceptual diversities underling implicit learning have triggered continuous disputes over the validity and the empirical amenability, or appropriate ways of operationalization, of implicit learning (Frensch, 1998, and Nakamura, submitted).

The most widely used paradigm is artificial grammar learning (AGL) where digit sequences (e.g., XXVX) are generated by a finite state Markov grammar.

Implicit learning is often operationalized as memorization of training sentences without instruction to search for underlying rules or explicit rule explanation. Subjects are assumed to be able to judge the grammaticality of a new sequence presented during the transfer session simply by memorizing digit sequences presented during a training session, without explicit instruction in the artificial grammar. Since they cannot explicitly verbalize the underlying rules but nevertheless can indicate correct grammaticality judgment (GJ) at an above chance level, it is argued that the acquired complex knowledge results from implicit learning and is tacit, i.e. unavailable to conscious awareness. For instance, Reber (1976) compared the explicit learning condition with the implicit learning condition. The explicit learning condition was operationalized as provision of the explicit instruction to memorize items as well as to search for underlying rules and was given at the training session. The implicit learning condition, on the other hand, was operationalized as provision of the instruction to simply memorize items. Reber found that participants in the implicit learning condition outperformed participants in the explicit learning condition in accuracy of remembering training items. Moreover, learners in the implicit learning condition significantly outperformed those who were in the explicit learning condition in their grammaticality judgment of the new transfer items.

Implicit and Explicit SLA in the Context of General Linguistic Traditions

Many SLA theories try to deal with discrepancies between child FLA and adult SLA. For instance, Universal Grammar (UG) approaches explain such discrepancies in terms of accessibility to UG. UG consists of universal principles that are uniform across all divergent languages and a set of parameters that stipulate possibilities of diversity among languages in a binary way (e.g., whether a language permits null subject or not). In this view, what children do is to set parameters in the direction of native languages. In UG approaches, it is important to distinguish native speaker competence (UG) from performance: the former provides knowledge about "how to form and interpret words, phrases and sentences in the [native] language" (Radford, 2009, p.11) and importantly it is "tacit": English native speakers, for instance, cannot explain why an article should be *the* instead of a on a particular occasion. Performance, by contrast, refers to actual usages of competence: external factors such as tiredness and WM limitation affect performance (but not competence) and therefore native speakers occasionally make errors. According to this view, then, children's acquired grammatical knowledge is implicit. Although the implicit/explicit nature of the learning processes is unclear in the UG-based approaches, DeKeyser (2003) speculated that parameter setting is an example of implicit learning, stating that "supposedly learners derive a number of characteristics of the language being learned from the setting of the parameter, and this clearly happens without awareness." (p.315).

On the other hand, some argue that adult L2 learners have no access to UG that guides children's successful mastery of native languages and provides implicit knowledge of grammar, and thereby FLA vs. SLA discrepancies arise (no access position, see White, 2012, for a concise summary of recent theoretical development of UG approaches). Instead, adult L2 learners rely on domain-general problem solving abilities (original version of the Fundamental Difference Hypothesis, see Bley-Vroman, 1990).

Usage-based approaches argue that both child and adult L2 learners develop constructions by gradual accumulation of the constructions: (Nakamura, 2012; Goldberg, 2006; Robinson & Ellis, 2008; Tomasello, 2003). In these approaches, input frequency has a prominent role in construction development and two types of input frequency are distinguished: type frequency leads to generalization while token frequency leads to knowledge entrenchment and automatization (Bybee, 2010; Ellis, 2002; Tomasello, 2003). The implicit/explicit nature of the L1 and L2 learning processes has not been explicitly stated in usage-based approaches until recently[1]. However, Goldberg (2006) explicitly argued that children make L1 constructions by implicit learning. In the case of adult SLA, Ellis (2005), a representative proponent of the approaches, considered that adult L2 learners need awareness at the level of noticing (Schmidt, 1990) during initial accumulation of L2 constructions, as described below. Therefore, the usage-based approaches can be argued to claim that child FLA is implicit learning while adult SLA is explicit, at least at the initial stage of construction development. However, apart from these UG vs. Usage-based linguistic approaches, awareness with relation to learning "natural" languages has been extensively treated in the SLA literature. I will give much consideration to the issue of explicit/implicit FLA vs. SLA in the next section.

Implicit and Explicit Learning in the Context of FLA vs. SLA

As in the domain of AGL described above, there have been two decades of interest in the implicit learning of natural languages (see DeKeyser, 2003, Dornyei, 2009, Ellis, 1994, 2007, Robinson, 1995a, 2003, 2007, Robinson et al., 2011, Schmidt, 1994a.b., 1995a, and Williams, 2009, for reviews). With regard to child FLA, it is argued that the learning processes involved are implicit, based on speculation (e.g., Ellis, 2007; Goldberg, 2006; Krashen, 2003; Winter & Reber, 1994), although some admit there are differences between artificial grammars employed

[1] A domain-general hierarchical Bayesian model (HBM: Perfors, Tenenbaum, & Wonnacott, in press) fits well with usage-based models of language acquisition here. In HBM, learners learn item-specific knowledge about constructions (such as knowledge about each verb in relation to a particular construction, for instance, the dative alternation construction). At the same time, they learn more general knowledge about constructions (higher-order knowledge about argument-structure constructions, for instance, verb-general knowledge with relation to the dative alternation construction). This knowledge at the higher order in turn works as a weak constraint (over hypothesis) on incoming item-specific knowledge about constructions and thus constrains learners' hypothesis space: they do not need to consider "all" possibilities. However, whether the HBM can reveal the implicit/explicit nature of learning is unclear.

in implicit learning experiments and natural languages (i.e., lack of meaning in artificial grammar experiments, Robinson, 2010; VanPattern, 1994; Williams, 2010; Winter & Reber, 1994, and see also papers in Gullberg & Indefrey, 2010).

In the SLA literature, driven by the well-known acquisition-learning distinction made by Krashen (1981,1985, 1994, 2003), the possibility of SLA without awareness has been disputed (DeKeyser, 2003; Dornyei, 2009; Ellis, 1994, 2007; Hulstijn & Schmidt, 1994; Robinson, 1995a, 2003, 2007; Robinson et al., 2011; Schmidt, 1995b; Williams, 2009) and empirically examined (N. Ellis, 1993; DeKeyser, 1995; Hama & Leow, 2010; Hulstijn & DeKeyser, 1997; Hulstijn & R. Ellis, 2005; Robinson 1996, 1997b; 2002, 2005, 2010; Rosa & Leow, 2004; Williams, 2005, 2010, to name just a few).

Unlike the implicit learning literature in cognitive psychology where incidental nature of the acquisition processes is confounded with implicitness, incidental and implicit learning are clearly distinguished in the SLA literature (DeKeyser, 2003; Hulstijn, 2003; Williams, 2009). Incidental learning refers to SLA without intention to learn various levels of constructions from vocabulary to syntax. As Williams (2009) noted, incidental learning is identified with learning linguistic forms while primary focus is allocated to negotiation of meaning (Long, 2007). This is because, as described below, Krashen (1981) argued that

> Language acquisition…requires meaningful interaction in the target language—natural communication—in which speakers are concerned not with the form of their utterances but with the messages they are conveying and understanding. (p.1)

The issues of implicit and explicit learning in the SLA literature are rather complicated because some only specify the nature of the learning "processes" (Robinson 1995, 2003; Tomlin & Villa 1994) and the nature of resultant "knowledge" remain largely unclear. Others concentrate solely on the nature of the acquired knowledge (R. Ellis, 1993), while the nature of the processes of learning is not addressed. As R. Ellis (2009a), Schmidt (1994b), and Williams (2009) noted, both learning and knowledge should be distinguished clearly, or else "the issue of the existence of implicit or explicit knowledge in the mind of the learner is distinct from the issue of how it got there" (R. Ellis 2009, pp. 320-321)[2]. However, research into explicit/implicit SLA has often inferred the nature of the learning processes from the nature of the resultant knowledge (Ellis 2009a). This is because assessing the nature of the acquisition processes independently, without interfering with them, is difficult.

Broadly speaking, there are three types of models for the possibility of SLA without awareness in the literature (see DeKeyser 2009, R. Ellis 2009a, and Robinson et al. 2011, for concise reviews). However none of the models provide decisive evidence due to a lack of reliable awareness measures during learning (the methodological problem of awareness). The way each model deals with both the nature of the learning processes and of the resultant knowledge is described below.

Krashen's Monitor Model

Krashen (1981, 1985, 1994, 2003) argued that adult L2 'acquisition' utilizes the *subconscious* system that children also engage in to acquire their L1s. The resultant implicit knowledge or native-like linguistic competence, according to Krashen, cannot be converted into explicit 'learned' knowledge that results from the conscious hypothesis testing typically observed in classroom SLA, or vice versa. Instead, explicit knowledge, particularly that of easy constructions developed by explicit learning, can function as a monitor for speech production only if students focus on form, and have planning time and prior knowledge of the pedagogic rule. Krashen further argued that these learning and knowledge systems are dissociable (hereafter acquisition and learning are marked with single quotation marks when used in Krashen's sense. Otherwise, both terms are used interchangeably). Neurological models of implicit and explicit memory that assign separate roles to the two types of memory systems (Paradis 1994, 2009; Ullman 2001, 2004, 2005) are the neurophysiologic underpinnings for Krashen's distinction. This conscious 'learning'-subconscious 'acquisition' distinction of both learning processes and resultant knowledge - is a non-interface position between implicit and explicit knowledge. This is because neither can be converted into, and or depends on the other. Furthermore, unlike implicit learning as proposed in the cognitive psychology literature (e.g., Reber 1993), what Krashen means by implicit learning or 'acquisition' is *incidental* learning: learning without intention to learn. For Krashen, acquisition (incidental learning) is where comprehensible input – i.e. input slightly beyond learners' current levels of proficiency – is provided and the primary focus is on understanding meaning, or *focus on meaning* in Long and Robinson's (1998) term. A typical example suggested by Krashen is reading where learners engage in comprehending texts without metalinguistic consideration of linguistic forms. For Krashen, explicit grammar teaching is not feasible for creating opportunities to 'acquire' languages since the primary focus is allocated to the linguistic forms or rules.

Schmidt's Noticing Hypothesis

One of the most extensive counterarguments[3] to Krashen (1981, 1985, 1994, 2003) was provided by Schmidt

[2] An anonymous reviewer pointed out that connectionism may not differentiate learning from knowledge (see Christiansen & Chater, 2001 and Ornis, 2012, for a review of connectionism).

[3] Schmidt's claim is fundamentally different from Krashen's view. In one sense, Schmidt's view can be accommodated within Krashen's (explicit) 'learning'. However, since Schmidt argued that all SLA needs attention and noticing, this suggests that Krashen's acquisition-learning distinction is denied. As an anonymous reviewer pointed out, SLA might be more or less conscious and the degree of explicit/implicit learning involved depends on learning conditions.

(1990, 1995a, see also Barasch & Vaughan James 1994; and McLaughlin 1987), who pointed out ambiguities in the definitions of consciousness in Krashen's model. Schmidt proposed three ways in which SLA could be viewed as an 'unconscious' form. Unconscious can mean (1) without intention (we can learn unconsciously in this sense) – we do not need to 'intend' to learn (incidental learning), (2) without explicit metalinguistic knowledge (no one has metalinguistic knowledge of all they know), and (3) without awareness. Schmidt (1990, 1995a) further distinguished between three levels of awareness: a) perception (we need to attend to, and perceive to learn at this very basic level), b) noticing (we also need to be subjectively aware of what we perceive for it to be learned – there can be subliminal perception, namely attention allocation and detection outside of awareness, but not subliminal learning), and c) metalinguistic understanding (we can learn unconsciously in this sense - no one has metalinguistic understanding of all they know on L2). Schmidt claimed that it is not possible to learn unconsciously in the former two senses of awareness (a) and (b). Moreover, based on two case studies of his own learning of Portuguese during a five-month visit to Brazil (Schmidt & Frota 1986), and of an untutored learner of English called Wes (Schmidt, 1984; see also Schmidt, 2010, for a concise summary of these), Schmidt (1990, 2001, 2010) argued that all SLA needs awareness at the level of 'noticing' and this has been termed "The Noticing Hypothesis".

Tomlin and Villa (1994), basing their work on a fine-grained model of attentional networks (Posner & Peterson, 1990; see also Posner & Rothbart, 2007, for a recent view), distinguished three functions of attention: (1) alertness: readiness for incoming stimuli, (2) orientation: allocations of attentional resources to some but not to other stimuli, and (3) detection: "the process that selects, or engages, a particular and specific bit of information" (p. 192). Importantly, they asserted that none of these attentional functions depends on awareness, although awareness might help attentional functioning. Furthermore, they claimed that what is necessary for SLA is attentional detection inside of the focus of selective attention, not awareness. However, Robinson (1995a, 2003) mediated between Schmidt and Tomlin and Villa, based on Cowan's embedded process model of WM (see Cowan, 1999). He argued that although detection is necessary, without rehearsal within WM focally attended stimuli will be soon dissipate and thus cannot be registered in long term memory (LTM). Robinson (1995a, 2003) distinguished between two types of rehearsal: (a) data-driven, maintenance rehearsal: repetitively rehearsing the same stimulus, and (b) conceptually-driven elaborative rehearsal: connecting a focally attended stimulus with conceptually-related prior knowledge or schemas stored in LTM. For Robinson (2003), "[I]t is these rehearsal processes that give rise to awareness, place limits on the extent of awareness, and constrain what can be verbalized during verbal reports" (p. 656). In other words, Robinson (1995a, 2003) specified the attentional and memory processes that are required for noticing to happen, the latter of which Schmidt (2010) was quiet on.

Robinson (1997a, 2001, 2002b, 2003) further extends Schmidt's Noticing Hypothesis into his Fundamental Similarity Hypothesis. The Fundamental Similarity Hypothesis claims that any learning conditions, learning tasks, or learning contexts in adult SLA require noticing developed by attentional selection and subsequent rehearsal within WM. Thus, all learning is fundamentally similar in requiring these attentional and memory processes.

Ellis's Weak Dynamic Interface Model

N. Ellis (2005), based on a comprehensive review of the relevant studies in the cognitive science literature, considered that both implicit/explicit learning and implicit/explicit knowledge are dissociable, as Krashen (1981, 1985, 1994, 2003) argued, and localized in different regions of the brain, as Paradis (1994, 2004) claimed. Although both learning and knowledge systems dynamically interact with each other, the primacy is implicit learning[4]. What Ellis (2005) means by implicit learning is frequency tallying of various statistical values of constructions such as the likelihood of co-occurrence of the constructions (transitional probability, contingency, or collostructions; Gries, 2008; Ellis, 2006a; Shanks, 2007),[5] and the strength of form-meaning mappings. Frequency tallying is implicit because learners do not explicitly count each occurrence of the constructions. Generalization gradually emerges through chunking (Bybee 2010; Ellis 1996, 2003; Newell 1990; Zeschel 2008) of co-occurrence or neighbouring instances at the elementary level of abstraction into the higher-order chunks. The resultant (abstract) knowledge is typically implicit knowledge stored in implicit memory. Therefore, Ellis (2005, footnote 4) considered that Schmidt (2001) underestimated the effects of implicit learning. However, Ellis (2005) claimed that much language is "unlearnable" by implicit learning alone, particularly for adult L2 learners. This is because adult L2 learners have prior L1 knowledge, matured cognitive abilities (Ellis 2003), and "learned bias or attention" (Ellis 2006b, 2008; Ellis & Sagarra 2010a, b). For instance, Ellis and Sagarra (2010a) demonstrated that previous exposure to Latin temporal adverbials blocked learning of Latin temporal morphology. This was because learners learned to focus their attention on temporal adverbials in order to interpret temporality of the construction. In other words, learners ignored cues provided by temporal morphemes when both temporal adverbials and morphemes were available. In such a case, explicit learning is necessary "in the initial registration of pattern recognizers for linguistic constructions" (p. 317), which results in rapid consolidations of the constructions in explicit memory. Once the consolidations of the L2 constructions in the form of explicit knowledge are complete and stored in the explicit memory, then implicit processes, such as frequency tallying, strengthen this initial explicit representation. Subsequently,

[4] Implicit learning is "primacy" in Ellis' model because large parts of SLA depend on frequency tallying and subsequent chunking of the constructions. However, since initial registration of stimuli is sometimes difficult by implicit learning alone, explicit learning in the sense of noticing takes a role in such cases. He therefore claims that initial learning processes are explicit learning.

[5] These are basically concerned with the probability of occurrence of Y given X (calculated by frequency of XY divided by frequency of X)

practice-induced automatization of access to this knowledge takes a larger role.

In a nutshell, Ellis (2005) provided the interaction between implicit and explicit learning and knowledge systems in such a way that the initial stage of adult SLA is explicit learning in the sense of noticing (Schmidt 1990, 2001, 2010). This results in explicit knowledge of registered constructions. Subsequently, implicit associative learning processes such as implicit tallying, chunking, strengthening, and automatization operate on this explicit knowledge, which results in (abstract) implicit knowledge. In Ellis's (2005: 340) terms, "the sequential motives of learning are novice + externally scaffolded attention → internally motivated attention → explicit learning → explicit memory → implicit learning → implicit memory, automatization, and abstraction = expert." A problem in Ellis's dynamic interface model is that no study has directly demonstrated positive evidence for the model as reviewed in the next section. Studies that compare implicit and explicit learning in the long term are clearly needed to consider the validity of his model.

Differential Contributions of Awareness to Learning of Different Aspects of L2

Before considering L2 laboratory studies that have investigated the possibility of implicit SLA, one issue should be noted here, albeit briefly. The target of studies reviewed in this paper is exclusively L2 syntax. Obviously, language learning is not only learning of syntax but also that of other aspects such as vocabulary and pragmatics. It is also true that learning linguistic form alone is not sufficient either. According to Enfield (in press), language is embedded within other factors in social conversation. Language only encodes conventionalized lexical and grammatical meaning, but is enriched by non-conventionalized meaning provided by gesture and conversational situation. In other words, many non- syntactic factors constitute language (or *composite utterance* in Enfield's term) and thus learning a language means learning these factors as well.[6]

Therefore, it might be possible that different aspects of L2 such as vocabulary and pragmatics might require a different amount of awareness. For instance, in the vocabulary acquisition literature, the possibility of "incidental" learning and its effectiveness have been investigated (see Hulstijn, 2003). As described above, the term incidental means without intention to learn, or more specifically without intention to pay attention to linguistic forms, and has been operationalized as focus on meaning (e.g., ask learners to comprehend linguistic items). In vocabulary acquisition, one typical example of incidental learning is the learning of vocabulary itself while engaging in comprehending an L2 text. However, in the sense of awareness at the level of noticing as differentiated by Schmidt , it can be argued that vocabulary, or surface forms of each word, should be noticed even when meaning is not.

The same is true for pragmatic principles. Again, Schmidt (1993) is explicit on this matter. While learners may not understand why native speakers use a particular form on a particular occasion to address a particular conversational partner, it is necessary for them to notice such linguistic forms in order to acquire L2 pragmatic principles (see also Kasper, 2009). In sum, as Dekeyser (2003) notes, implicit/explicit SLA research should extend the linguistic target into other aspects of L2 in order to explicate the possibility of implicit SLA as well as that of differential contributions of awareness to the learning of different aspects of L2.

Methodological Issues of Awareness

Overall, the experimental studies reviewed in this section (see Table 1) seem to confirm evidence against learning without awareness (Krashen 1981, 1985, 1994, 2003) and thus evidence for Schmidt's (1990, 1994a, 2001, 2010) Noticing Hypothesis. However, methodological considerations reveal that issues of learning without awareness are still, at the very least, controversial, as in the case of implicit learning of artificial grammar and sequences (Nakamura, 2013). Evidence for various interface-positions is unclear, partly because the empirical studies considered below tend to be confined to a short time span (e.g., within a day). However, to test Ellis's (2005) dynamic weak interface model, it is necessary to compare degrees of explicit and implicit knowledge between the initial and the middle phases of SLA. As DeKeyser (2007) notes, conducting longitudinal empirical studies is, practically speaking, highly demanding (e.g., larger number of participants, cost, etc). However, apart from such practical issues, methodological concerns, specifically how learner states of awareness should be measured, are of great concern to SLA researchers (Bowles 2010a,b; Leow & Bowles 2005; Robinson 2007; Robinson et al., 2011; Sanz & Lado 2007), and these are considered in this section.

Problems of awareness in implicit SLA centre around: (1) the issue of instructional orientations (Ellis 2009a), (2) biases in knowledge measurement (Doughty 2003; R. Ellis 2005, 2009b; R. Ellis & Lowen 2007; Norris & Ortega, 2000), and (3) reactivity in the online think-aloud protocol (Bowles, 2008, 2010a, 2010b; Bowles & Leow 2005; Leow & Morgan-Short 2004; Sanz, Lin, Lado, Bowden, & Stafford 2009). These issues are considered below with detailed reviews of prominent empirical studies. *(see Table 1).*

The Issue of Instructional Orientations

Ellis (2009a) notes that implicitness of instruction does not guarantee that learners engage in implicit learning processes because they "may follow their own inclinations" (p. 6). This is attested in Robinson (1995b, 1997a) and Williams (2005) (see Table 2 for a list of learning conditions used in typical implicit/explicit SLA studies).
(see Table 2).

[6] I would like to thank an anonymous reviewer for pointing out this important issue.

Table 1. Representative Explicit and Implicit SLA Studies

Studies	Targets	Awareness measurements		Learning measurements
		What	When	
deGraaff (1997)	Simple and complex morpho-syntactic constructions (artificial language called Experanto)	Differences in instructional orientations (explicit and implicit learning conditions)	during training	1) Timed grammaticality judgment 2) Untimed grammaticality judgmen 3) Gap-filling 4) Grammatical correction
DeKeyser (1995)	Categorical and Prototypical rules (artificial language called Implexan)	1) Differences in instructional orientations a) Explicit deductive learning condition b) Implicit inductive learning condition 2) Retrospective structured interview	1) During training 2) After the experiment	1) Picture-sentence matching 2) Production
Hama and Leow (2010)	Determiner-noun constructions (artificial language)	1) Concurrent think-aloud protocol 2) Retrospective awareness questionnaire	1) During training and testing 2) After the experiment	1) Multiple choice 2) Production (oral gap-filling)
Robinson (1996)	The easy SV inversion with locative adverbials and the difficult pseudo cleft construction	Differences in instructional orientations 1) Implicit learning condition 2) Incidental learning condition 3) Rule-search condition 4) Instructed condition	During training	Untimed grammaticality judgment
Robison (1995b, 1997a)	Follow-up analysis of Robinson (1996)	Retrospective awareness questionnaire	After the experiment	Same study as Robinson (1996)
Robinson (1997b)	English dative constructions	Differences in instructional orientations 1) Implicit learning condition 2) Incidental learning condition 3) Enhanced learning condition 4) Instructed condition	During training	Untimed grammaticality judgment
Rosa and Leow (2004)	Spanish contrary-to-the fact conditionals in the past	a) Differences in instructional orientations 1) Explicit feedback condition 2) Implicit feedback condition b) Concurrent think-aloud protocol c) Retrospective verbal report	a) During training b) Simultaneously during testing c) After the experiment	Controlled written production Multiple choice recognition
Rosa and O'Neill (1999)	Spanish contrary-to-the fact conditionals in the past	a) Differences in instructional orientations 1) Formal rule instruction + instruction on rule-search condition 2) Formal rule instruction without instruction on rule-search condition 3) Instruction on rule-search without the explicit formal rule instruction 4) No formal rule instruction and instruction on rule-search b) Concurrent think-aloud protocol	a) During training b) Simultaneously during testing	Multiple choice recognition
Williams (2005)	Determiner-noun constructions (artificial language)	Retrospective awareness questionnaire	One after the first test phase and another after the second test phase	Multiple choice

Studies that directly compared explicit and implicit SLA are included.

Table 2. Methods Used to Elicit Implicit, Incidental, and Explicit Learning

Type of operationalization	Description	Learning type	Example
Meaning comprehension	Ask learners to try to comprehend each training sentence without explicit instruction on underlying rules or search for such rules. Learners are tested on whether they understand the meaning of each training sentence. This is one operationalization of incidental learning because it concerns consciousness as intention but not consciousness as awareness (Schmidt, 1990) and learners are expected to learn not only the semantic aspects but also the formal aspects of L2 without intending to learn the latter. Meaning comprehension is operationalized as Krashen's acquisition in Robinson (1996, 1997b) because unlike Reber (1993) Krashen does not consider memorization of the stimuli (L2) as implicit (or subconscious in Krashen's term) acquisition. Instead, "meaningful interaction in the target language" (Krashen, 1981:1) is necessary for acquisition to occur.	Incidental	Robinson (1996)
Memorization	Ask learners to memorize each training sentence without explicit instruction on underlying rules or search for such rules as in typical implicit learning experiments in cognitive psychology (Reber 1993). Learners are tested on their degree of memorization after presentation of each training sentence.	Implicit	Robinson (1996)
Rule-search	Ask learners to try to find rules underling training sentences. This is a typical example of explicit learning often used in cognitive psychology	Explicit	Robinson (1996), Rosa and O'Neil (1999)
Explicit rule instruction	After explicit instruction on rules underlying training sentences, learners judge whether training sentences follow the rules. Usually, explicit feedback on their accuracy or disclosure of the rules is provided after each judgment. This is what Krashen argues as "learning"	Explicit	deGraaff (1997), DeKeyser (1995), Robinson (1996), Rosa and Leow (2004), Rosa and O'Neil (1999),

Robinson (1996) compared implicit, incidental, and two types of explicit learning of various English constructions in the Japanese L2 learner population. Following implicit learning in cognitive psychology (see Reber, 1993), the implicit learning condition was operationalized as memorization of training stimuli (e.g., *Were the words* Alice Stands *next to each other in the sentence* for *Where Alice stands is on the right not on the left*) as in Reber (1967), whereas the incidental learning condition focused on the meaning of the training stimuli. Robinson (1996, also 1997b) operationalized Krashen's acquisition in this way because learners' primary focus was directed to comprehension of the training stimuli without intention to focus on formal aspects of the training stimuli.[7] In the incidental learning condition, learners were given comprehension questions after each training stimulus (e.g., *Does Alice stand on the right?*). In a rule-search condition, learners were asked to find rules underlying the training stimuli (e.g., *Did this sentence contain a rule that you know?*), whereas they were taught these and given metalinguistic questions (e.g., *Did the verbs used agree in tense?*) in an instructed condition. The latter two conditions were explicit inductive and deductive learning, respectively. Two English constructions with different degrees of difficulty, which were independently motivated by difficulty judgments by experienced English teachers, were used in this study: (a) the easy SV inversion with locative adverbials (e.g., *Into the house ran John [John ran]*), and (b) the difficult pseudo cleft construction (e.g., *Where Mary and John live is in Chicago not in New York*).

The results clearly showed the superiority of the instructed learning condition over the other conditions in the learning of the easy construction in terms of response accuracy. As regards the response accuracy of the hard construction, the instructed learning condition outperformed the rule-search condition. However, the rule-search condition did not outperform the implicit and the incidental conditions. Therefore, the results of Robinson (1996) suggest that explicit inductive and deductive learning differ in their effectiveness in SLA. Particularly, the former is more similar to implicit and incidental learning, the learning processes which are clearly inductive (exemplar-based). The lack of significant differences between these three conditions confirms this interpretation. However, the null differences between them do not indicate that the rule-search condition in Robinson (1996) was implicit: the opposite possibility (all three learnings were indeed explicit learnings at least in this study) is also probable. The results of Robinson (1995b, 1997a) confirm this latter possibility.

Robinson (1995b, 1997a) conducted follow-up analyses on Robinson (1996). Awareness was measured by a retrospective verbal report and its levels were distinguished as; (1) not aware, (2) noticed, (3) looked for rules, and (4) able to verbalize. There were no differences in the number of the [noticed] and the [verbalizable] learners among all learning conditions. Explicit learning conditions (rule-search and instructed conditions) produced a greater number of the [looked for rules] learners than the implicit learning condition. It is important here that eleven

[7] It is possible that some learners in the incidental learning condition indeed tried to focus on form despite the fact that the instruction did not aim to do so. This is the very topic of this subsection: there is a possibility that learners do not follow the instructional orientation.

claimed to notice, nine claimed to look for rules, and six could actually verbalize the rules underlying stimuli in the implicit learning condition. Furthermore, those who could verbalize rules outperformed those who could not in learning both easy and hard constructions in the implicit learning condition.

Therefore, a series of analyses conducted by Robinson (1995b, 1997a) show that the majority of the learners in the implicit learning condition in Robinson (1996) engaged in explicit learning. The lack of significant differences among the implicit, the incidental, and the rule-search conditions indicates that the nature of learning in these three learning conditions was explicit and data-driven. Therefore, Robinson (1996) seemingly provides evidence against implicit learning on the one hand. The superiority of explicit or instructed learning over other conditions observed in Robinson (1996) is, on the other hand, clear indication of the efficiency of explicit learning.

Robinson (1997b) also examined the differential effectiveness of different learning conditions on the learning of an English dative-alternation construction (e.g., *John gave Mary the book – John gave the book to Mary*). An enhanced learning condition, instead of the rule-search condition in Robinson (1996), was employed and operationalized as provision of the training exemplars with textual enhancement, specifically boxing the verb and the surrounding elements or the to-dative (e.g., *Jean frepaned some warm clothes to Charles--Jean frepaned Charles some warm clothes*). This enhanced learning group received the same comprehension question following each training stimulus as the incidental learning group. In the experiment, three types of the training stimuli were utilized; (a) monosyllabic novel verbs in the to-dative construction (e.g., *Mary donked the car to the old women*), (b) disyllabic novel verbs in the double object construction (e.g., *Nick menided some hot coffee to Sue*), and (c) monosyllabic novel verbs in the double object construction (e.g., *Jane nawked Larry an expensive ring*). The critical rule of thumb was the syllabicity of the main verb: only monosyllabic verbs could appear in both constructions.

Robinson (1997b) found that although learning conditions did not differ in terms of reaction times (RTs) and response accuracy of the old grammatical stimuli, a superiority of the instructed learning condition over the other conditions in terms of both dependent variables of the new grammatical and ungrammatical stimuli was observed. Furthermore, the null differences between the implicit, the incidental, and the enhanced learning conditions were replicated only in response accuracy. The enhanced condition was worst in terms of speed of response to the new grammatical stimuli. The enhanced learning condition, unlike the rule-search condition in Robinson (1996), outperformed the incidental learning condition in terms of the response accuracy for the new ungrammatical stimuli but not in terms of RTs (slower than the implicit learning condition). The result that the enhanced learning group developed more generalizable knowledge than the incidental learning condition was reflected in the response accuracy of the ungrammatical stimuli. This suggests more compelling evidence for the superiority of explicit learning than incidental learning, contra Krashen (1981, 1985, 1994, 2003).

Williams (2005) considered the possibility of learning form-meaning connections without awareness. Specifically, the question was whether learners could generalize over individual form-meaning connections to form abstract knowledge applicable to new exemplars. In other words, what Williams (2005) meant by implicit learning was learning without understanding in Schmidt's terms (1990, 1994a, 2001, 2010). The target structure was determiner-noun phrases and four types of determiners were used; (a) those that denoted a remote location of an animate object to a subject of a sentence (e.g., *ul dog*), (b) those that denoted a remote location of an inanimate object (e.g., *ne sofa*), (c) those that denoted a near location of the animate object (e.g., *gi dog*), and (d) those that denoted a near location of the inanimate object (e.g., *ro sofa*). The crucial rule underlying the determiner+noun phrases was the animacy of the object; if the objects were animate, either determiners gi or ul was used. This was not taught and participants with various language backgrounds learned only the meaning of the determiners (near or far) during training. All words were actually English except for novel determiners. During training, participants were asked to judge whether the object was near to or remote from the subject, in aurally presented sentences (e.g., *I was terrified when I turned around and saw gi lion right behind me*). A test phase was divided into two subparts. At the first test phase, participants, given a sentence fragment (e.g., *The lady spent many hours sewing...*) were asked to choose one out of two deternimner+noun phrases that differed only in the determiners (gi cushion or ro cushion) based on "familiarity". An awareness questionnaire was then given. At the second test phase, only those who had not been able to verbalize the animacy relationship in the first test phase were employed and participants continued to answer similar multiple-choice test after instruction on the existence of some rules.

Williams (2005) found that eight out of 41 learners could develop understanding of the animacy rules. Particularly interesting is that two out of these developed animacy understanding after the first test phase, while the others developed the animacy understanding during training. This suggests that the test itself promoted understanding. These eight learners outperformed learners who were unaware of the animacy rules during the first test phase, who nevertheless performed above chance level. After the second test phase, 11 of the remaining 33 learners developed awareness at the level of understanding and they outperformed those who remained unaware. The latter unaware group, however, still showed an above chance level of performance. Similar results were found in experiment 2 where each noun only appeared with one determiner. Notably, in this experiment, learners' background knowledge of languages (e.g., their L1 and manipulable languages) affected the performance of the unaware learners in such a way that those who spoke language with gender distinctions outperformed those who did not. This suggests that prior

language knowledge could be one factor affecting implicit generalization of the target structures (see N. Ellis, 2003).

Based on these results, Williams (2005) concluded that the acquisition of form-meaning connections proceeded outside of awareness and that the results obtained contradicted Schmidt's (1990, 1994a, 2001, 2010) Noticing Hypothesis in general. However, Schmidt (2001) is clear on the target of noticing: this is a surface feature of utterances, rather than meaning or abstract rules underlying these surface features. Moreover, Williams did not distinguish the levels of awareness between noticing and understanding. Therefore, the results of Williams (2005) are compatible with the Noticing Hypothesis.

As in Robinson (1996) and Williams (2005), DeKeyser (1995) and deGraaf (1997) operationalized implicit vs. explicit learning in terms of differences in instructional orientation. However, these studies also provided corrective feedback to learners in the implicit learning condition. Moreover, all learners were informed of the existence of testing before training in DeKeyser (1995) (see Appendix H of DeKeyser 1995). Both measures easily promoted explicit learning modes. This interpretation is attested in the data on the retrospective structured interview: 17 out of 21 learners in the implicit inductive learning condition in DeKeyser (1995) claimed to suspect the existence of rules underlying the training stimuli. Therefore, as DeKeyser (1995) concedes, whereas the inductive/deductive distinction had authenticity in his experiment, the explicit/implicit distinction was dubious.

Overall, these results suggest that, firstly, the instructional orientations do not guarantee that learners exactly engaged in expected learning modes (learners looked for and noticed rules even though they were in the implicit learning condition, see Robinson (1996)) and, secondly, that it is important to measure learners' states of awareness in order to ascertain the effects of the instruction. Providing feedback easily orients learners towards explicit learning modes and should therefore be avoided in the implicit learning condition.

The Issue of Biases in Knowledge Measurement

GJ has often been used as a test of knowledge acquired during implicit and explicit learning in the SLA literature (e.g., deGraaff 1997; Robinson 1996, 1997a, b, 2002, 2005). Table 3 provides a list of knowledge measurement used in representative implicit/explicit SLA studies.

Norris and Ortega (2000) noted that about 90% of the studies they examined administrated a discrete and focused linguistic task (e.g., GJ, selected response, and constrained constructed response) that was supposed to measure explicit declarative knowledge. On the other hand, only 10 % used a freely constructed response that required a fluent, communicative use of knowledge. With this caveat, they found that measures which tapped explicit knowledge, namely, GJ, selected response (e.g., multiple-choice questions), and constrained constructed response (e.g., compliance of correct morphemes or verb forms to complete a whole sentence), were larger in effect size (d

Table 3. Methods Used to Elicit Explicit and Implicit Knowledge

Methods	Description	Type of knowledge	Examples
Elicited Imitation	Given a sentence, learners are asked to repeat it in a correct form	Implicit	Erlam (2006), Elder (2009)
Gap-filling	Given sentence fragment, learners are asked to complete test sentences	Explicit	deGraaff (1997) Rosa and Leow (2004)
Grammatical correction	Given test sentences, learners are asked to correct ungrammatical parts	Explicit	deGraaff (1997)
Metalinguistic knowledge test	a) Given an ungrammatical sentence, learners are asked to choose the appropriate metalinguistic explanation in order to correct it	Explicit	Elder (2009)
Multiple choice	Choose correct linguistic forms from alternatives	Explicit	Rosa and Leow (2004), Rosa and O'Neill (1999), Williams (2005)
Picture-sentence matching	Learners are asked to judge whether a picture corresponds to a sentence on a screen	Not specified	DeKeyser (1995)
Production	Given a picture, learners are asked to produce a corresponding sentence	Not specified	DeKeyser (1995)
Story-retelling	After reading a story that aims to elicit target structures (e.g., third person –s), learners are asked to retell the story within a time constraint	Implicit	R. Ellis (2005), R. Ellis and Lowen (2007)
Timed grammaticality judgment	Ask learners to judge grammaticality of each test sentence within give time	Implicit	deGraaff (1997)
Untimed grammaticality judgement	Ask learners to judge grammaticality of each test sentence	Explicit	deGraaff (1997), Robinson (1996), 1997b),

Classification into explicit vs. implicit knowledge is based on Norris and Ortega (2000) and the Marsden Fund project (R. Ellis et al., 2009).

= .82, 1.46, and 1.20, respectively) than free constructed response (e.g., written composition, d = 0.55). Norris and Ortega (2000) also revealed that 70% of the studies examined explicit learning, while only 30% investigated implicit learning. Recently, the Marsden Fund project (R. Ellis et al. 2009) addressed the issue of dissociation between implicit and explicit knowledge measures in a systematic way.

Loewen (2009) compared 18 English native speakers and 140 L2 learners of English from various countries in terms of GJ both with and without time pressure. Timed (T) GJ was constructed according to Ellis's (2004) suggestion: when GJ was provided without time constraints, learners could go through semantic processing of meaning in a test sentence, noticing potential deviations, and reflection on correctness of the test sentence. To minimize learner reflections potentially resulting from the use of explicit knowledge, and, instead, to promote implicit knowledge (intuition), time limits were set in the TGJ (ranging from 1.8 to 6.24 seconds depending on the items). After judgment of each test stimulus of the untimed (UT) GJ test, learners were asked to indicate their confidence on a 0-100% scale as well as a dichotomous response (rule or feel) about their judgment. The results showed that there were positive correlations between degree of certainty and accuracy in UTGJ and between degree of rule use and RTs on both grammatical and ungrammatical sentences in L2 learners' data. These suggest that as their knowledge became more explicit, their accuracy of UTGJ increased and as their knowledge became more metalinguistic, their RTs became faster. GJ, when it is implemented without time constraints, measures much more explicit than implicit knowledge.

Elder (2009) compared two implicit knowledge tests (TGJ and elicited oral imitation, or EI) and two explicit knowledge tests (UTGJ and a metalinguistic knowledge test, or MKT) in a factor analytical way. The EI test (Erlam 2006) required learners to express their attitudes towards the contents of a sentence presented orally (e.g., A good doctor always listens what patients say, agree or disagree, or uncertain) and then they were asked to repeat it in correct English. It was expected that learners' implicit knowledge would be tapped on this test because their primary attentional focus was on meaning. The MKT measured passive metalinguistic knowledge in that (a) in the first part, given an ungrammatical sentence (e.g., *If Jane had asked me, I would give her some money*), participants choose one out of four correct and incorrect metalinguistic descriptions (e.g., *When the "if" clause is in the past perfect tense, the main clause verb is in the past conditional*), and (b) participants completed examples for each grammatical category (e.g., *the for definite article*). The results of the confirmatory factor analysis showed that two factor models, where the scores on EI and TGJT were loaded onto one factor while those on UTGJ and MKT were on another factor, fitted best with the observed data.

Ellis (2005) and Ellis and Loewen (2007) provided more comprehensive factor-analytic studies using EI, story retelling, and TGJ as measures of implicit knowledge and UTGJ and MKT for explicit knowledge. Ellis (2005), firstly conducted the principle component factor analyses using data from 20 native speakers and 91 L2 learners on these various tests. The results showed that a two-factor solution (EI, story-retelling, and TGJ were loaded on the one factor, while UTGJ and MKT were loaded on another factor) fitted best with the observed data. Ellis and Lowen (2007; also R. Ellis 2009b) conducted the confirmatory factor analyses using R. Ellis'(2005) data and found that the two-factor model suggested by R. Ellis (2005) fitted better with the observed data. In sum, the results of the Marsden Fund project showed clear separation between implicit knowledge tests on the one hand and explicit knowledge tests on the other hand, and suggested that UTGJ was a test of explicit knowledge.

As Doughty (2003) explains in her elaboration of the findings of Norris and Ortega (2000), learned knowledge during implicit learning is often measured by explicit knowledge tests such as UTGJ. Consequently, test-outcome measures are mismatched – or transfer-inappropriate in Robinson's (2003) view. At the very least, therefore, measures for both implicit and explicit knowledge must be administered.

The Issue of Reactivity in Online Think-Aloud Protocol

Verbal reports have been predominantly used in the SLA literature with regard to investigations into learners' internal mental processes. The verbal reports can be implemented introspectively (concurrently) along with a main task, or retrospectively after the completion of the main task. Retrospective verbal reports, as in the case of implicit learning in the cognitive psychology literature, are claimed to suffer from the veridicality problem; temporal delay between the main task and the verbal reports might cause forgetting of, or learners might reconstruct or even worse fabricate, the contents of their minds (Sanz & Lado 2007). On the other hand, concurrent verbal reports or think aloud protocol suffers from the problem of reactivity: In Leow and Morgan-Short's (2004:38) words, "By thinking aloud, participants' internal processes may differ from what they would have been had they not performed the verbalization." In other words, the process of verbalization itself may alter the learning processes that learners engage in on the completion of the main task (R. Ellis 2001; Jourdenais 2001; Sanz & Lado 2007), particularly when it is metalinguistic in nature (Bowles & Leow 2005; Ericsson & Simon 1993; Leow & Morgan-Short 2004). When the think-aloud protocol itself produces learning effects, this is called positive reactivity while when it interferes with ongoing learning processes, this is called negative reactivity. In the implicit SLA literature, some studies employed the think-aloud protocol as an alternative measure of awareness to the verbal report (Hama & Leow 2010; Rosa & O'Neill 1999; Rosa & Leow 2004).

Rosa and O'Neill (1999, see also Rosa & Leow, 2004) investigated the roles of explicit grammar explanation and explicit instruction to search for rules underlying training stimuli in learning Spanish contrary-to-the fact

conditionals in the past. As a training task, a multiple-choice jigsaw puzzle was used. In the task, both the main clause and the subordinate clauses with differently tensed verbs were written on a piece of the puzzle. English learners of Spanish had to choose a piece with the verb in an appropriate tense to fit with the piece with the main clause. Four experimental groups were constructed: (a) formal rule instruction + instruction on rule search condition (FI+RS) where explicit grammar explanation was given before the jigsaw puzzle task and learners were asked to search for the rules, (b) formal instruction without instruction on the rule search (FI –RS) condition where they were asked to memorize the contents of the puzzle and given explicit grammar teaching, (c) instruction on the rule search without the explicit formal instruction (-FI +RS) condition where they were asked to search for the rules and read the text that did not contain the target structures as a compensation for the explicit grammar teaching, and (d) no formal instruction or instruction on the rule search (-FI –RS) condition where they read the text without the target structures and memorized the contents of the puzzle. A control condition simply required learners to engage in the puzzle. During tests, learners engaged in a multiple-choice recognition task, choosing correct verb forms to fill the gap in test sentences. Learner levels of awareness were tested by the concurrent, think-aloud protocol and divided, following Schmidt (1990, 1994a), into three categories: (a) understanding, (b) noticing, and (c) no verbal reports. The three major findings were: (1) although all conditions showed gains from the pre-test to the post-test (thus learning), the (+FI +RS) and (+FI –RS) conditions outperformed the (-FI, -RS), suggesting that formal grammar teaching as well as explicit instruction on the rule search are more effective than the purely inductive learning condition; (2) although all levels of awareness showed gains in performance, those who developed awareness at the level of understanding outperformed those who showed awareness at the level of noticing and those who could not verbalize the rules, and the latter two groups did not differ, suggesting that metalinguistic awareness is clearly facilitative for SLA; and (3) formal grammar teaching as well as the explicit instruction on rule search produced the greatest number of learners who developed awareness at the level of understanding.

These findings suggest that some impetus to explicit learning modes promotes higher-order metalinguistic awareness, which results in more learning. However, the results of these studies might not be evidence against learning without awareness for methodological reasons. Firstly, as Rosa and O'Neill (1999) note, during the jigsaw puzzle task, immediate feedback was given to all learners, and this might have created the same information that explicit grammar teaching provides (this is also applicable to Rosa & Leow, 2004)). Secondly, all learners, irrespective of the learning conditions, received explicit grammar teaching on one type of the contrary to the fact in the past construction before the experiments. This could easily bias learners to engage in explicit learning. Thirdly, in Rosa and O'Neill (2004) awareness was measured before the recognition and production tests. This also leads to explicit processes in both tests. In other words, these points in the experimental design itself may promote explicit processing, which results in learning and development of awareness, irrespective of differences in instructional orientations. Therefore, although it can be argued that Rosa and O'Neill's (1999) study showed that different degrees of explicit instruction promoted different levels of awareness and learning, the issue of implicit learning is disputable.

Hamma and Leow (2010) extended Williams (2005) to include the online think-aloud protocol as a measure of awareness. The think-aloud protocol was inserted into both training and test phases and three levels of awareness were distinguished, as in Rosa and O'Neill (1999): noticing, understanding, and no verbal response. Options in the multiple-choice task increased to four (near-animate [e.g., gi birds], near-inanimate [e.g., ro lamps], remote-animate [e.g., ul birds], and remote-inanimate [e.g., ne lamps]). A production test was also included, such that learners, given the sentence with a beep sound on the position of the determiner, pronounced the correct determiner while required to reveal their thoughts aloud during the test. The following is one participant's response on the test.

***Ne** birds because **ne** represents living thing.* (Hama & Leow, 2010: 478)

The results showed that when data of those who developed either noticing or understanding were removed from analyses, no evidence of learning the animacy relationships was found either on the production or the multiple-choice tests. Therefore, these results reinforce the interpretation given above, that Williams' study did not show learning without awareness at the level of noticing: if the finer-distinction between noticing and understanding is used, learners in the unaware group in Williams (2005) might indeed develop awareness at the level of noticing.

While Hama and Leow seem to provide evidence against learning without awareness at the level of noticing, it should be observed that in their study some learners only showed evidence for awareness in the think-aloud protocol but not in the retrospective awareness questionnaire. On the one hand, this implies that the think-aloud protocol is a more sensitive measure of awareness than the offline verbal report. However, this also indicates that it is the think-aloud protocol itself, not the learning treatments, that promote awareness (see also Sanz et al., 2009). Evidence for/against the reactivity of the think-aloud protocol has just begun to appear in the SLA literature.

Bowles (2010b) identified nine papers that had directly investigated the reactivity of the think-aloud protocol. Of these, some studies showed evidence of the reactivity (e.g., Bowles & Leow 2005; Rossomondo 2007; Sachs & Polio 2007; Sachs & Suh,2007; Sanz et al. 2009), whereas others did not (e.g., Leow & Morgan-Short 2004) in terms of accuracy and/or latency in verbal task performance such as reading and writing. The first study that empirically examined the issue of reactivity was by Leow and Morgan-Short (2004; see also Bowles, 2008 and

Bowles & Leow, 2005). They compared the think-aloud and the silent groups in the reading comprehension task. Learners in the think aloud group were asked to think aloud nonmetalinguistically either in their L1 (English) or in their L2 (Spanish) throughout the experiment (main task + test phases). Learners of Spanish at the beginner level engaged in reading short passages in Spanish that contained an impersonal imperative construction. Subsequently, they performed three tests: a) reading comprehension; b) multiple choice recognition where they chose one accurate verb from four candidates, given an infinitive verb form with an English equivalent; and c) written controlled production in the form of gap-filling where they produced the accurate form of a verb, given the infinitive verb form with the English equivalent. All targeted verbs were those that they saw in the reading task. The results were that the groups did not differ in any of the tests.

In contrast with studies reviewed above, Sachs and Polio (2007) found clear evidence of reactivity. In their Experiment 1, Asian learners of English enrolled for three weeks of writing tasks. In each week, they engaged in picture description. One week they received written error correction; in another week they received a version reformulated by native speakers and compared it with their originals; and in a further week they received a version reformulated by native speakers and were asked to think aloud nonmetalinguistically in their L2 during comparison with their originals. After each treatment, they revised their originals without looking at the correction or the reformulation. The results of the accuracy improvements showed that the written correction produced greater positive effects than the reformulation without verbalization. The reformulation without verbalization in turn showed greater effects than the reformulation with think-aloud. However, as the authors admitted, thinking aloud in L2 during task performance might put additional cognitive demands on the learners, which may have altered thought processes as well as outcomes. On the other hand, the authors continued, verbalizing in L1 during L2 task performance might also create interference with language processing in L2 verbal tasks. Therefore, Sachs and Polio (2007) show that regardless of languages, concurrent think-aloud deteriorates performance on the main task.

Sanz et al. (2009) found a positive reactivity during computer-delivered grammar instruction with explicit feedback tasks. In their Experiment 1, learners at the beginner level of Latin, received explicit grammar instruction on a Latin simple transitive construction. They then completed interactive practice with explicit corrective feedback. In order to create the accurate simple transitive in Latin, learners had to decide who was doing what to whom by checking cases of nouns and verbal agreement and assigning semantic roles to each noun because Latin allows free word order. In addition, learners in the think-aloud group received instruction in how to think their thoughts aloud at the beginning of the explicit grammar instruction, and thought aloud during the learning program while the silent group did not. Three tests were administered. An aural interpretation required learners to choose a picture correctly matched with an aurally presented sentence. GJ was administered in the usual way. In the guided production task, learners, provided with noun and verb roots, were asked to complete a sentence that matched a picture presented on the screen by choosing appropriate noun- and verb-endings. The results revealed that the nonmetalinguistic think-aloud group did not differ from the silent group on all tests in terms of the accuracy, but they were significantly slower on GJ than the silent group. Experiment 2 replicated Experiment 1 except for the removal of explicit grammar teaching. The results showed that think-aloud produced greater gains in the GJ of old exemplars and in the guided production of new exemplars. Therefore, expressing thinking verbally during task performance without support from explicit teaching created additional generalizable knowledge rather than simply performing the task, in some domains at the very least. It should be noted that think-aloud was permitted in L1 or L2 and thus no additional cognitive demand was imposed (because learners could choose languages) unlike in Sachs and Polio (2007). No difference was found in terms of response latency.

Finally, Bowles (2010b) conducted meta-analyses of 12 studies (9 of which were truly related to SLA) which had examined the effects of reactivity. The results showed that nonmetacognitive think-aloud had small positive effects (d = .21) on reading comprehension (N =4), and metacognitive and nonmetacognitive think-aloud had medium effect sizes (d = .51 and d = .67, respectively) on receptive learning (N = 2 and 4, respectively) but small negative effects (d = -.11 and d = -.12, respectively) on productive learning (N = 7 and 10, respectively). Finally, metacognitive think-aloud produced large positive effects (d =. 80), while nonmetacognitive think-aloud produced small positive effects (d = .17) on response latency (N = 7 and 4, respectively). Obviously, since an extremely small number of studies was included in the analyses, the results obtained were unclear and rather unreliable. Nevertheless, two issues should be noted. Firstly, experiments which considered the reactivity issue did not appear in the implicit/explicit SLA. Thus, it is uncertain whether the results obtained in the studies reviewed here can be generalized to implicit/explicit SLA. Studies that cross the think-aloud/non-think-aloud condition with implicit/explicit learning conditions are clearly needed. Secondly, even considering that the findings are generalizable to implicit/explicit SLA, including the distinction between noticing and understanding necessarily involves the metalinguistic think-aloud which has been claimed (Ericsson & Simon 1993) and found (Sanz et al. 2009) to be reactive. Therefore, the retrospective verbal report might still be the gold-standard measure of subjective experience during learning in this respect. However, studies that investigate implicit SLA failed to employ other behavioural measures of awareness such as the mere exposure effects and wagering that have obtained popularity in the current implicit learning literature (see Nakamura, for a detailed review). Although these measures still have their own problems, their sensitivities to implicit "SLA" processes should be empirically investigated.

Conclusions

Issues surrounding the implicit, unconscious learning of natural languages remain complex and controversial because of insufficiencies in measuring learners' phenomenology, as in the case of implicit artificial grammar and sequences learning (Nakamura 2013). It is often argued that the lack of awareness measured by the retrospective verbal reports does not necessarily indicate that learners acquire languages without awareness. This is because they might forget the contents of awareness at the time of the verbal reports. In other words, the retrospective verbal reports do not satisfy the information and the sensitivity criteria proposed by Shanks and St. John (1994). In Ned Block's (2007) terms, learners might have phenomenological but not retrospective or access consciousness. However, concurrent verbal reports such as the think-aloud protocol suffer from the problem of the reactivity. The processes of thinking aloud might themselves affect task performance positively or negatively. Whether the concurrent think-aloud is reactive or not remains under debate and is just beginning to appear in the SLA field. Therefore, the retrospective verbal report is still one of the best available methods for assessing learners' phenomenology during learning.

One important direction for researching awareness during learning is the multiple employment of other measures of awareness. One popular measure of awareness in implicit learning literature is confidence rating: participants reveal their confidence in their judgment (for instance, GJ). Together with the retrospective verbal report, if there are positive correlations between the scores on two measures, then, one can claim that learners may engage in explicit learning and acquire explicit knowledge at the time of learning with much confidence (though confidence rating itself needs methodological sophistication, see author submitted). A study that employed such multiple measures of awareness is Rebuschat (2009) but it involves learning an artificial language.

Balanced use of implicit and explicit knowledge tests is also important, as Norris and Ortega (2000) argued, and the Mudson Fund project (R. Ellis et al., 2009) found. The majority of implicit/explicit SLA studies conducted during early middle 1990s employed untimed GJ, which is supposed to be a measure of explicit knowledge. Although elicited imitation or story-retelling has not gained popularity among SLA researchers, these should be included in studies of implicit SLA. If there are negative correlations between the scores for the implicit knowledge test and those for the awareness measure, then one might say with confidence that learners engage in an implicit learning mode and acquire implicit knowledge.

Finally, as Dekeyser (2003) argued and Enfield (in press) considered, language learning is not only learning syntax but also learning vocabulary, semantics, and pragmatics. Therefore, it is necessary to consider whether awareness is necessary for learning these other aspects of language and if so how much is needed.

Taken together, future research into the possibility of implicit SLA must consider multiple employment of awareness measures and the balanced use of implicit and explicit knowledge tests, as well as investigation into other aspects of languages in order to resolve the methodological problem of awareness during learning.

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