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THINKING ALLOWED

Explicit and implicit knowledge and learning of an additional language: A research agenda

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Abstract

This paper puts forward a research agenda in the area of explicit and implicit knowledge and learning of second or additional languages. Based on a brief overview of reliable findings as well as open questions in the field, three agenda items are highlighted. First, valid and reliable measures of explicit and, in particular, implicit knowledge and learning need to be identified and their suitability for participants of different ages established. Second, and closely related to the previous point, explicit and implicit knowledge and learning should be investigated across the human lifespan. Therefore, studies need to include to a greater extent hitherto under-represented groups such as children and older adults in order to pinpoint the benefits or otherwise of implicit and, in particular, explicit knowledge and learning in these age ranges. Third, researchers should aim to capture with their designs the complex and dynamic interplay of the multiple cognitive, affective, biographical and contextual factors that influence the development of explicit and implicit knowledge over time. Concrete tasks for future research are proposed under these three agenda items, with a view to assisting interested investigators in formulating research questions and specifying research designs.

1. Introduction

The constructs of explicit and implicit knowledge, learning and teaching have featured prominently in additional or second language (L2) research for several decades. A considerable number of empirical studies has investigated their respective roles, primarily in the context of instructed language learning. Indeed, the relative contribution of each type of knowledge and learning as well as the potential interaction between the two types of knowledge and learning are of critical relevance not only to language learning theory, but also to language teaching practice. Accordingly, interest in this research domain remains strong.

While existing research has managed to answer some key questions, it has also thrown up new issues that are still to be resolved. The issues I consider to be of most immediate importance are discussed in the main body of this paper, and research tasks that can be undertaken to address them are specified. Before presenting this research agenda, I will set the scene by defining the concepts of explicit and implicit knowledge, learning and teaching, and by outlining how they relate to each other. I will then briefly summarise the main findings from previous research that can be regarded as reliable and thus requiring no further substantiation, before moving on to open questions. It will become clear that, perhaps unsurprisingly, the number of uncontroversial findings is fairly small, whereas several important questions are currently unanswered.

1.1 Explicit and implicit knowledge, learning and teaching

Explicit knowledge can be defined as knowledge that we are consciously aware of and that we can potentially articulate in a verbal statement (Anderson, 2005; Ellis, 2004; Hulstijn, 2005;

Roehr-Brackin, 2018). It is represented declaratively, typically accessed via controlled processing (Hulstijn, 2005) and can be called up on demand (Dörnyei, 2009). Examples of explicit knowledge include semantic knowledge in the sense of the form-meaning pairings underlying vocabulary items, and knowledge of pedagogical grammar rules. By contrast, implicit knowledge can be understood as intuitive knowledge that is accessed via automatic processing, can be used in performance, but cannot be brought into awareness or be articulated (Dörnyei, 2009; Hulstijn, 2005).[1] We may also describe implicit knowledge as knowledge that is not explicit.

Explicit learning is 'characterized by the learner's conscious and deliberate attempt to master some material or solve a problem' (Dörnyei, 2009, p. 136). During explicit learning, a learner has online awareness of the learning target and may formulate and test hypotheses relating to it. For instance, the learner may look for regularities in the linguistic input in order to identify systematic patterns, rules or concepts that capture these regularities. As explicit learning requires effort and strategic expertise, it is resource-intensive (Ellis, 2005). It is also potentially fast, with one-trial (or instantaneous) learning possible. Conversely, implicit learning is a non-conscious process of induction that takes place without online awareness and results in intuitive knowledge (DeKeyser, 2003; Ellis, 1994; Rebuschat, 2013). It is a gradual process that requires large amounts of input over time (Dörnyei, 2009), yet while the learning process is slow, it results in knowledge that is accessible in a fast and automatic manner.

Explicit teaching can be defined as any instruction that includes explanations of rules or regularities provided by the teacher or the teaching materials used, as well as any instruction that directs learners to attend to form(s) in order to arrive at metalinguistic generalisations (Norris & Ortega, 2001). The former type of instruction is typically labelled deductive, while the latter is considered inductive, but note that both are explicit (DeKeyser, 2003; Hulstijn, 2005).

As explicit learning activities can be incorporated into explicit classroom-based instruction, it is of immediate practical relevance to establish, first, whether explicit knowledge and learning are enough in and of themselves, and second, whether explicit knowledge can help with the construction of implicit knowledge and/or whether explicit learning can facilitate implicit learning. The first point has been met with the consensus view that additional language learning involves both explicit and implicit processes, and, likewise, that L2 proficiency is supported by both explicit and implicit knowledge (Ellis, 2005, 2006). The second point has been debated in terms of the so-called interface positions (Ellis, 1994), which make different assumptions about how explicit and implicit knowledge and learning relate to each other.

The classic interface positions are typically labelled no interface, strong interface and weak interface. The no-interface position argues that explicit and implicit knowledge are entirely independent from each other and will not interact or influence each other in any way (Krashen, 1982, 1985). This position is often (though not exclusively) associated with a generative nativist theory applied to L2 learning (Cook, 1994; Sharwood Smith, 1994) and can perhaps be described as a minority view in today's research landscape.

The strong-interface position is its direct opposite because it claims that explicit and implicit knowledge and learning interact directly, in the sense that the presence of explicit knowledge plays a causal role in the development of implicit knowledge. In other words, one type of knowledge is conducive to the construction of the other type of knowledge through extensive use and practice. Importantly, it has been argued that both types of knowledge can grow in parallel, in the sense that increasing implicit knowledge of a particular linguistic structure does not need to come at the expense of decreasing explicit, declarative knowledge pertaining to that same structure, or vice versa (DeKeyser, 2003, 2009, 2020).

The weak-interface position takes an intermediate stance, as its name suggests. Researchers supporting this position assume that explicit and implicit knowledge and learning are separate and distinct, but that they can nonetheless interact, with consciousness itself serving as the interface between them (Ellis, 2015). According to this view, explicit knowledge can contribute indirectly to the acquisition of implicit knowledge (Ellis, 2005, 2011; Ellis & Larsen-Freeman, 2006). It is argued that explicit

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knowledge and learning can lead to noticing, language practice and language use. Explicit practice creates implicit learning opportunities, since by virtue of using language we create more input for ourselves. Many proponents of the weak-interface position make a clear distinction between linguistic constructions on the one hand (e.g. *She moves quickly; John takes a walk every morning*) and metalinguistic descriptions in the sense of rules formulated as verbal propositions on the other hand (e.g. 'In English, an *-s* is added to a third-person verb in the present tense'), suggesting that 'it is not the rules themselves that become implicit, but rather the sequences of language that the rules are used to construct' (Ellis, 2004, p. 238). In addition, a weak-interface view implies that explicit knowledge can fill gaps in our implicit knowledge and increase its accuracy (Dörnyei, 2009; Ellis, 2011).

1.2 Reliable findings

A large body of both classroom- and laboratory-based research has focused on investigating and comparing the relative effectiveness of explicit and implicit teaching. In their seminal meta-analysis, Norris and Ortega (2001) reported on the cumulative results from 49 primary empirical studies on the topic conducted between 1980 and 1998. First and foremost, they found that form-focused instruction – that is, instruction that directs learners' attention to linguistic form (Ellis, 2001) – is indeed effective, since learners receiving such instruction consistently and substantially outperformed learners in control conditions. A comparison between different types of instruction found that explicit treatments were most effective, although treatment intensity may have led to some bias by favouring learners from explicit conditions compared with learners in implicit conditions, given that explicit learning is typically faster than implicit learning. The researchers also point out that the type of post-tests used may have influenced effect sizes, in the sense that the most frequently used measures relied on constrained response formats that were likely to encourage the use of explicit knowledge, although this did not undermine the key finding that form-focused instruction is indeed effective. Furthermore, the meta-analysis established that shorter-term treatments resulted in larger effects than longer-term treatments, while longer-term treatments led to more durable effects. In other words, shorter-term treatments led to larger effects on immediate post-tests, and longer term treatments led to effects that were maintained for longer and were thus in evidence on delayed post-tests. Overall, effects from instructional treatments in general lasted beyond immediate post-tests, but they gradually deteriorated over time.

We can conclude from this that form-focused instruction can enhance L2 learning, and more specifically that explicit types of form-focused instruction effectively promote additional language learning. These findings were confirmed by a more recent meta-analysis that included data from 34 primary studies published between 1993 and 2011 (Goo et al., 2015). In addition to presenting further evidence in support of Norris and Ortega's (2001) results, Goo et al. (2015) found that a combination of oral and written treatments worked best for both explicit and implicit instruction. In summary, the finding that explicit instruction is more effective than no instruction can be considered reliable. To the extent that explicit teaching encourages explicit learning and fosters development of explicit knowledge, the finding is potentially transferable to these constructs, but it arguably does not constitute direct evidence.

1.3 Open questions

Despite this endorsement of explicit instruction, caution is in order because open questions remain. Although the cumulative findings summarised in the previous section draw on substantial samples, they also rely on a selected population of educated young adults and adolescents at high school, college or university (see also Hulstijn, 2015). These are the most accessible research participants, and in view of the many practical and logistic constraints researchers face, these are the most investigated groups of learners. Young learners under the age of 12 and older adults over the age of 60 feature much less frequently in published studies (for other under-researched populations in the field of applied

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linguistics more generally, see Andringa & Godfroid, 2020). Accordingly, less is known about the role of explicit and implicit knowledge and processes in children's additional language learning, or about the role of explicit and implicit knowledge and processes in the L2 learning of older adults.

These caveats aside, existing cumulative findings are based on group averages that are known to even out differences between individuals and offer little insight into differences within individuals. Group averages cannot tell us, for instance, if explicit knowledge, learning and teaching work equally well for all learners at all times, regardless of their cognitive abilities, attitudes or personality traits. There is evidence suggesting that individuals may well differ as to the extent to which they can and will successfully construct explicit knowledge and draw on explicit learning, depending on their prior language learning experience (Roehr & Gánem-Gutiérrez, 2009; Roehr-Brackin et al., 2021), their level of proficiency in the language under study (Butler, 2002; Elder et al., 1999), the typological distance between the first language (L1) and L2 under study (Elder & Manwaring, 2004), their language learning aptitude (Alderson et al., 1997; Elder et al., 1999; Roehr & Gánem-Gutiérrez, 2009)[2], working memory capacity (Linck & Weiss, 2011; Roehr & Gánem-Gutiérrez, 2009; Serafini, 2017; Serafini & Sanz, 2016), or cognitive style (Ziętek & Roehr, 2011). What we do not have are studies that bring together all of these variables in a single research design and include measures of explicit and/or implicit knowledge and learning as well. Yet it is only such multivariate studies that can offer a (more) complete picture of the weight of specific factors and the interaction between different factors.

An important issue any researcher needs to address when deciding on a research design is the type of outcome measures they will use to assess explicit and implicit knowledge and learning. The meta-analyses referred to above (Goo et al., 2015; Norris & Ortega, 2001) identified constrained constructed response formats (e.g. gap-fill tasks) as the most popular assessment type, while free constructed responses (e.g. oral narratives or essay writing) were used least often, with selected response measures (e.g. multiple-choice tests) and metalinguistic judgements (e.g. grammaticality or acceptability ratings) ranging in between. On the plus side, it was found that individual studies used an average of two to three different outcome measures, that is, there was no undue reliance on a single type of test. It is worth noting, however, that different outcome measures may yield different observations about the effectiveness of a treatment, and in particular that more controlled outcome measures may favour explicit knowledge. Indeed, measures of explicit knowledge and learning appear to be much more readily available and thus be in wider use than measures of implicit knowledge. The latter are still in short supply, and validation studies are only beginning to appear.

2. Research agenda

2.1 Measurement of explicit and implicit knowledge and learning

The first item on the research agenda is concerned with the measurement of explicit and implicit knowledge and learning and, closely related to this, the possible conceptualisation of the two knowledge types as gradual and situated on a scale rather than as dichotomous categories (Hulstijn, 2015). Earlier work tended to tacitly assume that form-focused or metalinguistic tests that directly asked learners to report on their explicit knowledge about language via rule explanations, for instance, would measure explicit knowledge (Ellis, 2004), while meaning-focused production tests would measure implicit knowledge. An influential attempt at scrutinising this approach empirically was undertaken by Ellis (2005). A battery of tests that differed in terms of their focus (form vs meaning) and time

Research task 1

Validate measures of implicit knowledge and learning for adult learners

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pressure (present or absent) was subjected to a principal components analysis: an elicited imitation test requiring the repetition of previously heard sentences after an intervening task involving belief statements; an oral narrative test requiring the re-telling of a previously heard story; timed and untimed grammaticality judgements in a written modality; and a written test of metalinguistic knowledge. The analysis yielded a two-factor solution. The elicited imitation test, oral narrative test and timed grammaticality judgement loaded on one factor labelled 'implicit'. The ungrammatical sentences on the untimed grammaticality judgement and the metalinguistic test loaded on another factor labelled 'explicit'. In essence, these findings were confirmed in subsequent studies taking a similar approach (Ellis et al., 2009; Erlam, 2006; Zhang, 2015).

Whereas the measurement of explicit knowledge by means of written metalinguistic tests is uncontroversial, recent work has questioned the validity of timed grammaticality judgements (Godfroid et al., 2015; Maie & Godfroid, 2022; Vafaee et al., 2017) or oral tasks such as elicited imitation as measures of implicit knowledge (Suzuki & DeKeyser, 2015). In particular, it has been suggested that the combined use of retrospective verbal reports, direct and indirect tests, and subjective measures of awareness can help researchers pinpoint implicit knowledge and learning more reliably (Rebuschat, 2013). Retrospective verbal reports ask participants to verbalise any rules or patterns they have noticed in the input provided during an experimental treatment. If participants show a training effect but are unable to describe their knowledge, it is considered to be implicit. A direct test instructs participants to make use of all the knowledge they have, whereas an indirect test uses no such instructions. Indeed, participants would ideally not even know that they are being tested when completing an indirect test. The researcher can assume implicit knowledge if a participant shows evidence of learning on the indirect test but not on the direct one. Finally, participants' confidence ratings about their own performance constitute a subjective measure of awareness. A strong correlation between confidence and accuracy would suggest more explicit knowledge, while equal confidence in both correct and incorrect decisions would indicate more implicit knowledge. Source attributions can also be used, that is, participants are asked to indicate the basis of their answers in controlled response formats as guess, intuition, memory or rule (Rebuschat, 2013). While the weaknesses of these approaches are acknowledged, they have set the ball rolling for serious attempts at validating measures of implicit knowledge and learning for adults.

Two recent studies serve to illustrate the way in which future research can usefully address the first task, as follows. Maie and DeKeyser (2020) trained 49 English-speaking participants in a semi-artificial language under incidental conditions; the experimental group (N = 28) was exposed to exemplar sentences with fixed patterns, whereas the control group (N = 21) was exposed to sentences with pseudo-randomised patterns. Subsequently, participants were assessed by means of objective measures of explicit and implicit knowledge as well as subjective measures of awareness. As objective measures, the researchers employed an untimed auditory grammaticality judgement task to assess explicit knowledge and a word monitoring task to assess implicit knowledge. Subjective awareness was measured during the grammaticality judgement by means of confidence ratings and source attributions.

A word monitoring task requires participants to listen to sentences while simultaneously looking out for a previously specified monitoring word. Participants are to press a button as soon as they encounter the monitoring word, which is different for each sentence. Both grammatical and ungrammatical stimulus sentences are used. If participants show a slower mean response time to the monitoring word in ungrammatical sentences compared with grammatical sentences, this is taken as an indication of implicit knowledge of the targeted language feature. In other words, processing is temporarily slowed down on encountering the ungrammaticality, resulting in a slight but measurable delay in pressing the button on the occurrence of the monitoring word.

The results show that the experimental group outperformed the control group on the grammaticality judgement on all target features and with mostly large effect sizes. Confidence levels were significantly higher for correct than for incorrect responses, although the effect sizes were small. The source attribution of 'rule' was correlated with accuracy on almost all targets. Moreover, participants

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performed above chance on some targets when 'intuition' was the reported source of their answer. On the word monitoring task, the experimental and control groups did not differ in terms of response times or grammaticality effects. Thus, the subjective measures suggested that participants had acquired both explicit and implicit knowledge, whereas the objective measures indicated that any knowledge gained was essentially explicit (Maie & DeKeyser, 2020).

The findings from this innovative study demonstrate that objective and subjective measures intended to tap implicit knowledge did not converge. Ultimately, it remains unclear which measure really did tap implicit knowledge, if any, but the researchers argue that implicit knowledge can only be accessed reliably through objective measures. However, to prove this point, more than one such measure would need to be employed.

This is precisely what was attempted in the second study to be considered here. Suzuki and DeKeyser (2015) focused on the validation of an elicited imitation task incorporating word monitoring as a measure of implicit knowledge. An elicited imitation task requires participants to listen to stimulus sentences and then to repeat them back orally. The task comprises both grammatical and ungrammatical sentences, and participants are typically instructed to repeat the sentences they hear in correct English, or whatever the target language happens to be. To encourage a focus on meaning and prevent verbatim rehearsal of the stimuli, an intervening task that has to be completed after listening but prior to repetition is introduced. This can take the form of comprehension questions or belief statements relating to the content of the stimulus sentences, for instance. The task is scored for accurate production of the targeted linguistic feature(s) in the elicited sentences. Scores on grammatical and ungrammatical stimuli should correlate, since any implicit knowledge of the target is expected to both allow for accurate repetition of grammatical sentences and automatic correction of ungrammatical sentences.

In the study at hand, 63 Chinese participants who were advanced L2 speakers of Japanese were tested on five structures involving the use of Japanese particles. The elicited imitation task with a built-in word monitoring component required a stimulus sentence to be processed auditorily followed by a belief statement with which participants had to agree or disagree and then imitation of the stimulus sentence. Before imitation began, participants also had to read out aloud a 3-second countdown (3–2–1). For the word monitoring component, participants were presented with a specific word and required to press a designated keyboard button as soon as they heard the word in the stimulus sentence. The monitoring word always appeared immediately after the target structure. Participants were instructed to convert any ungrammatical sentences into grammatical sentences and, if necessary, to use different words in their repetition as long as those words conveyed the same meaning. The researchers also administered a metalinguistic knowledge test focusing on the grammar rules underlying the target structures. Aptitude for implicit learning was assessed via a serial reaction time task relying on non-verbal visual stimuli.

The results showed a significant difference with a small effect size between word monitoring response times in grammatical and ungrammatical sentences, with longer response times for ungrammatical sentences, as expected. Elicited imitation performance on grammatical and ungrammatical stimulus sentences was strongly correlated, indicating spontaneous correction of ungrammatical items and thus reconstructive processing, again as expected. Elicited imitation performance and aptitude for implicit learning were not correlated, whereas elicited imitation scores did correlate with metalinguistic knowledge test scores. As the metalinguistic knowledge test was unambiguously explicit, this result suggests that participants may have drawn on explicit knowledge during the elicited imitation test as well. At the same time, a moderate correlation with word monitoring was identified. In view of this set of results, the researchers argue that the registration of errors in the listening stage which was assessed by means of word monitoring represents a measure of implicit knowledge, while accurate repetition of the stimulus sentences in the production stage of the elicited imitation task can be considered a measure of automatised explicit knowledge (Suzuki & DeKeyser, 2015). The researchers thus conceptualise knowledge as situated on a scale ranging from explicit to automatised explicit to implicit knowledge, or alternatively

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and put slightly differently, on two scales ranging from greater to lesser awareness on the one hand and from lesser to greater automaticity on the other.

Further work concerned with the measurement of implicit knowledge and learning indicates that beyond word monitoring (Godfroid, 2016), self-paced reading tasks and visual-world tasks are good candidate measures (Suzuki, 2017; Suzuki & DeKeyser, 2017). A self-paced reading task involves the word-by-word presentation of both grammatical and ungrammatical stimulus sentences on a computer screen. The participant can move through the sentences at their own pace, and the speed of button presses to bring up the next word in a sentence is measured as the participant proceeds. If a participant has implicit knowledge of a targeted linguistic feature, they are expected to slow down after encountering a grammatical violation during reading. This delay in response time will be slight but measurable, similar to what can be observed in a word monitoring task.

A visual-world task presents participants with an array of pictures while they listen to stimulus sentences containing a target structure. By analysing eye movements during the listening process, the task reveals which picture(s) participants look at and for how long, thus providing an indication of their real-time comprehension of the targeted feature. A downside of this task is its relatively limited scope, since the array of images necessitates a focus on concrete objects or scenes that can be depicted unequivocally. Thus, a visual-world paradigm is suitable for investigating the processing and/or comprehension of grammatical gender or singular versus plural morphology, for instance. Concrete objects with different grammatical genders – for example, German *Tisch* (masc.) 'table', *Tasse* (fem.) 'cup' or *Haus* (neut.) 'house' or individual versus multiple objects, for example, a single cow versus several cows – can be represented pictorially, and the researcher can assess whether a participant gazes at the picture that matches the stimulus. However, this paradigm cannot be used for any morphological, syntactic or discourse-level targets that defy straightforward visual representation, which is arguably the majority of linguistic structures.

The task for future research is to conduct studies that include at least two measures hypothesised to tap each type of knowledge, so both convergent and divergent validity can be established. In other words, measures hypothesised to tap one type of knowledge should be correlated strongly and load onto the same component in a factor analysis, while at the same time they should not correlate/correlate only weakly with and not load onto the same component as measures hypothesised to tap the other type of knowledge. On the implicit side, two objective measures – for example, word monitoring and self-paced reading – can be employed (for further details on using response time measurements, see also Jiang, 2012), or a combination of objective and subjective measures may be administered. The latter approach would allow the researcher to examine the construct of implicit knowledge in qualitative terms by comparing participants' performance on measures using either the criterion of awareness (subjective) or the criterion of knowledge in use (objective). If a longitudinal or time-series design is chosen, it would enable the researcher to assess not only the presence or absence of implicit knowledge at a given point in time, but also the development of implicit knowledge over time. As subjective measures rely on (the absence of) awareness while objective measures rely on fast, automatised access to knowledge, a strong interface position would predict that at earlier stages of development subjective but not objective measures would indicate implicit knowledge, whereas at later stages both measures would indicate implicit knowledge.[3]

Overall, existing work is promising, and the pioneering research undertaken by Suzuki and colleagues, some of which is referred to above, points the way, but only a small number of studies have been carried out to date. Accordingly, a very limited number of participant samples, language combinations and target features has been investigated so far, and generalisation is not yet possible, though it is of course critical where questions of measurement are concerned.

Research task 2

Identify suitable measures of explicit and implicit knowledge for young learners

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While research concerned with adult (and adolescent) learners has begun to address the challenging issue of measuring implicit knowledge in particular, studies with young learners – defined here as children up to the age of 12 – often do not specify whether experimental outcome measures or other proficiency assessments focus on explicit or implicit knowledge. Nevertheless, as we shall see in more detail shortly, researchers of children's instructed additional language learning have begun to acknowledge that over and above constructing implicit knowledge, children can and do develop explicit knowledge. The issue thus arises of how to disentangle the different types of knowledge, in the same way as this has long been attempted in the context of adults' L2 learning.

While measures of explicit knowledge used with adults tend to require the verbalisation of generalisations as exemplified by metalinguistic labelling and the formulation, application or illustration of pedagogical grammar rules, measures for children tend to be more indirect, since younger children in particular may not have had the opportunity to acquire any metalinguistic terminology or fully formulated pedagogical grammar rules. By the same token, young learners' literacy skills are still developing – skills that are taken for granted in written measures used with adults and adolescents. Accordingly, explicit knowledge in studies with child participants is typically conceptualised as metalinguistic awareness or ability, that is, the capacity to separate form from function and to treat language as an object of reflection and analysis (Cummins, 1987; Birdsong, 1989; Baker, 2006; Roehr-Brackin, 2018). This ability is then assessed via tasks requiring the child to recognise and analyse patterns within a language or cross-linguistically, or both.

A prime example of a test of metalinguistic awareness for English-speaking children is the measure developed by Tellier (2013). This written test aimed at ages 8–11 requires children to carry out a series of tasks based on various European languages and an invented language. Tasks include cross-linguistic comparisons drawing on cognate recognition and translation, the recognition of ambiguity, and the identification and application of morphological and syntactic systematicities. Other studies have mainly drawn on acceptability judgements with various conditions (Bialystok, 1988; Bialystok & Martin, 2004; Bialystok et al., 2014; Hakes, 1980) or qualitative measures based on oral data such as teacher-guided analysis of video-taped instances of corrective feedback (Bouffard & Sarkar, 2008) or interviews focused on specific target structures (Ammar et al., 2010). Most recently, an innovative measure has been employed with 5-year-old children that relies on the non-verbal behavioural response of opting out of a trial as an expression of high uncertainty, taken as indicative of access awareness (broadly synonymous to noticing), if not phenomenal awareness (which would allow for the explicit verbal description of a subjective experience; for details, see Spit et al., 2021).

Future research should aim to establish the convergent and divergent validity of different test-based measures. In particular, it would be worth investigating whether performance on a test of metalinguistic awareness, such as Tellier's (2013) that uses a number of different languages including an invented mini-language, correlates with performance on measures focused on a specific language, such as acceptability judgements that require children to inhibit a focus on meaning and selectively attend to form (Bialystok, 1988) or a verbal fluency task in the letter condition (e.g. 'Name as many words as you can that begin with the letter L') (Bialystok et al., 2014). Moreover, it is unclear to what extent any of these measures, which essentially focus on the targeted retrieval, analysis and/or manipulation of language, correlate with measures focusing on inhibitory control at the conceptual level, albeit linguistically mediated, such as tested by the dimensional change card sort task (Bialystok & Martin, 2004), which requires children to sort cards according to a specified rule relating to the colour, shape or function of depicted objects, for instance, and then to re-sort the same cards according to an amended sorting rule. A possible validation study could administer a battery of three or four of the above tests to the same cohort of child language learners, with an age range from 8 onwards most likely to be suitable, given the need for basic literacy skills required by at least some of the measures. Subsequent correlational and factor analyses would allow the researcher to establish to what extent the different measures draw on similar or different types of knowledge.

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Furthermore, instead of tacitly assuming that children's performance on oral or written language measures that do not have a dedicated metalinguistic component will be based on implicit knowledge, future research should seek to establish if any of the measures that have recently been proposed for tapping adults' implicit knowledge are likewise suitable for use with children, provided they are adapted appropriately. In each case, a measure of explicit knowledge/metalinguistic ability as exemplified above can be combined with a (hypothesised) measure of implicit knowledge in order to establish divergent validity. On the implicit side, the visual world paradigm has been used with children as young as 3–5 years to investigate L1 comprehension (see, e.g., Huang et al., 2013; Pyykkönen et al., 2010) and is thus suitable even for the youngest age ranges, although the task is limited with regard to the linguistic targets that can be accommodated, as pointed out above. Alternatively, an elicited imitation test with an intervening task that prevents verbatim rehearsal could be trialled, bearing in mind that children's working memory capacity is more limited than adults' and thus making sure target sentences are shorter and simpler than in adult versions of the task. A self-paced reading task that is obviously dependent on literacy skills could work with older children in the 10–12 age range, for instance, whereas a simplified word monitoring task in an auditory modality might be an option for younger age ranges, although it remains to be established at which lower age boundary response times become too slow to be meaningful. To the best of my knowledge, none of these measures have been explored with child learners for the specific purpose of identifying and validating tools that tap implicit linguistic knowledge. It is a task worth undertaking, as the subsequent section demonstrates as well.

2.2 Explicit and implicit knowledge and learning across the lifespan

The second item on the research agenda is concerned with explicit and implicit knowledge and learning throughout the lifespan. No doubt owing to practical reasons, and as already indicated, existing work has primarily focused on young adult and adolescent learners, that is, the kind of study participants that can be recruited most readily by researchers working at universities, colleges and schools. A complementary focus on other age groups is sorely needed as, owing to maturational changes, the relative importance of different types of knowledge and learning processes can be expected to vary across the human lifespan. Two groups of specific interest are children under the age of 12 and older adults over the age of 60. The latter group has barely been studied with particular reference to explicit and implicit knowledge and learning, while work with child learners has begun to gather pace in recent years, although it is still lagging behind research with younger adults and adolescents.

Research task 3

Pinpoint the conditions required for an explicit approach to language learning and teaching to be successful with young learners

As we have seen in the previous section, researchers investigating children's instructed L2 learning often use outcome measures that do not specifically distinguish between explicit and implicit knowledge and processes (for an exception, see García Mayo, 2003, who acknowledges an explicit outcome measure). At first glance, one might conjecture that this is probably owing to the widespread assumption that children learn primarily implicitly and that, accordingly, any language tests administered to children that are not outright metalinguistic in nature will gauge their implicit linguistic knowledge. However, the same researchers often do refer to implicit versus explicit knowledge and learning when discussing their results. In other words, the key finding that in classroom settings older children consistently outperform younger children following the same amount of exposure is typically explained with reference to older children's more advanced cognitive development compared with

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their younger peers and, associated with that, their greater ability to draw on explicit knowledge and processes (e.g. Cenoz, 2003; Muñoz, 2006, 2009).

A small number of recent studies have specifically focused on children's metalinguistic awareness and its potential impact on additional language learning in the limited-input setting of the typical primary-school classroom (Roehr-Brackin & Tellier, 2019; Tellier & Roehr-Brackin, 2013, 2017). The findings indicate that even at ages 8–9, children's metalinguistic abilities develop significantly following age-appropriate form-focused language instruction. Moreover, metalinguistic awareness is closely related to language learning aptitude, which typically predicts explicit dimensions of L2 learning (Roehr-Brackin, 2018). Work that has directly compared children's with adults' L2 learning in the context of a controlled laboratory study suggests that the type of instruction used may be just as important as chronological age in determining whether learners draw on primarily explicit or primarily implicit approaches (see also Lichtman, 2013, 2016, 2021; Ferman & Karni, 2010). Taken together, these results indicate that a complex combination of factors is at play: children's chronological age, their relative cognitive maturity, language learning aptitude and metalinguistic awareness, and the type of instruction they experience all interact. What is currently unknown is the relative weight of each factor and thus the optimal combination of individual and contextual criteria for clear benefits of explicit learning and teaching to arise, as indexed by significant improvements in L2 proficiency. The task is to establish this by comparing children of different ages experiencing the same teaching approach, and/or by comparing children of the same age range with different levels of metalinguistic awareness and aptitude experiencing the same teaching approach, and/or by comparing different teaching approaches in the same age group.

Research task 4

Establish if, and to what extent, older adults differ from younger adults with regard to utilising explicit knowledge and learning

Research on additional language learning in older adults has only recently begun to gain ground, in acknowledgement of the scientific need to understand language and cognition across the entire lifespan, and in recognition of the fact that many countries across the world are seeing ageing populations as birth rates fall and life expectancy rises thanks to continuing improvements in healthcare. A greater share of older adults in the population as a whole makes researching this age group's language learning more relevant than ever (Cox, 2019). A small number of studies have specifically focused on older adults' L2 learning (Kliesch & Pfenninger, 2021; Mackey & Sachs, 2012; Pfenninger & Polz, 2018; Pot et al., 2018; Ware et al., 2017), demonstrating that additional language learning is possible at any age and that there is no 'upper limit'. Researchers have also begun to try and identify instructional approaches that may be particularly suitable for older learners (Gabryś-Barker, 2018).

It is well known that as we age, some of our cognitive functions decline, including working memory capacity, executive control and processing speed (Antoniou et al., 2013; Baum & Titone, 2014; Salthouse, 2004). Overall, online capacities relating to the speed of processing as well as sensory acuity – particularly in the auditory domain – are negatively affected by advancing age, while verbal and general knowledge in the sense of crystallised abilities tend to remain stable (Singleton, 2018; Singleton & Ryan, 2004). Moreover, older adults' life experience continues to develop and diversify (Gabryś-Barker, 2018); discourse and strategic competences are well developed and continue to be built up (Piechurska-Kuciel & Szyszka, 2018), offering facilitative potential.

Given the stability of crystallised abilities as well as the relative strategic expertise of older learners, it is possible to hypothesise that explicit knowledge and learning will be particularly important for this age group. Indeed, it has been suggested that older learners may demonstrate enhanced grammatical understanding and lexical learning as well as advanced strategies for searching for underlying patterns

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in the linguistic input (Singleton, 2018). According to anecdotal evidence from the 1980s, older L2 learners may desire grammar rules, explanations and systematic analysis (Singleton & Ryan, 2004). At the same time, a decline in working and declarative memory would lead to the hypothesis that explicit knowledge and learning will be adversely affected, resulting in difficulties with the acquisition of lexical items and complex syntax, for instance (Ramírez Gómez, 2016).

In view of these contrasting hypotheses, it is of immediate interest to both theory and practice to gain a better understanding of how and to what extent older adults utilise and/or benefit from explicit knowledge and processes in the context of L2 learning. It seems that only three studies to date have directly considered this issue (Cox, 2017; Cox & Sanz, 2015; Lenet et al., 2011). The studies in question investigated participants' learning of Latin subject and object case marking through computer-administered instruction. Overall, the findings show that participants improved between pre- and post-test, that is, they learned the target structure successfully. When the researchers looked at whether learners would benefit from explicit information about the target structure in addition to input-based practice, it was found that explicit information had no additional facilitative effect when it was provided prior to practice (Cox, 2017; Cox & Sanz, 2015), and that it actually had a detrimental effect when it was provided as part of corrective feedback during practice (Lenet et al., 2011).

In Lenet et al. (2011), an explicit feedback group received feedback on the accuracy of answers and a metalinguistic explanation, while a less explicit group received feedback on the accuracy of answers only. Less explicit feedback was more effective for the older learners than more explicit feedback, although it is worth noting that the participants complained that the metalinguistic comments were not visible for a sufficient amount of time, so this may have had a negative impact. Interestingly, the findings also showed that despite a time lag of up to 50 years, older participants exhibited evidence of retention of Latin encountered at school, pointing towards the existence of a long-term store of language-related knowledge (Lenet et al., 2011).

Cox and Sanz's (2015) experimental treatment began with an explicit grammar lesson explaining the roles of subject and object and how they are encoded morphologically in Latin. Participants were advised on more and less appropriate processing strategies: attend to case marking rather than word order. Subsequently, participants completed a pen-and-paper test measuring their explicit knowledge, and this was followed by a practice phase with receptive language activities. The results showed that the older adults achieved a high mean score on the explicit grammar test, but they were significantly less successful than a young adult comparison group. The researchers suggest that the memory demands of the explicit information session and subsequent test may have played a role, disadvantaging the older adults.

Cox (2017) compared the effects of explicit information on the target structure in monolingual and bilingual older adults. The provision of metalinguistic information prior to comprehension practice had little effect overall. When it did play a role, it yielded an advantage for bilinguals, but not monolinguals. Specifically, advantages were observed on tasks requiring transfer of knowledge, suggesting that metalinguistic reflection was beneficial in such circumstances and that bilinguals were better able to engage in such reflection than monolinguals.

While these results appear to suggest that explicit knowledge and learning may not convey particular benefits for older adults' L2 acquisition, it is important to bear in mind that at this point in time we do not have nearly enough data to generalise beyond the research designs at hand. In particular, the studies summarised here were laboratory-based with extremely short treatments and thus rather limited ecological validity. In addition, specific experimental variables such as the length of time available for reading metalinguistic comments could have adversely affected the usefulness of explicit information for the older participants in at least one of the studies. It is also worth noting that individual differences can be expected to play a role (Kliesch et al., 2018). The studies reviewed above rightly controlled for one or more of the following: non-verbal intelligence, working memory capacity, processing speed, language learning experience and level of education.

The task for future studies is to examine explicit knowledge, learning and teaching in the context of older adults' classroom language learning. Measures of explicit knowledge should be complemented by

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measures of implicit knowledge for comparison purposes. Moreover, a variety of sample populations should be investigated, including third-age language learners/retired citizens who undertake language study as a leisure activity, migrants who arrived in the target language country at a younger age, and newly arrived older migrants (Cox, 2019). In a classroom setting, it will be worth measuring affective factors such as attitudes and motivations, over and above the biographical and cognitive variables that were taken into account in the laboratory studies. Researchers may aim for a direct comparison of older and younger adults from similar backgrounds within the same study, or they may wish to focus exclusively on older adults with a view to comparing their findings with cumulative results from existing research with younger adults.

2.3 Factors interacting with explicit and implicit knowledge and learning

The third item on the research agenda is concerned with the need to capture the complex, dynamic interplay of the multiple factors known to influence language development and therefore also explicit and implicit knowledge and processes. Studies conducted within the theoretical framework of complex dynamic systems theory strive to address this challenging issue and can serve as models for future research, as we shall see below. Virtually no research to date has specifically investigated explicit and/or implicit knowledge and learning from the perspective of this theoretical paradigm (for an exception, see Roehr-Brackin, 2014, 2015), and it is argued here that this is an avenue well worth exploring.

As its name suggests, complex dynamic systems theory conceptualises phenomena as complex and dynamic, thus emphasising the multiple elements and/or agents engaged in interaction in any given system as well as the continuous and often non-linear changes systems go through. A complex dynamic system is seen as emerging from the interaction of its components (de Bot & Larsen-Freeman, 2011; Larsen-Freeman & Cameron, 2008). It is not only natural phenomena such as the eco-system of a forest or the weather that can be conceptualised as complex dynamic systems; social phenomena can likewise be understood as such – for example, a speech community, a school classroom or a nuclear family – and so can individuals – for example, an L2 speaker. Hence, in essence, a system is something that has phenomenological validity and/or concrete existence (Hiver & Al-Hoorie, 2016).

Systems are nested within each other, and we can investigate them at any level of granularity, from the micro-level of neurons in the human brain to the macro-level of human society, and anything in between. By the same token, systems operate on a range of timescales, from the milliseconds of online linguistic processing to the decades or centuries of diachronic language change. Crucially, whichever system we choose to focus on, we must take its context into account, that is, other systems it is nested within or otherwise connected to, and the environment it operates in (de Bot et al., 2007). Accordingly, it is argued that we can only investigate the development of an individual's language system(s) – including their explicit and implicit knowledge – in a meaningful way if we consider the elements that constitute the system itself, its interactions with other characteristics of the individual, and the context in which the individual functions.

As complex dynamic systems theory seeks to understand how the interacting parts of a system and the interaction of the system as a whole with other systems give rise to new patterns of behaviour, variability and change are of primary interest. Systems co-adapt, in the sense that change in one system leads to change in another, connected system, and this mutual influence continues over time. Changes in variability itself – that is, more or less variability or indeed stability – can help explain developmental processes. Any particular outcome is not only dependent on a system's initial state, but also on the ongoing interactions of system components, and it is thus attributable to multiple causes (de Bot & Larsen-Freeman, 2011; de Bot et al., 2007); it is the researcher's task to describe the system in focus, its constituents and any interactions, so relationships can be identified, their dynamics pinpointed, and causes uncovered.

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Research task 5

Think big and explore the interplay of contextual, demographic, cognitive, affective and linguistic factors in the development of explicit and implicit knowledge

Two example studies that were conducted more than 25 years apart can serve to illustrate how 'thinking big' can be implemented. Although neither of these studies was explicitly framed within complex dynamic systems theory, both managed to capture an impressive array of variables in an attempt to assess their impact on L2 proficiency. Ehrman and Oxford (1995) tested 855 highly-educated English-speaking professionals (mean age 39) who were employed by various U.S. government agencies and undergoing training in 34 different languages. The participants completed seven instruments aimed at measuring motivation, anxiety, psychological boundaries, personality type, learning style, language learning strategy use and language learning aptitude. Scores from these measures where then correlated with end-of-training language proficiency scores based on ratings on a five-point scale for reading and speaking ability. The researchers found that the cognitive factors of language learning aptitude and level of education showed the strongest correlations with proficiency attainment, followed by motivation, self-confidence and affective arousal, that is, emotional factors. The researchers did not conduct further analyses, so the interactions between the factors themselves remained underexplored.

A recent ground-breaking study conducted in Switzerland (Berthele & Udry, 2021) investigated factors interacting with foreign language learning in more than 600 school children aged between 9 and 14. An extensive range of factors was measured over 18 months: fluid and crystallised intelligence, verbal and visuo-spatial working memory capacity, field independence, language-analytic and phonetic components of language learning aptitude, self-efficacy, motivation, self-concept and anxiety, linguistic and cultural background, home environment and socioeconomic background. Factor and regression analyses identified (a) a cognitive factor including both general and language-specific analytic abilities, (b) first language reading proficiency, and (c) an emotional factor primarily comprising intrinsic motivation as significant predictors of progress in the foreign language(s) learned by the young participants. The L2s in question were English and French.

It goes without saying that the sheer scale of these two studies means that the researchers went further than most in trying to do justice to the complexity of additional language learning and the multiple factors that exert an influence on the achievement of L2 proficiency. The concise outcome measures of in-house end-of-training proficiency ratings for reading and speaking (Ehrman & Oxford, 1995) or C-tests (Berthele & Udry, 2021) were no doubt chosen for practical reasons, given the many tests that had to be administered to the participants. Bearing in mind our research task at hand, it seems clear that such global measures would have allowed for the use of either explicit or implicit knowledge, or both explicit and implicit knowledge in conjunction, with the latter arguably the most likely scenario.

It is a task for future research to try and identify the impact of multiple factors on explicit and implicit knowledge and processes in L2 learning and to determine the relative weight and importance of each factor for the attainment of each type of knowledge. Are individual differences in L1 proficiency, level of education, language learning history, cognitive ability and affect equally strong predictors of explicit and implicit L2 knowledge? Or are some factors such as education, prior language learning experience and cognitive capacity more important for the attainment of explicit knowledge than implicit knowledge? To what extent do aptitude for explicit learning and aptitude for implicit learning differentially predict the development of explicit and implicit L2 knowledge? Are affective factors more important for the attainment of implicit knowledge than explicit knowledge? Or does knowledge type no longer matter if the list of predictors is sufficiently comprehensive? These questions deserve to be answered. Given the large sample sizes required for the proposed undertaking, intact classrooms in schools, colleges or universities, including universities of the third age, are the most

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likely research settings. In view of the scarcity of existing work, large-scale data sets on learners of all ages are needed.

The researcher(s) undertaking such a study would need to administer a comprehensive battery of measures that capture background, cognitive and affective variables, as well as language assessments that tap explicit and implicit knowledge, respectively. Measures of explicit knowledge are more readily available and/or less challenging to design, at least for cognitively mature learners, because use of explicit, metalinguistic knowledge can be 'forced' more easily with tasks requiring the formulation or application of language rules, for instance. Conversely, the choice of measures of implicit knowledge would depend on the extent to which Tasks 1 and 2 have been addressed.

Research task 6

Think small(er) and explore the interplay of these factors in the development of explicit and implicit knowledge in a small(er) number of individuals longitudinally

Whereas the large-scale studies outlined in the preceding paragraphs went further than most in doing justice to the complexity of learning an additional language, the dynamic nature of the developmental process was not foregrounded, so any changes in predictive and developmental patterns or variability in interactions between different factors over time were not considered. Capturing this dynamicity constitutes an important endeavour, however, because quite clearly language development is not always a linear process, and different factors may have different weights at different points in time. Non-linear patterns can be expected, and only longitudinal studies that take measures at frequent intervals are able to identify when progress occurs, ceases, or resumes, or if a predictor is only relevant at early stages but not at more advanced stages of proficiency, for instance.

A recently published study has attempted to do just that. Kliesch and Pfenninger (2021) describe the L2 Spanish development of 28 older adults aged between 64 and 74 with Swiss German as their L1 and low levels of knowledge of other languages. In a time-series design, the participants' Spanish learning was tracked alongside their performance on cognitive measures and any socio-affective fluctuations over the course of 32 weeks. Participants completed eight cognitive measures, seven language measures, single questions on overall well-being and training motivation on a weekly basis, resulting in a total of 544 measurements per person and 14,019 data points. Spanish was taught in the classroom for 45 minutes per week, supplemented by two to three hours per week of independent online study. The dense data set was analysed in accordance with the principles of complex dynamic systems theory, so the focus was on development over time, individual learning trajectories in comparison with group means, and the influence and interaction of cognitive, socio-affective and demographic factors over the duration of the language training.

The key results show that mean L2 development was not necessarily representative of individual learning trajectories. For instance, in the case of fluency, the group mean reflected individual performance well, but in the case of lexical richness of language use, this did not apply, indicating that some L2 measures allow more easily for generalisation at the group level than others. While morphosyntactic accuracy showed linear development, all other L2 measures displayed non-linear growth. In those instances, development was most evident in the initial phases of training and then levelled off. Individual differences in cognition significantly moderated the effect of language training over time. Specifically, a measure of vigilance, operationalised as a combination of alertness and inhibition, and L1 verbal fluency showed a linear positive relationship with L2 performance, while other cognitive factors showed curvilinear patterns. Effects were either mainly positive, or positive for specific levels of cognition only, that is, they were typically found at lower levels of performance, pointing towards a threshold effect, or, put differently, the existence of a point after which better cognitive performance no longer conveys any significant benefits. Participants with greater working memory capacity outperformed those with smaller capacity after about 15 weeks of training, with the performance gap

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continuing to widen thereafter. In the affective domain, it was found that almost all L2 proficiency measures were associated with high socio-affect in the sense of training motivation and well-being, but only for participants reporting below-average values, indicating a possible ceiling effect and/or selection bias in the generally positively disposed sample of volunteers. Finally, an analysis of day-to-day fluctuations yielded few significant findings, indicating that short-term variability in cognitive performance had little influence overall.

The L2 measures used by the researchers were comprehensive: they included a C-test to assess overall proficiency, a multiple-choice odd-one-out task to test lexical comprehension, a multiple-choice grammar task, and an oral production task administered as an interview that yielded measures of fluency, morphosyntactic accuracy, target-like use of vocabulary and lexical richness (Kliesch & Pfenninger, 2021). While these tasks were not designed to assess explicit and implicit knowledge separately, it is informative to scrutinise the detailed analyses conducted by the researchers for any differences in results between those measures most likely to have encouraged the use of one or the other type of knowledge, such as the receptive grammar task (explicit knowledge?) and indices derived from the oral interview (implicit knowledge?). It is clear from the results presented that patterns of variability as well as the role of predictors differed between these measures. This suggests that a targeted investigation with dedicated explicit and implicit knowledge measures administered to (adult) learners of different ages would indeed be a worthwhile endeavour.

The task for future research would thus be to apply the innovative and ambitious research design and sophisticated analytic approach modelled by Kliesch and Pfenninger (2021) to a study specifically aimed at eliciting both explicit and implicit knowledge of an additional language. A time-series design and analyses capable of capturing non-linear trajectories would allow for the discovery of 'tipping points' in L2 development at which, for instance, certain cognitive abilities or affective dispositions no longer convey any advantages, or, conversely, at which they begin to play a role. It is acknowledged that a longitudinal study conducted over several months or years and involving weekly or monthly measures of multiple variables is only an option if considerable funding is available to the research team. However, it is equally important to note that a quantitative approach with high statistical power is not the only way forward. None of the example studies reviewed here included qualitative measures, yet the collection and analysis of qualitative data, whether at weekly or monthly intervals over a long period of time or within the tight time frame of hours or even minutes in a microanalytic approach to specific classroom interactions is critical if underlying reasons for observed patterns of development, variability and change are to be uncovered. In this spirit, case studies (Roehr-Brackin, 2014, 2015), which are perhaps a more realistic option for lone researchers and/or researchers relying on their own resources, can also yield valuable insights into the complex, dynamic interplay of cognitive, socio-affective and linguistic factors as well as offer potential explanatory accounts.

3. Conclusion

In the preceding sections, I have put forward a research agenda for the investigation of explicit and implicit knowledge and learning of additional languages. Taking the current state of research as a starting point, three major agenda items have been proposed: first, the measurement of explicit and implicit knowledge and learning; second, explicit and implicit knowledge and learning across the lifespan; and third, factors interacting with explicit and implicit knowledge and learning. Under these overarching themes, I have outlined six specific research tasks concerned with the validation of measures of implicit knowledge and learning for adults; the identification of suitable measures of explicit and implicit knowledge for children; the pinpointing of the conditions required for an explicit approach to language learning and teaching to be successful with young learners; the need to establish if and to what extent older adults differ from younger adults with regard to their utilisation of explicit knowledge and learning; the large-scale exploration of the interplay of contextual, demographic, cognitive, affective and linguistic factors in the development of explicit and implicit knowledge; and, last but not least, the in-depth, longitudinal investigation of the interplay of these factors in the

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development of explicit and implicit knowledge in individual learners. While it is acknowledged that other items can and should be added to the research agenda in our field, addressing the research tasks discussed above is bound to bring significant progress in terms of both empirical evidence and theoretical insights into explicit and implicit learning and knowledge of additional languages.

Notes

[1] As pointed out by an anonymous reviewer, not all researchers would make a direct association between explicit and implicit knowledge on the one hand and controlled and automatic processing on the other hand. Depending on one's theoretical position, it can be argued that explicit knowledge may be automatised, for instance, as discussed further on.

[2] For a comprehensive overview of cumulative findings from research on language learning aptitude, see the meta-analyses by Li (2015, 2016).

[3] I am grateful to an anonymous reviewer for this suggestion.

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