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Individual differences in adult second language learning: A cognitive perspective

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Abstract: What makes some people more successful language learners than others? Scholars and practitioners of adult second language learning traditionally have cast the issue of individual differences in terms of such constructs as aptitude, motivation, learning strategies, learning styles, meta-linguistic awareness, and personality traits (e.g., extraversion), as well as a range of other social and affective variables (Ehrman, Leaver & Oxford, 2003). These are complex constructs that often lack a clear description of the underlying mechanisms. In this short overview we will take a cognitive perspective and link individual differences in adult L2 learning to individual differences in cognitive abilities. Examining cognitive factors that are predictive of L2-learning success can help to illuminate the mechanisms that underlie the learning process. At the same time, recognising and understanding the links between cognitive abilities and language learning may help teachers and learners to adjust their teaching methods and the learning environment in ways that are beneficial to individual learners. Although we are still far from being able to make specific evidence-based recommendations, reviewing what is known about cognitive predictors of successful language learning may be a useful start.

Keywords: language learning, cognition, learning strategies, adult learners

Introduction

In an attempt to gain some control over the many variables involved in language learning, cognitive psychologists typically study isolated aspects of L2 learning such as learning of a specific grammatical feature or a small set of novel vocabulary items. Often these studies utilise artificial micro-languages with carefully constructed phonological properties and grammars. This approach provides valuable insights into the basic cognitive mechanisms involved in L2 learning but is restricted in its generalisability to more complex aspects of learning. In our research, we pursue a more integrative approach and try to maximise ecological validity by examining how cognitive abilities predict various aspects of L2 learning as they take place simultaneously. Typically, our experiments require participants to learn a small set of nouns from a morphologically rich language, Russian, in a variety of contexts over a number of training sessions. Participants engage in various activities such as listening and repeating short phrases, identifying referents and producing short statements. No explicit teaching of rules takes place. At the end of training, we test the learners' ability to generalise aspects of grammar like gender agreement or case marking to items they have not encountered before. We also test their incidental retention of vocabulary. Lately, we have expanded the study of individual differences to L2 phoneme perception and production (Kempe, Thoresen & Brooks, 2007). We then link performance in various domains of L2 learning to performance on a variety of cognitive tasks. Examining multiple

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cognitive predictors simultaneously allows us to use statistical techniques that partial out the effects of mechanisms that are shared by the different tasks and to look at the unique contribution of the specific cognitive mechanisms. This is important because every cognitive task used to assess a specific cognitive ability (e.g., working memory) always engages a number of difficult mechanisms, and it is often difficult to disentangle their individual effects on language learning. From this research, we have gained some insights into which cognitive abilities facilitate language learning and whether these abilities affect different aspects of learning in different ways.

Phonological short-term memory

Phonological short-term memory (PSTM) serves to retain sequences of sounds in memory over short periods of time. It comprises a phonological store and an articulatory rehearsal mechanism which maintains decaying representations. To illustrate, it is this mechanism that is engaged when someone reads out a phone number and the listener then silently rehearses it to keep it in memory until they are ready to dial it. The capacity of PSTM can be assessed by such tasks as the digit span task or the non-word repetition task. The digit-span task requires individuals to reproduce sequences of digits of increasing length. The non-word repetition task requires individuals to repeat made-up pseudo-words like bleximus.

Baddeley, Gathercole and Papagno (1998) suggested that the main function of PSTM is to learn new words, both in first language acquisition as well as in second language acquisition. Indeed, a sizeable body of research has confirmed that non-word repetition is a good predictor of how well learners retain new L2 vocabulary (Ellis & Sinclair, 1996; Gupta, 2003; Papagno, Valentine & Baddeley, 1991; Service, 1992, Service & Kohonen, 1995; Speciale, Ellis & Bywater, 2004; Williams & Lovatt, 2005): Individuals with larger PSTM capacity tend to be more successful in learning L2 vocabulary. One explanation of the underlying mechanism suggests that individuals who can hold more phonological material in a short-term store are able to pass on more material into long-term-memory. Another explanation suggests that the same factor—the ability to generate good-quality phonological representations—underlies both short-term storage as well as long-term retention (Service, Mauri & Luotoniemi, 2007).

In a recent study, we found that non-word repetition uniquely predicted learners' incidental vocabulary learning in our miniature language learning paradigm (Brooks, Kempe & Donachie, 2009) over and above the effects of other cognitive predictors such as working memory capacity, non-verbal intelligence or prior language learning experience, thereby confirming the previous findings from studies that had examined PSTM and vocabulary learning in isolation. Interestingly, PSTM did not predict grammar learning when the other cognitive predictors were taken into account, even though the simple positive correlation between non-word repetition and our measure of grammar learning, correct production of Russian inflections, was significant (see also Ellis & Schmidt, 1998; Williams & Lovatt, 2005). This suggests that other cognitive predictors, while sharing certain components with PSTM, are better able to explain grammar learning. After all, grammar learning requires the learner not just to commit sequences of sounds to long-term memory but, most importantly, to detect regularities in those sequences.

Working memory

PSTM is one of the sub-components of working memory, i.e., of the general ability hold in mind information required for the execution of cognitive tasks. However, in many theories the construct of working memory comprises not only a storage system but also a processing component engaged in allocating cognitive resources to the various tasks at hand. Consequently, working memory is typically measured with tasks requiring both storage and processing capacities. For example, the Reading Span task (Daneman & Carpenter, 1980) requires individuals to read aloud sets of 2, 3, 4 or 5 semantically unrelated sentences; after reading each set of sentences, the individual is asked to recall the last word of each sentence in the set. The Reading Span task requires the executive processing components of working memory to allocate resources to reading and understanding the sentences as well as storage capacity to remember the sentence-final words. Because individuals are reading aloud, they are unable to use articulatory rehearsal to maintain the words in PSTM.

There is evidence that working memory capacity is related to native language processing (Just & Carpenter, 1992). Differences in working memory capacity typically manifest themselves in the processing of grammatically complex sentences where several interpretations have to be held in mind temporarily until an ambiguity can be resolved. For example, in the sentence The defendant examined by the lawyer shocked the jury which contains a reduced relative clause, the word examined initially might be misinterpreted as the main verb in the sentence. Higher working memory capacity also increases the fluency with which sentences are produced and the speed with which inferences are generated during comprehension (Miyake & Friedman, 1998). It can be expected, then, that working memory capacity should constrain L2 learning and processing in similar ways. Indeed, there is evidence that L2 learners with high working memory capacity, as measured using the Reading Span test, are better able to integrate multiple cues (e.g., word order and noun animacy) when assigning semantic roles to nouns in L2 sentences (Miyake & Friedman, 1998).

In our work, we have tried to estimate the effects of working memory capacity over and above the effects of non-verbal intelligence (see next section) and PSTM. Typically, working memory capacity and non-verbal intelligence are positively correlated due to shared mechanisms related to executive functioning and attention allocation (Cowan, 2000). Mechanisms of working memory that are not shared with non-verbal intelligence pertain mainly to information storage. We found that after accounting for the effects of non-verbal intelligence, performance on the Reading Span task predicted not only vocabulary retention, but also learning outcomes for those aspects of grammar that were irregular and require memorisation, e.g., learning the gender of non-transparently gender-marked feminine Russian nouns such as pech’ [oven] which do not end in the suffix –a that characterises the majority of Russian feminine nouns in the citation (nominative) form (Kempe & Brooks, 2008; Kempe, Brooks & Kharkhourin, 2010). Thus, aspects of L2 learning that require memorisation such as individual vocabulary items or irregular grammatical forms benefit from higher working memory capacity.

Non-verbal intelligence, sequence learning and meta-linguistic awareness

As mentioned in the previous section, the positive correlation between working memory capacity and non-verbal intelligence is assumed to be due to a shared central executive component that controls the ability to allocate attentional resources to various components of a task. However, in addition to executive control functions, non-verbal intelligence tests also tap into something else, namely, the ability to notice and identify patterns in complex stimuli. For example, one widely used non-verbal intelligence test, Cattell's Culture Fair IQ test (Cattell & Cattell, 1973), requires individuals to detect patterns among sets of geometrical forms and then to find the correct continuation of each pattern in a set of response alternatives. We found that this ability to detect complex patterns is a powerful predictor for learning grammar over and above the effects of all other cognitive predictors mentioned thus far (Brooks, Kempe & Donachie, 2009; Kempe & Brooks, 2008; Kempe et al., 2010). Specifically, the ability to detect patterns benefits the learning of regular aspects of grammar, e.g., learning Russian gender categories and case marking from regular markings on noun endings. Crucially, only individuals scoring high on pattern detection were able to benefit from rich linguistic input comprising a sufficiently large database from which to extract regular patterns. Individuals who scored low on pattern detection actually experienced a deterioration of performance when exposed to rich, rather than restricted input (Brooks et al., 2006). Interestingly preliminary data suggest that regularity detection also facilitates identification of non-native phonological contrasts such as Norwegian tone differences (Kempe, Thoresen & Brooks, 2008).

In our most recent study (Brooks, Kempe & Donachie, 2009), we added auditory sequence learning (Misyak & Christiansen, 2007) as an additional predictor task. Over 30 minutes of listening time, participants were exposed to sequences of pseudo-words organised according to an artificial grammar. Subsequently, using a forced-choice procedure, participants were tested to see whether they could distinguish grammatical sequences of pseudo-words from ungrammatical ones. We found that both non-verbal intelligence and auditory sequence learning were positively correlated and contributed roughly equally to Russian grammar learning. Despite earlier claims that artificial grammar learning and non-verbal intelligence are not related (Reber, Walkenfeld & Hernstadt, 1991), this result is not surprising if one takes into account that both of these tasks require pattern detection, with non-verbal IQ tasks involving the detection of visual-spatial patterns and artificial grammar learning involving the detection of auditory patterns.

What is the mechanism by which the ability to detect regular patterns leads to successful learning of morphological and syntactic rules in an L2? At the end of our last study (Brooks et al., 2009), we asked participants what they had noticed about the Russian language after six language learning sessions. We coded their responses with respect to whether they had become aware of the underlying grammatical regularities, thus obtaining a measure of meta-linguistic awareness (e.g., reporting that 'All the nouns that ended in consonants added an –u in one context and an –a in the other.' indicated awareness of Russian gender and case marking). Meta-linguistic awareness of gender and case marking correlated positively with non-verbal intelligence and with auditory sequence learning. Most importantly, when we added meta-linguistic awareness to the set of cognitive predictors in a statistical model of grammar learning, it superseded all the other effects. This suggests that the better individuals are at detecting patterns of regularity, whether visual-spatial or auditory, the more likely they are to become aware of grammatical patterns in L2 input. Meta-linguistic awareness, in turn, drives the ability to generalise grammatical regularities to novel words. Moreover, meta-linguistic awareness was also found to be predictive of incidental vocabulary retention. We take this to mean that the more efficient individuals are at grammar learning, the more resources they have available for vocabulary learning. Thus, the well-established link between vocabulary size and grammatical abilities observed in L1 learning (Bates & Goodman, 1997) finds an interesting complement in L2 learning, which underscores the tight coupling between grammar and vocabulary acquisition.

Prior experience with other languages

When participants come to our lab to take part in one of our training studies, they have varying degrees of prior experience with L2 learning. We always carefully assess prior exposure to other languages and obtain self-ratings for all the languages an individual has previously studied. These data are then entered into the statistical models to control for prior L2 learning. This means that all the effects mentioned here have been obtained after effects of prior L2 learning have been taken into account. But looking at the effects of prior language exposure is interesting in its own right. We have found consistently that individuals try to transfer their knowledge from a previously learned language to the new language, and in some cases this may prove helpful while in other cases it may not. For example, those individuals who had studied Spanish or Italian, languages that also have a quite transparent system of gender-marking on the noun, benefited from this experience and were much more likely to learn the Russian gender categories and case marking (Kempe & Brooks, 2008), especially since these languages all share the same transparent feminine suffix –a. Nonetheless, the cognitive abilities described here contribute to L2 learning outcomes over and above the effects of prior language exposure.

Bringing it all together

We can briefly summarise the research on the cognitive mechanisms involved in adult L2 learning as follows: First, there is the ability to retain good-quality sequences of L2 phonological representations for short periods of time as a pre-requisite for transfer to long-term memory. This ability is especially important for the acquisition of new vocabulary: Individuals with superior ability for short-term retention of phonological information tend to be better vocabulary learners. Second, information storage capacity does not just affect the quality and durability of phonological representations but the ability to memorise other types of novel linguistic material as well. This is particularly important for learning aspects of linguistic structure that are irregular: Individuals with larger working memory capacity are better able to remember irregular aspects of linguistic structure. Third, the ability to detect patterns of regularity in the input is important for learning grammatical patterns, and, in turn, may free resources for vocabulary learning. Interestingly, the effect of pattern detection ability on grammar learning appears to be mediated by cognitive awareness: Individuals who perform better at non-linguistic tests that require pattern detection are also more likely to become aware of complex structural regularities in linguistic input.

It has been suggested previously that the somewhat vague concept of language learning aptitude might be decomposed into a set of underlying cognitive abilities like the ones considered here (Miyake & Friedman, 1998). Indeed, a well established test of language aptitude, the Modern Languages Aptitude Test (Carroll & Sapon, 1959), contains a number of tasks that, to varying degree, tap into the cognitive mechanisms described above. These tasks, however, often share underlying mechanisms like storage, attention allocation, or pattern detection, thus, making it difficult to assess the contribution of each cognitive mechanism. When statistical techniques are employed to disentangle the unique effects of these mechanisms, it turns out some of them are more relevant for some aspects of language learning than for others. These insights might promote a more nuanced view of individual differences in L2 learning: Rather than distinguishing between 'good' and 'bad' L2 learners in general, we may come to appreciate that some individuals may be more successful in some aspects of L2 learning, e.g., phoneme discrimination, than in others, e.g., grammar learning. Thus, a better understanding of how specific cognitive abilities support specific aspects of L2 learning may eventually enable learners to capitalise on their individual strengths and to find ways to compensate for their weaknesses.

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