The interface between research on individual difference variables and teaching practice: The case of cognitive factors and personality

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Abstract

While a substantial body of empirical evidence has been accrued about the role of individual differences in second language acquisition, relatively little is still known about how factors of this kind can mediate the effects of instructional practices as well as how empirically-derived insights can inform foreign language pedagogy, both with respect to shaping certain variables and adjusting instruction to individual learner profiles. The present paper is an attempt to shed light on the interface between research on individual difference factors and teaching practice, focusing upon variables which do not easily lend themselves to external manipulation, namely intelligence, foreign language aptitude, working memory and personality, with the role of the last of these in language learning being admittedly the least obvious. In each case, the main research findings will briefly be outlined, their potential for informing instruction will be considered, and, in the final part, the caveats concerning practical applications of research on the variables in question will be spelled out.

Keywords: individual differences; intelligence; foreign language aptitude; working memory; personality

1. Introduction

There have recently been several attempts to relate the findings of research into individual difference (ID) variables in the field of second language acquisition (SLA) to everyday foreign language instruction,[1] as superbly demonstrated, for example, in the book-length overviews by Gregersen and Macintyre (2014), or Williams, Mercer, and Ryan (2015), and pedagogical implications also tend to be included in volumes devoted to specific ID factors (e.g., Dörnyei & Kubanyiova, 2014; Oxford, 2011). Nevertheless, there is a clear need to take stock of what has thus far been accomplished in this respect, bring together some of the loose threads, and address the question whether, to what extent and in what ways such research could inform classroom practices. With this in mind, the present paper, intended as the first in a sequence of two dedicated to the consideration of practical applications of empirical investigations into selected ID variables, focuses on factors which are believed to be relatively stable, or, at best, malleable only to a minute degree in response to external manipulation, that is, *intelligence*, *foreign language* (FL) *aptitude*, *working memory* (WM) and *personality*. The conviction that these variables are by and large immune to pedagogical intervention originates in classical cognitive psychology, which views cognitive ID factors as latent traits, determined by genetic and environmental influences, with the contribution of the former having been much more thoroughly scrutinized and much more firmly confirmed (Jensen, 1997; Plomin, 1997; Plomin & Deary, 2015). Research into these factors, which are crucial in the process of L2 learning, has a long tradition in SLA (see Dörnyei, 2005, 2009; Dörnyei & Ryan, 2015; Ellis, 2008; Pawlak, 2012). By the same token, personality is also seen as a relatively stable and universal trait, determined by both genes and the environment (see McCrae & Costa, 2003), although its role in learning an FL is less obvious than, for example, that of aptitude. In what follows, first, general perspectives on the status of cognitive ID variables and personality in language learning will be considered and the ways in which the interface between research and everyday teaching practice can be approached will be highlighted. This will be followed by a more detailed discussion of this interface in the case of the ID variables in question, and the paper will close with an evaluation of the extent to which research on IDs has succeeded in informing language pedagogy as well as the consideration of the limitations of empirically-derived insights for successfully influencing language instruction in the classroom.

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[1] The terms *second* and *foreign* are used interchangeably in the present paper to refer to any language that an individual might be learning in addition to his or her mother tongue. The same caveat applies to the terms *acquisition* and *learning,* which are meant here to refer to the general process of gaining mastery of an additional language.

2. The role of cognitive factors and personality in SLA

Although IDs are considered to be influential variables affecting both the process of second language learning and the outcomes of this process, their status, understood in terms of their contribution to the outcomes of FL learning, is varied, and so is the amount of research devoted to them. Generally speaking, it is possible to identify in SLA theory and research several key hypotheses concerning cognitive IDs and personality traits. They could be summarized as follows:

1. Most IDs are heterogeneous constructs, composed of several factors, entering into intricate interactions, both with each other and with the environment (Dörnyei & Skehan, 2003; Robinson, 2002). The corollary of this characterization is that it would be unreasonable to assume that all the diverse ID factors, also such that are hypothesized to be constitutive components of a given variable (e.g., phonemic coding ability in the case of FL aptitude), can be put on a par with respect to their stability and trainability.
2. Different factors are relevant to different learning stages, skills and subsystems (cf. Robinson, 2002; Skehan, 2002), which means that learners can benefit from them to varying degrees under different instructional conditions, in various learning situations and while performing specific tasks in the classroom, also such that they are confronted with in the real world.
3. All the factors are in a constant flux, and they influence each other dynamically, with the effect that, in line with the tenets of dynamic systems theory, they should be seen as constellations of variables rather that single entities (see Dörnyei, 2005, 2009, 2010; Dörnyei & Ryan, 2015; Gregersen & MacIntyre, 2015; Larsen-Freeman & Cameron, 2008). What logically follows is that, for example, FL aptitude cannot be considered in separation from, say, motivation, since they are bound to remain in constant, dynamic interaction. In fact, empirical evidence for the existence of such interdependencies has been provided by neuroscience. For example, the neurotransmitter dopamine has been found to affect such attributes and processes as WM, language learning motivation and learning reinforcement, defossilisation, and the effectiveness of learning grammar (see e.g., Schumann, 2004; Wong, Morgan-Short, Ettlinger, & Zheng, 2012). Empathy, on the other hand, can be more relevant for pronunciation attainment at advanced stages of learning than WM (Hu et al., 2013).
4. Most people can succeed in FL learning, with success being interpreted in terms of the attainment of adequate levels of communicative ability, given that they manifest high motivation and have access to a conducive environment (e.g., copious opportunities for interaction in the target

language). Over the last several years, for example, evidence has accumulated that adept reliance on language learning strategies as well as self-motivation strategies can boost the effectiveness of the language learning process, even after the closure of critical or sensitive periods,[2] regardless of whether such strategies have been recommended by specialists, suggested by the teacher or developed by the learner himself or herself (Gregersen & MacIntyre, 2014; Moyer, 2013).

Broadly speaking, two tendencies can be recognized with respect to the theory-practice nexus in research on ID factors: (a) a qualitative/quantitative change due to training, and (b) aptitude-treatment interaction (ATI). The former pertains in the main to WM, which is considered to be the most trainable of cognitive IDs (Söderqvist & Nutley, 2015). The latter embraces the application of compensatory or matching approaches, aimed at, respectively, compensating for learners' weaknesses or adjusting instructional practices to their strengths, and it can be extended to other IDs, such as motivation, learning styles or learning strategies (Gregersen & MacIntyre, 2014). In other words, even if some factors appear to be stable and their modification is hardly feasible, teachers have at their disposal an array of other possible pedagogic interventions, which might involve matching learners' cognitive-affective profiles to instructional techniques, creating varied assessment criteria for learners depending on the level of their FL aptitude, raising students' awareness with reference to their strengths and weaknesses, or attempting to alter counter-productive, outcome-related attributions or beliefs (e.g., by changing causal ascription from lack of ability to lack of effort). These issues will be considered in more detail in the following sections in which the selected cognitive IDs and personality are dealt with separately.

3. Intelligence

The factor that has been most thoroughly examined in cognitive and genetic psychology and at the same time is the least amenable to pedagogic intervention is *intelligence*. It should also be noted at the outset that the contribution of this variable to the processes and outcomes of L2 learning has largely remained on the sidelines of SLA research. Following Sasaki's (1996) and Skehan's (1998) suggestions, intelligence is believed to affect only analytical abilities and be of little relevance for success in language learning. Evidently, this reasoning is based on limited and outdated evidence from 20 years ago, when a two-factor

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[2] Even though the concept of the critical or sensitive period is debatable in the field of SLA (e.g., Singleton, 2014), many researchers (e.g., Abrahamsson & Hyltenstam, 2008; Long, 2013) provide a substantial body of empirical evidence to confirm its significance.

approach to intelligence (i.e., verbal vs. nonverbal) prevailed. Moreover, in western education, which has been dominated by socialization theories (cf. Scarr, 1997), intelligence is a factor too often shamefully but at the same time conveniently swept under the carpet. This is undeniably a major oversight as this is a powerful variable encompassing a multitude of other cognitive IDs, which themselves correlate with one another. A contemporary definition of intelligence, offered by Plomin and Deary (2015), is as follows:

> Although there are many types of cognitive ability tests of individual differences, they almost all correlate substantially and positively; people with higher ability on one cognitive task tend to have higher ability on all of the others. Intelligence (more precisely, general cognitive ability or *g*, as discovered and defined by Spearman in 1904) indexes this covariance, which accounts for about 40 per cent of the total variance when a battery of diverse cognitive tests is administered to a sample with a good range of cognitive ability . . . Intelligence is at the pinnacle of the hierarchical model of cognitive abilities that includes a middle level of group factors, such as the cognitive domains of verbal and spatial abilities and memory, and a third level of specific tests and their associated narrow cognitive skills. (p. 99)

In view of such a characterization, an assumption that intelligence exerts no effect on adult FL learning outcomes becomes clearly untenable. Even though evidence has been mounting as to the heritability of this factor (cf. Plomin & Deary, 2015), there is still an ongoing debate in education between behavior-genetic theorists and socialization theorists (Scarr, 1997) concerning the persistent nature or nurture problem. Intelligence is undoubtedly not only the most often discussed ID (Sternberg & Grigorenko, 1997) but also such that arouses the most emotions. This is because, on the one hand, this factor is known to impinge on basically all aspects of life, including success in education and work, income, health, marriage and even a sense of happiness in life, but, on the other, it is also undemocratically distributed on account of the fact that it is for the most part genetically derived. The most radical genetic determinists, such as Jensen (1997), Plomin (1997), and Loehlin, Horn and Willerman (1997, the Texas Adoption Project) provide hard scientific data for the heritability of cognitive abilities. They claim that the heritability of the intelligence quotient (IQ) is approximately 70%, whereas other factors, such as socio-economic status, cultural background, parents' education and occupation or the number of books in the home, factors which are emphasized by socialization theory, account for no more than 10% of variation in intelligence (Jensen, 1997). Contrary to common assumptions, genetic effects increase rather than decrease with age, a phenomenon which is corroborated by a large body of evidence from twin, adoption and family studies. According to Plomin and Deary (2015), the heritability of

intelligence increases from about 20% in infancy to approximately 80% in later life. Although the family environment does have a significant effect, this applies only to children and the impact gradually lessens at an older age, to finally become of minor importance in adulthood. These results derive mainly from twin studies and have now been confirmed by the first new quantitative genetic technique, known as *genome-wide complex trait analysis* (GCTA), which is used to estimate genetic influence with the help of genome-wide genotypes in large samples of unrelated individuals (Plomin & Deary, 2015). What makes the situation even less optimistic is the fact that the available evidence suggests that fluid IQ cannot be trained and improved (Jensen, 1997; Plomin & Deary, 2015).

In accordance with the definition presented above, IQ is a general term which subsumes all other cognitive abilities, including those required for learning FLs, especially in instructional settings, and, therefore, all such abilities can be naturally expected to share the same characteristics as general IQ. From this perspective, teachers, educators and learners have two possibilities: They can either ignore factors which are uncontrollable anyway or try to find evidence for their pliability. Socialization theorists have adopted a mixed approach (Ceci, 1996; Sternberg, 2002; Sternberg & Grigorenko, 2000). Drawing on Vygotsky's (1978) sociocultural theory and his concept of the zone of proximal development, they claim that cognitive factors are highly flexible, with social conditions playing a major role in the process of cognitive development. The first psychologist who applied this theory to instructed SLA was Sternberg (1997, 2002) in his *triarchic theory of human intelligence*, which posits a dynamic, interactive nature of cognitive abilities. In his view, expertise is far more important than natural ability and cognitive factors tend to be overestimated in education. A similar stance is embraced by Dweck (2006) and Mercer (2012), who emphasize the contribution of the social and cultural context to SLA over that of congenital cognitive factors. Yet another convincing argument advanced by socialization theorists is that only part of human potential can be subjected to measurement (Ceci, 1996). This is because we have no access to the whole possible potential of a person, which makes it impossible to offer an ultimate prediction of what that person would be able to do if he or she were provided with conducive environmental conditions. According to Ceci (1996), heritability coefficients may be overestimated as they refer solely to the fulfilled genetic potential. On these grounds, constructivists (cf. Williams & Burden, 1997) argue that the impact of the environment on cognitive development surpasses the impact of genetic variation. This approach can surely be considered as more optimistic than the behaviorist-genetic one, since it allows the possibility of effective pedagogic intervention aimed at modification of intelligence-related factors. Consequently, it should perhaps come as no surprise that it is preferred by many researchers and practitioners in the field of SLA (e.g., Gregersen & MacIntyre, 2014).

In the field of education, Gardner's (1983) model of multiple intelligences has become extremely widespread and influential. Gardner suggests that traditional models of intelligence, assuming the existence of a general cognitive ability, should be abandoned and replaced with a set of independent multiple intelligences. His theory aims at identifying individual profiles of natural abilities which can be further developed while the weaker areas can be improved upon. Although severely criticized by cognitive psychologists for lacking scientific validity, this theory has gained immense popularity, particularly among educators and FL teachers. Nevertheless, it must be emphasized that nowadays most researchers representing various approaches and schools of thought accept the fact that some ID factors are highly heritable but, at the same time, extreme, all-or-nothing positions are typically avoided. Rather than emphasizing arguments against the existence of cognitive differences between people, the discussion has been revolving around the issue of efficacious pedagogic intervention with an eye to compensating for weaknesses in cognitive functioning, as well as raising awareness in this respect among both teachers and learners.

4. Foreign language aptitude

A cognitive factor that has attracted considerable attention from SLA researchers but has also generated a good deal of controversy is *FL aptitude.* This ID is a powerful variable, covering a number of cognitively-based learner differences, which explains the largest proportion of variation in the outcomes of FL learning among all IDs. FL aptitude is the strongest predictor of the rate of progress as well as high levels of achievement in learning an additional language after the closure of critical or sensitive periods (Doughty et al., 2010; Linck et al., 2013; Long, 2013). It is a complex, multi-faceted factor, which means that there is no single FL aptitude, but, rather, there exists a whole range of FL aptitudes which are included in the domain of cognitive IDs (see Abrahamson & Hyltenstam, 2008; Granena & Long, 2013; Robinson, 2002) and operate differently under various learning conditions. Thanks to major advances in the fields of SLA, cognitive psychology, genetics and neurolinguistics, the construct has been considerably updated and reconceptualized over the last two decades.

The contemporary concept of FL aptitude is based on the classical definition proposed by Carroll (1959, 1981). In Carroll's model, FL aptitude is described as a latent, innate, relatively stable trait, which is distinct from motivation and interest, and manifests itself only indirectly in the process of FL learning as well as in language performance. The construct includes four, fairly independent, subcomponents, that is: *phonetic coding ability*, *grammatical sensitivity*, *inductive language learning ability*, and *associative memory*. While Carroll (1981)

considered FL aptitude to be relatively fixed, he did not exclude the possibility of its development and modifiability. He suggested that aptitude measures in part reflect some kind of achievement because they depend to some extent on past learning. Carroll's view of the construct was restricted to the prediction of the rate of learning and did not pertain to the ultimate achievement in learning a FL. The four-component model of aptitude and the test constructed on its basis, the *Modern Language Aptitude Test* (MLAT; Carroll & Sapon, 1959), were points of reference for subsequent research endeavors in this area (Doughty, 2013; Doughty et al., 2010; Grigorenko, Sternberg, & Ehrman, 2000; Meara, 2005; Pimsleur, 1966; Robinson, 2002; Skehan, 1998; Tare et al., 2014).

Recently, FL aptitude has been operationalized as a set of cognitive abilities, which can be approached from the perspective of psycholinguistics and cognitive psychology. Within this approach, two influential conceptualizations of FL aptitude can be recognized, those proposed by Skehan (1998, 2002) and Robinson (2002, 2007). In Skehan's (1998) model, aptitude components are related to consecutive stages of information processing in SLA. He decided to merge Carroll's (1959) grammatical sensitivity and inductive language learning ability into *language analytic ability*, which is related to central processing. As regards phonetic coding ability and memory abilities, he saw them as corresponding to input processing, and output and fluency, respectively. An updated version of the model (Skehan, 2002) distinguishes four stages of SLA processing, namely *noticing*, *patterning*, *controlling* and *lexicalizing*. Robinson's (2002, 2007) model of FL aptitude consists of four *aptitude complexes*, including *primary* and *secondary abilities* that are differentially related to FL learning under different conditions. The *aptitude complex hypothesis* (Robinson, 2007) posits that some FL learners might possess strengths in abilities that are facilitative under specific learning conditions but prove to be ineffective in others. The ultimate aim of his approach is to "make predictions about how to optimally match learners to instructional options" (Robinson, 2007, p. 274), thus creating the most advantageous environments for specific learner abilities. Robinson opts for the application of various focus-on-form techniques as a means of pedagogic intervention in the performance of communication tasks (see e.g., Loewen, 2011, 2015, for a discussion of focus on form). Thus, for example, communicative practice of target language features is optimized according to learners' aptitude profiles when those more implicitly-oriented are exposed to recasts (i.e., corrective reformulations of erroneous utterances that retain their intended meaning; Robinson, 2002) in order to facilitate incidental learning, while those more analytically-oriented are provided with rule explanations with a view to catering to their preferred ways of processing. A comment seems to be in order at this juncture on the contributions of the two proposals. The major

strength of Skehan's (2002) model lies in the fact that it relates stages of SLA to FL aptitude components in a way which firmly situates the construct within mainstream SLA research. Robinson's (2002, 2007) model is consistent with the tenets of ATI (cf. Vatz, Tare, Jackson, & Doughty, 2013), and its main value concerns relating cognitive profiles of FL learners to different types of instruction. Both models give weight to WM, which reconceptualizes the original model of FL aptitude proposed by Carroll (1959) by adding extra abilities, such as noticing language forms in the input (see Section 5).

With regard to practical application of the theory of FL aptitude, as signaled in Section 2 above, two different approaches can be adopted, namely: (a) FL aptitude training intended to facilitate its development, and (b) ATI. The former has its roots in socialization theory. From this perspective, FL aptitude is considered to be dynamic, that is, it undergoes evolutionary development in interaction with the environment (cf. Sternberg & Grigorenko, 2000), and it is thus potentially modifiable rather than predetermined. Consequently, it is believed that this attribute can be shaped in the process of education (Sternberg, 2002). This idea is reflected, for example, in a method of testing proposed by Sternberg (2002), known as *dynamic testing*, during which learners are given ongoing feedback in order to improve their scores. Basing on this assumption, Grigorenko et al. (2000) developed an FL aptitude test, labeled the *Cognitive Ability for Novelty in Acquisition of Language* (CANAL-FT). All of this clearly demonstrates that Sternberg's model extends the research agenda by enriching the concept of FL aptitude with a dynamic, developmental dimension. In fact, in recent years, the questioning of aptitude as a fixed trait has intensified (see Singleton, 2014), especially since the development of a claim that WM, which is believed to be susceptible to the influence of experience and instruction (Gathercole, 2014), should be recognized as an important component of FL aptitude (Wen, 2016). A question also arises as to whether language aptitude and language experience or awareness are actually separable or whether they can be perceived as operating on the same continuum. As Singleton (2014) suggests, the instruments used to measure FL aptitude and language awareness seem to capture at least partly overlapping constructs.

The latter perspective, ATI, assumes that FL aptitudes should be matched to appropriate teaching methods. This approach is clearly represented by Robinson's (2002) model that has been described above. Researchers in the areas of SLA and FL pedagogy have been attempting to translate these theoretical proposals into classroom practice by, for example, identifying learners' cognitive profiles in order to uncover the best teaching method that would recognize their strengths and weaknesses. By matching learners to different types of instruction, researchers are able to determine whether or not a specific teaching technique is

beneficial and whether students with different profiles perform differently under varied learning conditions. One of the first attempts of this kind was Wesche's (1981) study in which learners representing different aptitude profiles, that is, analytically-oriented or memory-oriented, were matched with different instructional options. She indeed found that matching students' learning profiles to corresponding learning conditions contributes to better quality of learning (see Vatz et al., 2013, for a review of ATI research). Ranta (2008), in turn, suggests that students should first be explicitly taught a specific rule and only then participate in consciousness-raising tasks to become able to extract information about a structure from the communicative input. In the case of learners with weak phonological skills, Ranta proposes a *multisensory structured learning approach*, in which learners are given opportunities to simultaneously attend to sound-spelling relationships, morphology and syntax, using all their senses and different modalities.

Admittedly, all of these ideas have mainly remained in the sphere of theory and have never been empirically verified to the extent that would allow offering a set of reliable and at the same time feasible pedagogical proposals (cf. Ranta, 2008). A rare example of a practical illustration of how different IDs can be shaped or at least taken advantage of is the volume by Gregersen and MacIntyre (2014), who offer a wide array of hands-on activities related to all major ID variables, including FL aptitude. More specifically, drawing upon Skehan's (1998) theory, the authors present activities that can be deployed to improve learners' skills required for the four stages of noticing, patterning, controlling and lexicalizing. In more general terms, Gregersen and MacIntyre (2014) stress the importance of individualization of instruction through task-based learning in groups. Following Cook's (2001) and Ranta's (2008) reasoning, they recognize two principles that have been identified in the literature, namely *matching* versus *compensatory*. The matching principle is in line with Robinson's ATI approach as it suggests that teaching should accommodate the strengths of the learner to increase his or her chances for success, while the compensatory principle, reflecting Skehan's (2002) position, holds that instructional practices should have as their aim compensating for learners' weaknesses. For instance, explicit grammar instruction could be used either to capitalize upon learners' strong analytical skills, which would indicate reliance on the matching principle, but it could also be employed as a means of remediation with a group of learners with lower analytic skills, in which case the compensatory principle would come to the fore. Gregersen and MacIntyre (2014) also recommend awareness-raising activities aimed at identifying learners' individual aptitudinal profiles by "matching some tasks to their strengths and compensating for limitations in others" (p. 86) according to Vygotsky's (1978) zone of proximal development.

Clearly, it is ultimately the teacher's decision which principle he or she chooses to follow, the matching or compensatory one.

In accordance with ATI principles, some efforts have recently been made to investigate the relationship between different types of input or interaction and specific aptitude profiles, which can be seen, for example, in the realm of grammar instruction. Li (2015a) reports 16 interactional studies that have examined the interface between aptitude and the effectiveness of various instructional treatments. The results of the studies are often contradictory as to the effectiveness of implicit versus explicit type of feedback (Sheen, 2007; Trofimovich, Ammar, & Gatbonton, 2007) and the role of the learners' proficiency level as a variable mediating the benefits accruing from different types of feedback (Li, 2009). Li (2015b) presents the results of his study examining the relationship between the effectiveness of recasts, as moderated by IDs in analytical ability and WM in learners at different stages of L2 development. Although learners representing both low and high proficiency levels appeared to benefit equally from recasts, it turned out that the less proficient students relied more on analytical ability, whereas advanced ones were more likely to draw upon WM. Li (2015b) concluded that WM and analytical ability are sensitive to L2 learners' proficiency and feedback type, thereby offering new insights into the role of the ATI approach, as is evident in the following comment: "The results afford further evidence against an eclectic approach to language teaching/learning . . . and underscore the importance of tailoring instruction to cater to learners at different stages of L2 development" (Li, 2015b, p. 156). Similarly to Ranta (2008) and Gregersen and MacIntyre (2014), Li suggests that explicit instruction coupled with metalinguistic explanation is more appropriate for beginners, especially those with poor analytic ability, whereas more advanced learners, who are likely to depend more on WM capacity, may benefit from memory strategies which can aid them in processing and retrieving new information as well as reconceptualizing old information. Some work on ATI has been done as well in the case of pronunciation, a good example being the research project by Perrachione, Lee, Ha, and Wong (2011), who explored the interaction between learners' perceptual ability and training of non-native phonological contrasts in an input-variation study. The general conclusion was that different kinds of input, that is such characterized by high as opposed to low variability, can have a differential effect on learners manifesting different levels of phonological aptitude.

Tare et al. (2014) and Doughty, Clark, Cook and Tare (2013) elaborate on cognitive IDs, the knowledge of which can be useful in creating learners' profiles, thus further informing FL pedagogy in general and possibilities for suitable training in particular. They emphasize both the need to recognize learners' cognitive profiles and the necessity of ensuring on that basis optimal instruction conditions.

Doughty and her team developed a battery of tests, known as *High-Level Language Aptitude Battery* (Hi-LAB; Doughty et al., 2010), which can be used to predict the ultimate success of adult language learners in reaching high levels of proficiency in an FL. From this perspective, FL aptitude is defined as "a student's ceiling on language ability, or the highest level that an individual is likely to achieve" (Tare et al., 2014, p. 6). The test taps into the following constructs: *executive functioning* (i.e., WM, inhibitory control, task-switching), *rote memory*, *perceptual acuity*, *processing speed*, *primability*, and *implicit and explicit induction*, with the researchers offering pedagogical recommendations related to all these (Tare et al., 2014). For example, since learners with low scores for rote memory have difficulty in learning words and phrases out of context, they may not be able to learn long lists of items. Such learners may benefit from focusing on discovering word meaning, building associations for new vocabulary via tasks in the target language, or being exposed to visually enhanced input. By contrast, in the case of students who score high on this construct and are thus able to learn decontextualized words, recommended techniques include the use of flashcards, translations or activities involving learning chunks of language. When it comes to learners who exhibit an aptitude for explicit learning, they are likely to benefit from direct, explicit grammar instruction, learning by induction and metalinguistic explanation. On the other hand, for those less explicitly-oriented, who are not good at extrapolating rules, a more traditional, deductive approach is advised, in which structures are first explained and only then applied. As regards learners endowed with high implicit learning ability, they tend to exhibit a preference for coping with complex or unfamiliar language in rich context rather than be taught explicitly. For this group, the best solution is to avoid explicit presentation of rules and to ensure instead a variety of language examples in context. Thus, implicitly-oriented learners can benefit from exposure to input, which can take the form of extensive listening and reading, meaning-based tasks as well as the provision of recasts in the course of message communication.

5. Working memory

Working memory is now probably the most often studied ID factor in various fields, including cognitive and developmental psychology, neuroscience and SLA. A contemporary definition of WM is offered by Bunting and Engle (2015): "A convenient analogy for working memory is to think of it as the mental workspace of the mind: The small amount of memory that holds information and the capacity for attention control to manipulate that information for ongoing use" (p. xvii). As far as the relationship between WM and SLA is concerned, the studies conducted to date have addressed all target language skills and subsystems,

different levels of proficiency and ultimate attainment, as well as different aspects of bilingualism, with WM having been found to act as an influential factor across all these areas (e.g., Biedroń & Szczepaniak, 2012; DeKeyser & Koeth, 2011; Doughty et al., 2010; Juffs & Harrington, 2011; Kormos & Sáfár, 2008; Linck et al., 2013; Linck, Osthus, Koeth, & Bunting, 2014; Miyake & Friedman, 1998; Robinson, 2003; Sawyer & Ranta, 2001; Skehan, 2015; Wen, 2015, 2016; Wen & Skehan, 2011). WM as a construct composed of four subsystems, that is *phonological loop*, *central executive*, *visuospatial sketchpad* and *episodic buffer*, was first conceptualized by cognitive psychologists Baddeley and Hitch (1974) and Baddeley (2000). Subsequently, the concept gradually began to enter the field of applied linguistics to finally become an integral part of the dominant models of FL aptitude (Robinson, 2002; Skehan, 2002), and it is now proposed as a new FL aptitude (Wen, 2015, 2016; Wen, Biedroń, & Skehan, in press; Wen & Skehan, 2011).

The discussion of WM usually revolves around its limited capacity, which is bound to constrain cognitive performance. To be more precise, individuals with greater WM capacity perform better on a variety of cognitive tasks, including, among others, complex learning, reading and listening comprehension, grammar and vocabulary learning, than those with smaller WM capacity. Therefore, in the words of Skehan (2015), the problem is "how these limitations can be minimized or circumvented" (p. 200), and finding a solution to this challenge constitutes one of the main objectives of FL teaching practice. Unfortunately, we still do not know which components of WM affect what aspects of language learning, which severely curtails the potential for pedagogical intervention. Two components of WM, namely the phonological loop and the central executive, are considered to be the most vital for this process. The first is a temporary verbal-acoustic storage system, whereas the other is a system responsible for attentional control of WM. Drawing upon the available empirical evidence, Wen (2015) makes an attempt to relate the phonological loop and the executive components of WM to specific aspects of language subsystems as well as SLA processes. Thus, he suggests that the phonological loop underlies language learning in the domains of lexis, formulaic sequences and morphosyntactic constructions, while the executive component plays a role in monitoring and attention-related processes, such as comprehension, interaction and production. In fact, the latter seems to be of particular importance to SLA, and, given its high correlation with verbal intelligence (Engle, Laughlin, Tuholski, & Conway, 1999) and learning outcomes in general, it seems to be implicated in more processes than researchers have been able to establish so far (Baddeley, 2015). Still, as has already been mentioned, there are numerous controversies surrounding WM and contradictory research findings abound, often due to the application of inconsistent research methodologies (Wright, 2015). On the whole, although it is evident that

learners with more capacious WM exceed in language learning, and that enhancement of WM translates into better learning outcomes, there are still many doubts concerning the nature of this relationship. One such controversial area is the contribution of WM to grammar learning. While many studies (e.g., Fortkamp, 2003; Juffs, 2015; Linck et al., 2014; Martin & N. Ellis, 2012; Williams & Lovatt, 2003) provide evidence for a complex relationship between WM capacity and learning grammar structures, the executive component is definitely more strongly implicated in grammar development than the phonological loop (see Linck et al., 2014).

There is copious evidence that the efficacy of various types of instruction, including the provision of corrective feedback, is moderated by WM. Such instructional options as explicit explanation, input flooding, input enhancement, negotiation for meaning or recasting may be more or less efficient for specific learners, depending, among others, on the capacity of WM. For example, recasting, which is a popular technique in the focus-on-form approach (see Ellis, Basturkmen, & Loewen, 2002; Loewen, 2011, 2015), depends on noticing ability, and, thus, its utility may be limited in the case of learners endowed with low WM capacity (e.g., Goo, 2012; Mackey, Philip, Egi, Fujii, & Tatsumi,2002). Noticing the gap is one of FL aptitude factors, defined as aptitude for learning from recasting, in which the learner is supposed to learn from becoming aware of the difference between the recast and his prior, erroneous utterance, thus being able to make the requisite internal comparisons (Robinson, 2007, p. 274). As Tare et al. (2014) suggest, implicit feedback in the form of recasts is suitable for learners with high WM abilities because "they are able to notice various language aspects while performing a language task, while those with low working memory may need more explicit feedback prior to, during, or after the task" (p. 14). Other types of instruction appropriate for learners with high WM ability include online tasks performed in real time (e.g., interpretation, listening comprehension), discussions of cognitively complex topics, tasks with no planning time, interactive tasks, or learning words from context. All these activities are unsuitable for low WM capacity learners who benefit from more scaffolding and tasks which are less cognitively demanding. This is because such learners need more time for planning, the inclusion of pre-task activities as well as more repetitions.

Analogically to FL aptitude, there are two approaches to WM in language instruction (Williams, 2012), namely: (a) manipulation aimed at increasing L2 learners' WM capacity (Söderqvist & Nutley, 2015), and (b) modification of instruction to suit L2 learners' cognitive WM profile (Skehan, 2012). It should also be borne in mind that the two components of WM discussed above require adequate pedagogical intervention. This means that educators have to start with identification of learners with poor WM, decide which components are problematic,

and apply proper, individualized training. There is a large body of empirical evidence showing that deficits in both the phonological store and attentional system severely impair language learning (Gathercole, Lamont, & Alloway, 2006), and that these deficits can be leveled out to some extent thanks to adept pedagogic intervention (Gathercole 2014; Gathercole & Alloway, 2008; Holmes & Gathercole, 2014; Söderqvist & Nutley, 2015). Gathercole and colleagues have provided evidence that skillful training in the case of young children whose general academic performance is severely affected by poor WM produces considerable and sustained results. This means that WM is a cognitive ID variable that is the most susceptible to improvement (Dehn, 2008; Gathercole, 2014; Gathercole & Alloway, 2008; Klingberg, 2010; Söderqvist & Nutley, 2015).

Because individualization of the learning process may be an unrealistic prospect for many teachers due to different limitations (e.g., scant classroom time, difficulty in identifying learner profiles, challenges of preparing different sets of materials), it seems advisable for them to encourage parents and learners to train WM with the use of special computer programs, all the more so that numerous websites exist which help students develop their WM skills. Neuroscientific data from studies conducted at Karolinska Institute in Sweden indicate plasticity of the areas of the brain responsible for WM capacity. An impressive number of 55 original research studies published in peer-reviewed journals demonstrate that WM could be trained to enable more and higher quality information processing (see Söderqvist & Nutley, 2015 for an overview). Overall, the research findings testify to sustained improvement in WM capacity from childhood to adulthood, durable gains in attention, enhanced functioning of low-performing learners in math and reading, as well as better functioning of individuals with attention deficit hyperactivity disorder (ADHD). Moreover, improvement in WM capacity has been shown to be mirrored by changes in brain functioning. The improvement of WM resulting from the application of a popular commercial WM training program is supported by 25 controlled studies and has been validated by independent meta-analyses (Cortese et al., 2015; Melby-Lervåg & Hulme, 2013; Spencer-Smith & Klingberg, 2015). The reported increase in WM capacity is truly impressive: an average 26% in visuo-spatial WM and 23% in verbal WM, as compared to the control groups (Söderqvist & Nutley, 2015). It is perhaps not surprising that these results have triggered doubts concerning their reliability. To quote from the report:

> The fact that WM is proven to be malleable with practice is a groundbreaking finding, which has caused some resistance and controversy in the academic world of psychological theory in which WM capacity had traditionally been viewed as a fixed trait. (Söderqvist & Nutley, 2015, p. 6)

A number practical tips as to how WM can be exercised and enhanced as well as tasks that can be applied for this purpose can be found in Gregersen and MacIntyre (2014, pp. 72-73). Firstly, students with poor WM capacity should be identified, with the warning signs including, among others, inadequate recall, persistent inability to follow instructions, difficulty in keeping pace and failure to complete the set tasks. These problems are likely to stem from WM capacity overload, which can be minimized by limiting the amount of learning material, increasing the meaningfulness of the language input, and reorganizing complex tasks. The authors propose different means of pedagogic intervention, which could entail activation of relevant schemata, an increased number of repetitions of key information, as well as reliance on memory aids, such as, for example, realia, wall charts or audio-recordings. They also suggest falling back on multi-modal support, with the use of visualizations (Hummel & French, 2010), and various technical aids, such as multi-media or computer-assisted language learning. Finally, Gregersen and MacIntyre (2014) emphasize the role of strategies-based instruction that would aim at the development of individualized repertoires of strategies aiding the transfer of the relevant information from WM to long-term memory and the other way around, as well as subsequent retrieval (e.g., note-talking, requesting assistance or organizing the learning process).

6. Personality

As far as *personality* factors are concerned, there are several firmly established taxonomies in psychology, which view the main traits, that is agreeableness, conscientiousness, extraversion/introversion and neuroticism as separate, universal and replicable factors that can be found in all societies and cultures of the world (McCrae & Costa, 2003). Although their impact on human behavior, including the outcomes of education, is well-established in the field of psychology, there is no convincing evidence that they correlate, whether positively or negatively, with success in learning FLs (see Dörnyei, 2005; Robinson & Ellis, 2008). One possible reason for this may be their general and universal nature. As is the case with intelligence, analyses of twin, adoption and family studies provide robust and consistent evidence for both genetic and environmental contributions to personality, with the latter being far more difficult to detect and measure (Bouchard & McGue, 2002). Most likely, personality factors interact with cognitive variables and with success in learning FLs in a non-linear way, constituting interactions and relationships that are complex, dynamic and thus difficult to capture in research studies (Dörnyei, 2005). This is not to say, however, that such a link has not been demonstrated in SLA. For example, empirical evidence for the impact of personality has emerged from research on multilingualism (Dewaele,

2009, 2011; Ożańska-Ponikwia, 2011; Ramirez-Esparza, Gosling, Benet-Martínez, Potter, & Pennebaker, 2006) as well as studies of high levels of attainment (Biedroń, 2011; Forsberg Lundell & Sandgren, 2013; Hu & Reiterer, 2009). An increasingly important role is ascribed to empathy, which has been found to affect success in learning pronunciation (Hu et al., 2013; Rota & Reiterer, 2009) and to highly correlate with FL aptitude (Forsberg Lundell & Sandgren, 2013). What is interesting, the boundary between affect and cognition is blurred in contemporary psychology. In fact, there is copious evidence for intelligence-personality associations in this domain (e.g., Asendorpf, 2014; Von Stumm, 2014), which might suggest that future SLA research should focus to a much greater extent on the interface between cognition and affect, somewhat in line with Dörnyei's (2005) pronouncement that "examining the *combined effect* or *interrelationships* of personality traits and other ID variables may also yield meaningful insights" (p. 30). What is more, teachers intuitively know that much of their students' learning and their response to particular instructional tasks are underpinned by personality factors. Shy and introverted students, for example, may be less willing to communicate than extrovert and risk-taking ones, while analytical and conscientious learners are likely to do well in a traditional classroom.

It is one thing, however, to be intuitively aware of the contribution of personality traits or even to prove empirically that they mediate the effects of specific instructional activities or determine the choice of language learning strategies, and quite another to employ pedagogical intervention in this area. For one thing, it is difficult to decide what the overall aim of such an intervention should be because it is clear that, even if this were possible, language teachers should not strive to change the personalities of their learners, however desirable such changes might seem in some situations. It would thus seem that the practical application of the results of research on personality are restricted and could perhaps take the form of individualization, awareness-raising, application of varied activities that would cater for different personality traits, and encouraging learners to perform tasks that may not be fully compatible with their personality profiles. With respect to individualization, although such an approach is feasible in one-on-one tutoring or in very small groups of learners, it poses a major challenge in a class of 20 or 30 students for the reasons already mentioned above, and therefore it is highly unlikely to assume the status of a regular instructional practice. Much easier to implement is awareness-raising, which, as Gregersen and MacIntyre (2014) note with regard to learning styles, applies in equal measure to learners and teachers. This could be achieved, for example, by having students fill out simple surveys on personality available on the Internet but also by means of tools intended to tap into learning style preferences, such as the *Learning Style Survey* (Cohen, Oxford, & Ci, 2001), as they also incorporate personality

dimensions. Armed with requisite knowledge about themselves and their learners, teachers will find it easier to ensure variety in the sense that the learning tasks employed will take into consideration the various personality traits represented by students in a particular class. On the one hand, this will ensure a certain degree of *matching* instructional options to the profiles of specific learners, but, on the other, it will also encourage what could be referred to as *personality stretching*, as some activities are bound to force learners to engage in the kind of learning that goes against predominant personality traits (Gregersen & MacIntyre, 2014; Oxford, 1999, 2003). This having been said, it should be emphasized that being too adamant about getting learners to leave their personality-related "comfort zones" (Ehrman, 1996) may backfire, because not only is it unlikely to be effective, but it could also alienate some students, producing negative consequences for motivation, willingness to communicate or anxiety levels.

7. Conclusion

The aim of the present paper has been to consider the extent to which the findings of research into cognitive variables in SLA, such as intelligence, FL aptitude and WM, as well as personality traits, all of which can be regarded as difficult to manipulate through pedagogic intervention, can be applicable to classroom practice. On the face of it, as demonstrated with respect to all the factors in question, the available empirical evidence offers important insight into the contribution of these ID variables, sometimes providing a basis for suggesting concrete solutions that teachers could fall back upon to assist their learners. After all, there are certainly ways in which practitioners could employ the matching or compensatory options by trying to emphasize their learners' strengths and resorting to remediation to offset the negative effects of their weaknesses, try to build upon the dominant intelligences or hone those that are somewhat lacking, get learners to use the available software to expand their WM capacity, ensure that students are cognizant of their ID profiles or implement a modicum of variety which would at the same time involve a certain degree of matching, compensation and stretching. This is certainly the position adopted by Gregersen and MacIntyre (2014), who comment with reference to cognitive abilities: "Although they may be somewhat stable features (perhaps in specific domains), we believe that cognitive abilities and attentional variables can be changed or manipulated through instruction and experience" (p. 79). While the activities included in their book indeed demonstrate that teachers can do a lot to manipulate the ID factors discussed in this paper, there are grounds to temper our optimism in this respect for several reasons. First, as was made clear in the current discussion, the research findings are still patchy and at times contradictory, with

the effect that the exact role of, say, different components of FL aptitude or WM, is far from clear. Second, there is still a paucity of research that would shed light on the way in which the factors in question mediate the effects of specific instructional techniques or such that would examine the effects of training, and empirical evidence of this kind is certainly needed if reliable pedagogical proposals are to be offered. Third, irrespective of what the research findings reveal, a question arises as to the extent to which teachers can capitalize on such insights with respect to intelligence, FL aptitude, WM or personality, for the simple reason that they lack the necessary expertise and tools to tap these IDs, their judgments are bound to be intuitive and thus often inaccurate, and these constructs as such may seem far removed from the realities of the classroom. Fourth, there are many practical reasons which may cause teachers to shy away from implementing pedagogic intervention, such as the lack of time, the need to achieve curricular goals, focus on exam requirements, the additional burden of preparing extra materials that would cater to individual learner profiles, the unfeasibility of individualization in large classes, or simply resistance and lack of interest on the part of students. All of this should not be taken to mean that practitioners had better do nothing to respond to various cognitive and personality profiles, but, rather, that consistent research findings are indispensable as a basis for clear-cut and feasible pedagogical implications that could guide teachers in their efforts to effectively develop some abilities or adjust their instructional practices in such a way that individual learner variation with respect to intelligence, FL aptitude, WM and personality becomes an asset rather than a liability.

Acknowledgements

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