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Cross-linguistic and cross-cultural effects on verbal working memory and vocabulary:

Testing language minority children with an immigrant background

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**Abstract**

*Purpose* – This study explored the impact of test language and cultural status on vocabulary and working memory performance in multilingual language minority children.

*Method* – Twenty 7-year-old Portuguese-speaking immigrant children living in Luxembourg completed several assessments of first- and second-language vocabulary (comprehension and production), executive-loaded working memory (counting recall and backward digit recall), and verbal short-term memory (digit recall and nonword repetition). Cross-linguistic task performance was compared within individuals. The language minority children were also compared with multilingual language majority children from Luxembourg and Portuguese-speaking monolinguals from Brazil without an immigrant background matched on age, sex, socioeconomic status, and nonverbal reasoning.

*Results* – Results showed that (a) verbal working memory measures involving numerical memoranda were relatively independent of test language and cultural status; (b) language status had an impact on the repetition of high- but not on low-wordlike L2 nonwords; (c) large cross-linguistic and cross-cultural effects emerged for productive vocabulary; (d) cross-cultural effects were less pronounced for vocabulary comprehension with no differences between groups if only L1-words relevant to the home context were considered.

*Conclusion* – The study indicates that linguistic and cognitive assessments for language minority children require careful choice among measures to ensure valid results. Implications for testing culturally and linguistically diverse children are discussed.

## **Introduction**

International migrations have led to an increasing number of children growing up with immigrant origins speaking several languages (OECD, 2010; U.S. Census Bureau, 2004). Immigration and multilingualism are important factors to consider in language testing for both clinical and research settings. Many linguistic and cognitive tasks have been found to be reliable and valid measures if applied in the first language to native speakers from a dominant cultural group. What remains less clear is whether these same tasks provide an accurate indication of ability if given in a non-native language to participants from a minority culture. The main purpose of the present study was to explore performance of language minority children on a range of widely used vocabulary and verbal working memory tasks.

When assessing an immigrant child in a non-native language, clinicians are faced with the obvious challenge of adequately interpreting the resulting test scores as the observed behaviour can not easily be compared to the norms established on his/her majority culture peers. Currently there are a lack of diagnostic tools that allow practitioners to distinguish between language differences related to the environmental context of growing up as a multilingual immigrant and language impairments of a neurolinguistic origin. The identification of primary or specific language impairment (SLI) is particularly challenging in polyglots (Nation, Clarke, Marshall, & Durand, 2004; Spaulding, Plante, & Farinella, 2006; Windsor, Kohnert, Lobitz, & Pham, 2010). Standardized tests are generally biased in favour of individuals from the majority culture for whom the test language is native. Many immigrant children's language problems therefore go misdiagnosed with intervention programs often focusing on poor academic achievement more generally (Girbau & Schwartz, 2008).

A large body of research findings indicate that working memory and language learning are related (see Baddeley, 2003 for a review). Working memory is a cognitive system that

temporarily holds and manipulates information over brief periods of time in the course of ongoing cognitive activities. It has been described to consist of domain-general executive processes that coordinate and direct attentional resources and of domain-specific short-term memory systems (Baddeley, 2000; Cowan, Elliott, Saults, Morey, Mattox, Hismjatullina et al., 2005; Engle, Tuholski, Laughlin, & Conway, 1999). Verbal short-term memory has been found to play a key role in supporting vocabulary acquisition in native and foreign languages (Engel de Abreu, Gathercole, & Martin, 2011; Gathercole, Willis, Emslie, & Baddeley, 1992; Majerus, Poncelet, Greffe, & Van der Linden, 2006; Masoura & Gathercole, 2005; Papagno, Valentine, & Baddeley, 1991; Service, 2006). Executive processes of working memory have been shown to make important contributions to higher-order linguistic abilities including language comprehension and word decoding (Cain, Oakhill, & Bryant, 2004; Engel de Abreu & Gathercole, 2012, Engel de Abreu et al., 2011; Kail & Hall, 2001). Recent findings indicate that SLI is marked by a deficit in both verbal short-term memory and executive-loaded working memory tasks (Archibald & Gathercole, 2007; Henry, Messer, & Nash, 2012).

There is some evidence suggesting that a subset of working memory measures are independent of significant environmental factors such as socioeconomic status, whereas norm-referenced assessments of language appear to be strongly influenced by an individual's social background. Engel, Santos, and Gathercole (2008) compared children from impoverished and wealthy families in Brazil and did not find significant differences between the groups on verbal short-term memory and executive-loaded working memory tasks involving digits. However, large group differences emerged on experience-dependent measures of vocabulary (see also Campbell, Dollaghan, Needleman, & Janosky, 1997 and Ellis Weismer, Tomblin, Zhang, Buckwalter, Chynoweth, & Jones, 2000). Whereas most language measures rely on crystallized knowledge that depends on acquired skills and

experience, working memory tasks emphasize processing and storage of new information and, may therefore, not confer the same advantages or disadvantages as crystallized assessments to individuals with differing prior knowledge.

Although processing-dependant working memory measures are thought to primarily tap into fluid abilities (Conway, Cowan, Bunting, Theriault, & Minkoff, 2002; Engel de Abreu, Conway, & Gathercole, 2010; Engle et al., 1999), they are likely to secondarily reflect domain-specific processes that rely on long-term memory support. It is now clearly established that working memory performance is influenced by the knowledge base for the to-be-remembered material. In the verbal domain, individuals present an advantage in recalling words over nonwords (Gathercole, Frankish, Pickering, & Peaker, 1999; Hulme, Maughan, & Brown, 1991), high-wordlike over low-wordlike nonwords (Gathercole, 1995; Gathercole et al., 1992), and emotion words over neutral words (Majerus & D'Argembeau, 2011). These psycholinguistic effects indicate that long-term phonological and lexico-semantic knowledge can impact verbal working memory tasks and that caution needs to be taken when interpreting performance on these measures, particularly for children for whom the lexical knowledge base is poorly developed. Low scores on verbal working memory tasks might reflect, in part at least, weak long-term lexical support.

Most studies comparing vocabulary performance of bilinguals and monolinguals conclude that bilinguals know fewer words in one of their languages than comparable monolingual speakers (see Bialystok, 2001 and Bialystok, Luk, Peets, & Yang, 2010 for reviews). The experience of living with several languages reduces the frequency of exposure to a particular language which might impact bilinguals' performance on linguistic tasks (Gollan, Fennema-Notestine, Montoya, & Jernigan, 2007; Grosjean, 2010). Furthermore, bilinguals activate both their languages during speech production, reducing the efficiency with which words from either one of the languages can be retrieved (Bialystok, Craik, & Luk,

2008; Costa, Roelstraete, & Hartsuiker, 2006; Gollan, Montoya, Fennema-Notestine, & Morris, 2005). It should be considered, however, that bilinguals generally acquire their languages in different contexts and are likely to develop different vocabulary content for each language with some areas of complementary knowledge across languages (Genesee & Nicoladis, 1995; Grosjean, 2010; Namazi & Thordardottir, 2010; Pearson, Fernández, & Oller, 1993; Umbel, Pearson, Fernandez, & Oller, 1992). In a recent aggregated analysis combining data from 1,738 children, Bialystok and colleagues (2010) found that despite a general bilingual disadvantage in vocabulary comprehension in the language of schooling, differences between bilinguals and monolinguals were less pronounced for vocabulary items related to the school, rather than the home context.

### **The present study**

This study investigates whether measures of working memory, that comprise linguistic processing, are affected by the language of test administration and the cultural and linguistic background of the child. A particular interest was to contrast the effects of linguistic background on verbal working memory tasks to respective effects on measures of vocabulary knowledge. The study also explored whether cross-linguistic and cross-cultural proficiency in vocabulary varies as a function of modality (comprehension or production) and type of lexical item (home or school).

The study involved a population of Portuguese language minority children living in the Grand-Duchy of Luxembourg. Luxembourg is a trilingual country: Luxembourgish, German, and French are recognized as official languages but only Luxembourgish bears the status of national language and is the main language spoken throughout the country. The Portuguese speaking community represents by far the largest immigration group in the Grand-Duchy (16% of the country's total population). In the Luxembourgish educational system, German is taught as a second language in the early elementary school years, and together with

Luxembourgish, used as medium of instruction (see Engel de Abreu & Gathercole, 2012 for a detailed description of Luxembourg's language context). The Portuguese-speaking language minority group was carefully matched with language majority speakers of Luxembourgish from the same multilingual classrooms and with monolingual speakers of Portuguese from Brazil. A series of important methodological points were taken into account to yield accurate and valid results: Firstly, attention was paid to assess a relatively homogeneous group of language minority children with a similar language and migrant history and to control for potential confounding factors such as age, socioeconomic status, gender, and nonverbal reasoning. Secondly, the working memory measures were based on the two major languages of the language minority children (Portuguese and Luxembourgish). Thirdly, the lexical knowledge of the immigrant group was explored by considering performance on their single-language measures as well as the total vocabulary across all their languages (Portuguese, Luxembourgish, and German).

Vocabulary was assessed with the Expressive One Word Picture Vocabulary Test (EOWPVT; Brownell, 2000) and the British Picture Vocabulary Scale (BPVS-II; Dunn, Dunn, Whetton, & Burley, 1997). Both measures assess knowledge of a specific set of lexical items that cover a wide range of topics and contexts and are widely used in the literature to test children's vocabulary production and comprehension (Archibald & Gathercole, 2006; Munson, Kurtz, & Windsor, 2005; Webster, Majnemer, Platt, & Shevell, 2004). Since the language minority children primarily use Portuguese at home and Luxembourgish and German at school, it is likely that certain portions of their vocabulary are selectively covered by their home or their school languages (Bialystok et al., 2010). An item analyses was therefore conducted in order to establish whether the words being tested affect performance, and to provide a preliminary evaluation of potential vocabulary differences between home and school languages.

Two factors were taken into account in the choice of the working memory tasks: First, children with SLI have been found to present particular difficulties in tasks that draw on processing and storage skills in the verbal domain (Ellis Weismer, Evans, & Hesketh, 1999; Marton & Schwartz, 2003). Second, long-term lexical knowledge has been identified as a critical determinant of verbal working memory performance (Gupta, 2003; Majerus, 2009). As one major objective of this research was to identify culture-fair assessment tools for language minority children that are clinically relevant, the study focused on verbal working memory tasks involving familiar lexical items (i.e. digits). Number words are generally acquired at an early age (Gathercole & Adams, 1994; Wynn, 1992); tasks involving digits might therefore be equally familiar to all children and consequently be less sensitive to verbal long-term memory effects. The study also explored performance on nonword repetition across languages. Nonword repetition was selected because of its consistent association with vocabulary size (see Gathercole, 2006 for a review) and its suggested clinical relevance in assisting the diagnosis of SLI (Bishop, Adams, & Norbury, 2004; Ellis Weismer et al., 2000).

Substantial debate exists in the literature on whether nonword repetition should be regarded as a verbal working memory or a language task (Edwards & Lahey, 1998; Snowling, Chiat, & Hulme, 1991). As the phonological form of a nonword is unfamiliar, it has been argued that children have to rely on verbal short-term storage to encode and maintain the novel phonological sequence. Nonword repetition was originally conceived as a pure measure of verbal short-term memory, however, it has become increasingly clear that lexical and sublexical knowledge exerts a strong influence on nonword repetition especially if the nonwords to remember are similar to real words in a language (see Gathercole, 2006 for a review). The few studies exploring nonword repetition in bilinguals generally identify a native language (L1) advantage (Kohnert, Windsor, & Yim, 2006; Masoura & Gathercole, 1999). Windsor et al. (2010) showed that Spanish-English bilingual children performed

significantly worse than their English monolingual peers in the repetition of nonwords in their L2 English, but outperformed the English monolinguals in the repetition of Spanish-like nonwords. Although it is now clear that nonword repetition does not entirely eliminate the role of language experience, it is important to note that L1-nonword repetition is less dependent on a child's linguistic background than classic tests of vocabulary. Nonword repetition has been shown to reduce the cultural bias associated with socio-economic status, racial, and gender differences (Campbell et al., 1997; Ellis Weismer et al., 2000; Engel et al., 2008; Roy & Chiat, 2004).

Taken together, the presented research is important in relation to improving culture-fair assessment tools for language minority children. To our knowledge, few studies have explored the effect of test language on linguistic and cognitive task performance by administering the same tests in different languages to the same language minority participants which were carefully matched with language majority speakers from different linguistic and cultural groups. Cross-linguistic effects were investigated via within-subject comparisons of different test languages in the language minority group who came from a home where a language other than the dominant language of the society was spoken and were also being schooled in second languages. Cross-cultural effects were investigated by comparing native language performance of the language minority group to monolingual speakers of Portuguese from Brazil, and second language performance of the language minority group to language majority students from Luxembourg who spoke the dominant language and were schooled in the same multilingual classrooms as the minority group.

No cross-linguistic and cross-cultural effects were anticipated for digit recall, counting recall, and backward digit recall measures of working memory. All three measures rely on item information that are sampled from a closed pool and are likely to be equally familiar to all children irrespective of the language. Nonword repetition was expected to recruit

linguistic knowledge bases to a larger extent than the working memory tasks involving digits. More specifically, it was predicted that for Portuguese language minority children Luxembourgish nonwords would be acting as less familiar stimuli than Portuguese nonwords. Cross-cultural differences might emerge in the repetition of the Luxembourgish but not the Portuguese nonwords, with the Portuguese language minority group performing equally well to the Brazilian monolinguals in the repetition of the Portuguese-like nonwords but manifesting weaker performance than the Luxembourgish language majority children in the repetition of the Luxembourgish-like nonwords.

Given the extant literature on vocabulary differences in bilinguals, it was anticipated that language minority children with Portuguese as their first, Luxembourgish as their second, and German as their third language, would manifest a language dominance effect with higher scores on the Portuguese than on the Luxembourgish and German vocabulary measures. Cross-linguistic proficiency was expected to vary with the type of lexical item with a native language advantage for items relative to the home environment and a weaker or no effect for items relative to the school context. Finally, it was predicted that the total vocabulary of the language minority group would be comparable, or exceed, the vocabulary knowledge of language majority children from Luxembourg and monolinguals from Brazil (Bialystok, 2001; Genesee & Nicoladis, 1995; Pearson et al., 1993).

## **Method**

### **Participants**

In total, data from 60 children from 3 different cultural groups were analysed. The groups were as follows: (1) 20 Portuguese language minority children living in Luxembourg; (2) 20 Luxembourgish language majority children living in Luxembourg; (3) 20 monolingual children living in Brazil.

The Portuguese language minority group was recruited from 20 primary school classes of 10 different schools across the Grand-Duchy of Luxembourg. Children were selected on the basis of a language and social background questionnaire that provided information on the socio-demographic characteristics of the family, the language uses in the home, the child's exposure to his/her native and foreign languages, as well as the caregivers' native and foreign language knowledge. Only children who acquired Portuguese as a first language (from birth) and with Portuguese-speaking caregivers were included in the study (see Appendix for further details on the linguistic characteristics of the sample). The sample consisted of 70% second-generation immigrants (i.e., children that were born in Luxembourg). The remaining 30% of first generation immigrant children had moved to Luxembourg before the age of 4. For all children Portuguese was the dominant language spoken at home, and caregivers indicated no, or very limited, knowledge of Luxembourgish and German. For 80% of the sample Portuguese was the sole language spoken at home, and the remaining 20% spoke Portuguese and Luxembourgish only with their siblings. All participants had completed two or three years of pre-school education in monolingual Luxembourgish schools during which the main emphasis is given to Luxembourgish (MENFP, 2010).

The data from the Luxembourgish language majority children was collected for a larger longitudinal study exploring links between working memory and second language learning (Engel, 2009). Children were recruited from the same classrooms as the language minority group. They spoke Luxembourgish as a first language, had Luxembourgish-speaking caregivers, and no foreign language was actively spoken in the home environment or wider family.

The data from the monolingual Portuguese-speaking sample was taken from a published study investigating the effects of socioeconomic status on children's working memory and

vocabulary performance (Engel et al., 2008). Children were recruited from monolingual households in Brazil (see Engel et al., 2008 for further information on the sample).

All children scored at or below the 95<sup>th</sup> percentile and above the 25<sup>th</sup> percentile on the Raven Coloured Progressive Matrices (Raven, Court, & Raven, 1986) and had not been diagnosed with learning difficulties or frank neurological deficits as indicated by caregiver and teacher reports. In total, 209 children were assessed (50 Portuguese language minority children, 119 Luxembourgish language majority children, 40 monolingual Brazilians): They were matched on gender, chronological age, nonverbal reasoning, and socioeconomic status leading to an equal number of 20 children in each group. All children were tested in Year 1 of primary school. The language minority and majority groups had learned the second language German in school for 9 months, whereas the monolingual children from Brazil did not study any foreign languages. Descriptive statistics on the matching variables are represented in Table 1.

Table 1 about here

Each group consisted of 9 boys and 11 girls, with a mean chronological age of 7 years 1 month ( $SD = 3.2$  months, range = 6 years 4 months - 7 years 6 months). Groups did not differ significantly in age or nonverbal reasoning<sup>1</sup>. Socioeconomic status was indexed by caregivers education using the International Standard Classification of Education (UNESCO, 1997) converted into estimated years of schooling (OECD, 2009). The highest educational level of either caregiver was used. On average, caregivers had completed 10.8 years of schooling ( $SD = 2.67$ , range = 6 - 16 years) with no significant differences between groups<sup>2</sup>.

### **Procedure**

All children were tested individually, in a calm area of the school. The language minority children completed all the measures in both Luxembourgish and Portuguese (counterbalanced across different testing sessions). The language majority children were assessed in

Luxembourgish as part of a larger test battery (Engel, 2009). Both, language minority and majority groups were also administered a German version of the productive vocabulary task. The Brazilian monolingual children completed all the tasks in Portuguese only (see Engel et al., 2008 for details on task administration). The same data had been consistently collected for all the children, with the exception of the vocabulary comprehension task, which was only completed by the Portuguese-speakers.

All children were assessed by the first two authors who are multilingual L1-Luxembourgish speakers having extensive knowledge of Portuguese and German. Task instructions of the Portuguese language measures were recorded by a native speaker of Portuguese in a neutral accent and digitally presented to all children. Children's responses on the Portuguese tests were recorded for later analyses and scored by a native speaker of Portuguese. Presentation of the working memory measures was computerized. All the measures had been used in previous studies with Luxembourgish- and Portuguese-speaking children (Engel de Abreu & Gathercole, 2012; Engel de Abreu et al., 2011; Engel et al., 2008).

## **Material**

**Vocabulary.** Vocabulary comprehension in Portuguese was evaluated with the *British Picture Vocabulary Scale* (BPVS II; Dunn et al., 1997) in which children have to match a spoken word to a picture out of a choice of four. No starting criterion was applied and the test stopped for all children after the completion of 81 items. Productive vocabulary in Portuguese, Luxembourgish, and German was assessed with the *Expressive One Word Picture Vocabulary Test* (EOWPVT; Brownell, 2000) in which children need to name pictures. Test administration started at item one and stopped after the administration of 74 items or after 10 consecutive errors. Children received a single-language score for each

language and a composite total vocabulary score indicating the number of unique concepts that could be named independent of the language.

Following Bialystok et al. (2010), an item analysis was conducted on the vocabulary measures to classify words on the basis of their primary context being either at home or school. According to Bialystok's guidelines, items related to food, household, and items that are unlikely to occur in the classroom context, were classified as home items. Professions, animals, plants, shapes, musical instruments, and items reflecting school experiences, were classified as school items. All items were classified by the first author and a qualified Portuguese-speaking researcher. Interrater raw agreement was 87% for the BPVS and 92% for the EOWPVT. Chance corrected agreement was satisfactory, with Cohen's Kappa of .69 and .83 for BPVS and EOWPVT respectively. Consensus was reached on all disagreements. For each vocabulary measure, the dependent variables used for analyses were the percentage correct on the overall test and the percentage correct in each category (BPVS: home = 27 items, school = 54 items; EOWPVT: home = 28 items; school = 46 items).

**Executive loaded working memory measures.** The counting recall and the backward digit recall tasks from the Luxembourgish and the Portuguese versions of the Automated Working Memory Assessment (AWMA; Alloway, 2007; Engel de Abreu, 2011; Engel et al., 2008) were administered. For both measures the amount of items to be remembered increases progressively over successive blocks and testing stops if the child fails three trials in one block of six trials. In the *counting recall* test the child is presented with pictures containing circles and triangles and is asked to count and memorize the number of circles in each picture. At the end of each trial the child has to recall how many circles s/he counted in each picture in the right order. In the *backward digit recall* test the child has to repeat sequences of spoken digits in the reverse order.

**Verbal short-term memory** was assessed with Portuguese and Luxembourgish digit recall and nonword repetition tests. The *digit recall* tasks from the adapted AWMA (AWMA; Alloway, 2007; Engel de Abreu, 2011; Engel et al., 2008) were administered. Children are asked to immediately repeat sequences of spoken digits in the same order that they were presented. Trials start with one digit and progressively increase to trials of nine digits, with six trials in each block. Testing stops after failing three items in one block.

For *nonword repetition* two existing measures were administered: the Luxembourgish Nonword Repetition Task (LuNRep; Engel de Abreu & Gathercole, 2012) and the Brazilian Children's Test of Pseudoword Repetition (BCPR; Santos & Bueno, 2003). Both measures are validated versions of the Children's Test of Nonword Repetition (CNRep; Gathercole & Baddeley, 1996) in which children hear unfamiliar phonological word forms and are asked to immediately repeat them. For each language version, 40 nonwords that range in length from two to five syllables (with 10 items of each syllable length) were administered. The nonwords were presented auditorily and responses were digitally recorded for later analysis. Each nonword received a score of one or zero with a total maximum score of 40. If the child produced a sound that differed from the target nonword by one or more phonemes the response was scored as incorrect.

Test administration and scoring was identical for both versions of the test. Interrater reliability (Cohen's Kappa) was good with coefficients of .83 for the Portuguese version and .86 for the Luxembourgish version. Although the two tasks are parallel versions of the CNRep (Gathercole & Baddeley, 1996), they were not designed to be equivalent in item difficulty. The items of each language version follow the stress pattern and phonotactics of the respective test language. The LuNRep includes 341 phonemes and 24 consonant clusters (occurring in the same syllable). Half of the test items are highly wordlike whereas the other half are substantially different from existing Luxembourgish words (based on wordlikeness

rating). The BCPR consists of 295 phonemes and no consonant clusters. In contrast to the LuNRep, the wordlikeness classification of the BCPR is not controlled for item lengths – 80% of the high wordlike items consist of two-syllable long nonwords and 90% of the low wordlike items consist of four- or five-syllable long nonwords (see Santos & Bueno, 2003).

### **Results**

Descriptive statistics for the working memory and vocabulary measures are provided in Table 2 and Table 3 respectively. To correct for the effect of multiple tests on the likelihood of a type I error, a significance cutoff of  $p < .013$  was adopted for the working memory measures, representing a Bonferroni correction for four tests. For the vocabulary measures a significant cutoff of  $p < .025$  was adopted for the Portuguese measures and of  $p < .017$  for the school language measures, representing Bonferroni corrections for two and three tests, respectively.

Table 2 about here

### **Cross-linguistic comparisons**

The first set of analyses focused on the working memory measures and was carried out on the data of the language minority group only. For counting recall, backward digit recall, and digit recall no within-subject effects between the Portuguese and Luxembourgish version of the measures emerged (Table 2). On nonword repetition, results indicate a substantial within-subject effect with better performance on the Portuguese than on the Luxembourgish task version [ $t(19) = 17.65, p < .001, d = 3.95$ ]. It is important to point out that this finding is most likely related to differences in the linguistic properties between the Portuguese and the Luxembourgish stimuli. Even when assessing majority-language-speakers in their respective L1, differences in performance emerged. The Brazilian monolingual group (who completed the task in Portuguese) outperformed the Luxembourgish language majority group (who

completed the task in Luxembourgish) [ $t(38) = 5.39, p < .001, d = 1.70$ ] indicating that caution is needed when nonword repetition scores are directly compared across languages.

Table 3 about here

For the vocabulary measures (Table 3), within-subject analyses were conducted on both the language minority and majority groups. Results showed that the language minority group performed comparably in Portuguese, Luxembourgish, and German vocabulary production whereas the language majority children manifested a language dominance effect in their L1 Luxembourgish in contrast to their L2 German [ $t(19) = 3.71, p < .001, d = .83$ ]. Furthermore, the data showed that the total vocabulary score of the language minority group was significantly higher than their single language production score in Portuguese [ $t(19) = 7.04, p < .001, d = 1.58$ ] and their combined production score in the school languages of Luxembourgish and German [ $t(19) = 5.69, p < .001, d = 1.27$ ]. Finally, the data on the context scores (i.e., home and school words) revealed a tendency of a cross-linguistic difference for the language minority group with an advantage in naming items relative to the school environment in the school languages over Portuguese [ $t(19) = 2.03, p = .057, d = .45$ ] but no significant difference between the school languages and Portuguese in naming items relative to the home context.

### **Cross-cultural comparisons**

As can be seen in Table 2, the language minority children did not differ significantly from their Luxembourgish- and Portuguese-speaking peers in counting recall, backward digit recall, and digit recall. In nonword repetition, the language minority group performed significantly less well than Luxembourgish language majority children in the LuNRep [ $t(38) = 3.80, p < .001, d = 1.20$ ] and than monolinguals from Brazil in the BCPR [ $t(38) = 2.66, p < .013, d = .84$ ]. Notably, for the Portuguese nonword repetition task (BCPR), the mean of the language minority children was within 1 *SD* of the mean of the Brazilian monolinguals

whereas on the Luxembourgish version (LuNRep) the language minority group performed more than 1.5 *SD* below the mean of the Luxembourgish language majority children. For both language versions the effect disappeared if productive vocabulary in either Portuguese (for BCPR) or Luxembourgish (for LuNRep) was taken into account. A two-way ANOVA, comparing the LuNRep wordlikeness scores of the language minority and majority groups revealed a significant interaction effect [ $F(1; 38) = 7.19, p < .05, \eta_p^2 = .16$ ]. Whereas the language minority group performed significantly less well than the language majority children in the repetition of high-wordlike nonwords [ $t(38) = 5.32, p < .001, d = 1.68$ ], the two groups did not differ significantly in performance in the repetition of low-wordlike items. Importantly, paired sample *t*-tests showed that whereas the language majority group manifested significantly better scores in the repetition of high- than low-wordlike items [ $t(19) = 4.36, p < .001, d = .98$ ], no wordlikeness effect emerged for the language minority group<sup>3</sup> (see Figure 1).

Figure 1 about here

Results on the vocabulary measures (Table 3) showed that the language minority children knew significantly fewer words in their L1 Portuguese than monolingual speakers from Brazil [comprehension,  $t(38) = 4.90, p < .001, d = 1.55$ ; production,  $t(38) = 9.19, p < .001, d = 2.91$ ]. To further explore this effect, a series of two-way ANOVAs were carried out on the Portuguese measures. A significant interaction effect between group and modality [ $F(1; 38) = 48.31, p < .01, \eta_p^2 = .56$ ] emerged, indicating that the language minority children performed more similarly to the Brazilian monolinguals in vocabulary comprehension than production. In addition, the effect of lexical item (home and school words) on cross-cultural proficiency was tested for each modality. For the comprehension measure the interaction effect was significant [ $F(1, 38) = 10.37, p < .01, \eta_p^2 = .21$ ]. Monolingual children from Brazil understood significantly more school [ $t(38) = 5.64, p < .001, d = 1.79$ ], but not home

words than Portuguese language minority children from Luxembourg. No significant interaction effect emerged for the Portuguese vocabulary production measure.

The data on the Luxembourgish and German single and combined production scores showed that, independent of the item type, the Portuguese language minority group consistently manifested lower scores than the Luxembourgish language majority children [Luxembourgish total words,  $t(38) = 9.36$ ,  $p < .001$ ,  $d = 2.96$ ; German total words,  $t(38) = 7.23$ ,  $p < .001$ ,  $d = 2.29$ ; School languages total words,  $t(38) = 8.03$ ,  $p < .001$ ,  $d = 2.54$ ].

Between-subjects ANOVAs were conducted on the total vocabulary scores comparing performance of the three groups of children. Significant effects emerged for total words [ $F(2, 57) = 25.06$ ,  $p < .001$ ,  $n_p^2 = .47$ ] and the home and school words sub-scores [ $F(2, 57) = 18.99$ ,  $p < .001$ ,  $n_p^2 = .40$  and  $F(2, 57) = 24.21$ ,  $p < .001$ ,  $n_p^2 = .46$  respectively]. In each case, the language minority group performed significantly less well than the language majority children from Luxembourg and the monolingual children from Brazil who did not differ significantly from each other.

### **Discussion**

Although research on bilingualism has substantially increased in recent years, an important issue that has not been subject to much scrutiny in past studies is the socio-cultural context in which bilingualism occurs. Surprisingly little research has focused on exploring cognitive and linguistic skills in language minority immigrant children. Such studies are challenging because immigrants constitute a heterogeneous group from a range of countries of origin and language backgrounds. Immigrant children are often socioeconomically disadvantaged and standardized assessments are generally complicated due to the practical limitation of having to assess children in a non-native language. The number of language minority children with immigrant origins is rising dramatically, and these children frequently

present academic difficulties (OECD, 2009). Questions about how to accurately assess their cognitive abilities are therefore pressing and deserve further investigation.

The main purpose of the present research was to explore a range of verbal working memory and vocabulary tasks in a population of Portuguese language minority children growing up in Luxembourg. More particularly, the study aimed to determine if performance on the selected measures is dependant on the language demands of the tasks and the linguistic and cultural status of the child. The major strength of the paper lies in its focus on a relatively homogeneous group of multilingual immigrants that were matched with comparable language majority speakers from two different linguistic and cultural groups, while paying attention to factors known to affect cognitive task performance. The study indicates that assessments of cognitive and linguistic abilities in language minority children require some consideration and careful choice among measures to ensure valid and reliable results.

The study showed that in Portuguese language minority children growing up in Luxembourg, vocabulary proficiency in Portuguese, Luxembourgish, and German was at an equivalent level that fell below the linguistic competence of Portuguese-speaking monolinguals and Luxembourgish language majority children. Importantly, results showed that although the total vocabulary of the language minority group exceeded their single language scores, it remained substantially lower (2.1 standard deviations) than the lexical knowledge of their language majority and monolingual peers (see also Engel de Abreu, Cruz-Santos, Tourinho, Martin, & Bialystok, in press). Language minority children growing up in Luxembourg thus produce significantly fewer concepts than language majority children from Luxembourg and monolinguals from Brazil. As children were matched on a range of social background variables, the findings rule out the possibility that vocabulary differences merely boil down to differences in socioeconomic status. In terms of total vocabulary, the Luxembourgish-speaking group manifested the highest scores, suggesting that multilingual

education is likely to have beneficial effects for lexical learning in language majority children, whereas it might hamper new word learning in language minority groups. These findings are in line with other studies on bilingual education showing that the inclusion of a second language does not reduce or disrupt proficiency in a socially valued first language (e.g., Anglophone children in North America who receive instruction in a second language), but might lead to a subtractive form of bilingualism if the first language is not valued outside of the home (Lambert, Genesee, Holobow, & Chartrand, 1993; Umbel et al., 1992; Wright, Taylor, & Macarthur, 2000). One possibility is that for Portuguese language minority children in Luxembourg, the first language is gradually replaced by the more prestigious school languages. Further research is clearly needed to explore vocabulary growth in language minority children across the lifespan.

An important finding was that cross-linguistic proficiency varied with the type of lexical item and the linguistic modality assessed (see also Kohnert & Bates, 2002). The study suggests that productive vocabulary is more sensitive to language minority effects than vocabulary comprehension possibly because naming pictures involves retrieving a verbal label which might lead to conflict between competing words in different languages in the multilingual lexicon (Green, 1998). The study also showed that language minority effects in vocabulary comprehension occurred only for L1-words that children are not frequently exposed to in the home. This finding indicates that the type of lexical item can affect bilingual performance on vocabulary tasks and is a factor to consider when testing language minority children (see also Bialystok et al., 2010).

Results on the verbal working memory measures showed that language minority children performed equally well in the Portuguese and Luxembourgish backward digit recall, counting recall, and digit recall tasks and that their performance on these measures did not differ significantly from their language majority peers from Luxembourg and monolinguals from

Brazil. Test language and cultural status does not therefore, seem to affect assessments of verbal working memory that involve numerical memoranda. These findings are in line with previous evidence showing that socioeconomic background did not impact performance on these same measures (Engel et al., 2008). As number knowledge will have been extensively trained in 7-year-old children, it is likely that tasks involving digits are equally familiar to all children and consequently less sensitive to lexicality effects (Gathercole et al., 1999; Majerus et al., 2006; Majerus & d'Argembeau, 2011). Whether our findings extend to other verbal working memory measures with a stronger verbal component (e.g., listening span) remains to be seen.

For nonword repetition, the study showed that irrespective of the language version, the language minority group performed with lower accuracy than the Luxembourgish and Brazilian children. Group differences disappeared once vocabulary knowledge was taken into account, indicating that the effects were largely driven by the smaller lexicon of the language minority group. Notably, group effects were more pronounced when the Portuguese language minority children completed the task in their L2 Luxembourgish than in their L1 Portuguese, consistent with previous evidence indicating a native language advantage in bilingual nonword repetition (Kohnert et al., 2006; Masoura & Gathercole, 1999). A remarkable feature of the findings was that wordlikeness affected Luxembourgish nonword repetition accuracy only in the Luxembourgish language majority group; for the language minority children means on the two sets of nonwords (i.e. high- and low-wordlike) were virtually identical and did not differ significantly from the performance of the Luxembourgish children on the low-wordlike items. It has been argued that low-wordlike nonword repetition relies predominantly on mechanisms of verbal short-term storage, whereas repetition of high-wordlike items is also mediated by long-term lexical and sublexical knowledge (Gathercole, 1995). The data suggests that language minority children might not benefit from sublexical

and lexical facilitation in the repetition of high-L2-wordlike nonwords because phonological representations in their L2 might be poorly defined rendering all items low-wordlike for them.

The research presented has important practical implications for assessing culturally and linguistically diverse children. It was shown that the native language of a language minority immigrant child does not necessarily represent the language that the child is most proficient in when completing lexical tasks (see also Kohnert & Bates, 2002). Instead, performance of language minority children depends on a range of factors including the context in which the languages were acquired, the type of lexical item that is assessed, and the modality that is being tested. The study further indicates that caution needs to be taken when combining the lexical knowledge across all the languages of a language minority child. Although total vocabulary provides a better estimation of a bilingual's lexical development than single language measures, it remains subject to significant cross-cultural differences and may not accurately reflect the language ability of language minority children. Assessment tools that emphasize processing abilities over more experience-dependent measures of vocabulary might be more appropriate for culturally and linguistically diverse children. The study clearly showed that in contrast to tests of vocabulary, verbal working memory tasks were less sensitive to differing experience with language. Notably, verbal working memory measures involving digits and nonword repetition with low-wordlike items, could be reliably assessed in language minority immigrant children with tasks that were administered in the language of the host country. This finding is of considerable significance as practitioners and researchers often lack the language skills and/or access to translated tasks in an immigrant child's first language.

### Conclusions

Distinguishing neurolinguistic deficits from cultural-linguistic differences is a key issue for many clinicians. Immigrant children with low lexical performance may be inaccurately diagnosed with language impairment when none is present, or may be diagnosed as “normal for a bilingual” even though they present true language learning difficulties and treatment might be needed. This research suggests that vocabulary comprehension tasks with items related to the home context, verbal working memory tasks involving familiar stimuli from a closed pool (e.g., digits), and nonword repetition tasks with low-wordlike items may provide valuable tools for distinguishing between *language impairments* of a neurolinguistic origin and *language differences* related to the environmental context of growing up as an immigrant with more than one language. This distinction is crucial in order to avoid erroneous diagnostics and provide appropriate remedial support that would aid language minority children in overcoming their language differences in order to improve their chances of accessing the same opportunities as their majority culture peers.

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### Footnotes

<sup>1</sup> Nonverbal reasoning was assessed with the Raven Coloured Progressive Matrices Test (Raven et al., 1986) in which the child has to complete a pattern by choosing the missing piece among 6 possible drawings.

<sup>2</sup> The reported pattern did not change when analyses were completed with SES as a covariate.

<sup>3</sup> As wordlikeness was confounded with word lengths for the BCPR, wordlikeness effects could only be analysed for the LuNRep.

Table 1

*Descriptive Statistics on the Matching Variables According to Group*

	Max.	Portuguese language minority group		Luxembourgish language majority group		Brazilian monolingual group	
		M	SD	M	SD	M	SD
Age (in months)	--	85.85	2.21	83.95	2.58	84.00	4.12
Socioeconomic status							
Caregiver education (years)	21	10.20	3.09	11.85	2.60	10.30	2.00
Nonverbal reasoning							
Raven CPM	36	20.35	2.92	19.30	2.39	18.90	2.17

*Note:* Raven: Raven Coloured Progressive Matrices Test

Table 2

*Mean Scores on the Verbal Working Memory Measures According to Group*

	Max.	Portuguese language minority group		Luxembourgish language majority group		Brazilian monolingual group		
		M	SD	M	SD	M	SD	
Portuguese measures								
Executive-loaded working memory								
Counting recall	42	12.55	3.46	--	--	11.40	2.98	
Backward digit recall	36	6.85	2.91	--	--	8.15	2.46	
Verbal short-term memory								
Digit recall	54	20.25	3.02	--	--	21.60	3.63	
Nonword repetition (BCPR)	40	31.90	3.54	--	--	34.72	3.17	
Luxembourgish measures								
Executive loaded working memory								
Counting recall	42	12.90	2.51	13.55	2.44	--	--	
Backward digit recall	36	7.35	2.35	7.50	1.96	--	--	
Verbal short-term memory								
Digit recall	54	20.40	2.56	22.05	3.02	--	--	

Cross-linguistic and cross-cultural effects

Nonword repetition (LuNRep)	40	22.70	3.92	27.90	4.69	--	--
High wordlikeness (% correct)	100	56.75	10.42	73.50	9.47	--	--
Low wordlikeness (% correct)	100	56.75	11.50	66.00	14.65	--	--

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*Note:* BCPR: Brazilian Children's Test of Pseudoword Repetition; LuNRep: Luxembourgish Nonword Repetition Task

Table 3

Mean Percentage Correct on the Vocabulary Measures According to Group

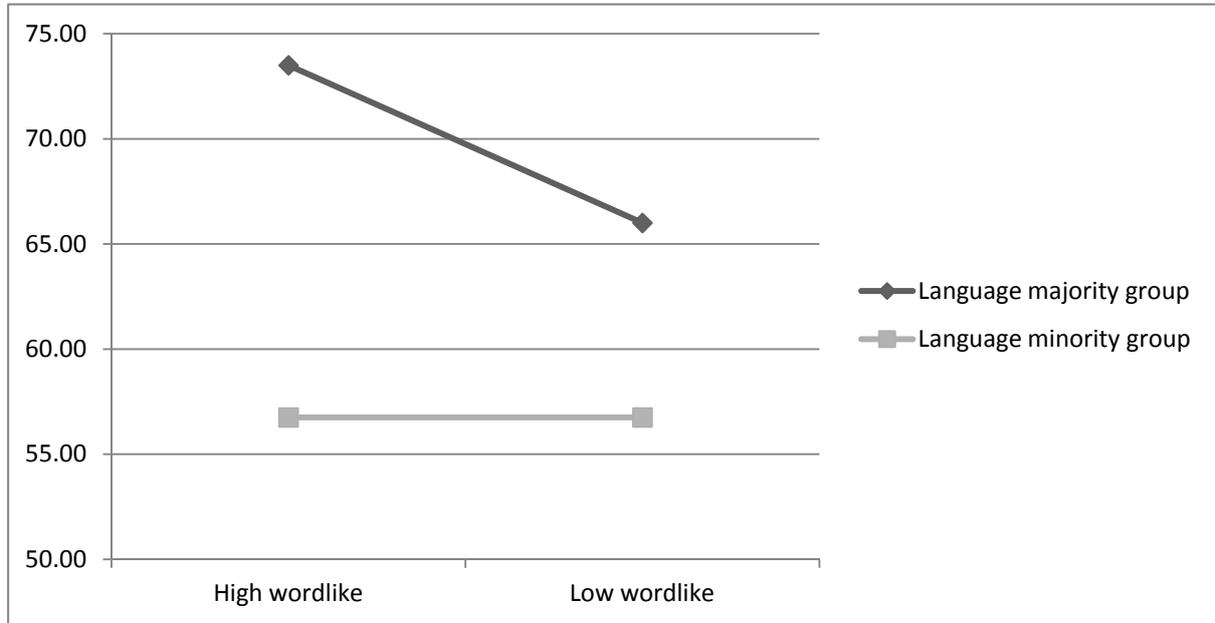
	Portuguese language minority group		Luxembourgish language majority group			Brazilian monolingual group	
	M	SD	M	SD		M	SD
Portuguese single language scores							
Comprehension (BPVS)							
Total words	64.57	6.54	--	--	--	75.99	8.10
Home words	74.07	9.61	--	--	--	79.26	8.94
School words	59.81	7.74	--	--	--	74.35	8.52
Production (EOWPVT)							
Total words	41.35	11.58	--	--	--	71.08	8.68
Home words	48.75	15.64	--	--	--	77.32	6.68
School words	36.85	10.09	--	--	--	67.28	10.85
Luxembourgish single language scores							
Production (EOWPVT)							
Total words	37.03	14.29	72.30	8.95	--	--	--
Home words	40.18	16.13	77.50	8.20	--	--	--
School words	35.11	13.72	69.13	10.62	--	--	--
German single language scores							

Production (EOWPVT)							
Total words	36.49	15.31	67.30	11.34	--	--	
Home words	40.36	17.43	70.36	10.75	--	--	
School words	34.13	15.34	65.43	12.46	--	--	
School languages (Luxembourgish & German)							
Production (EOWPVT)							
Total words	46.15	15.09	78.11	9.43	--	--	
Home words	51.07	17.54	83.04	7.50	--	--	
School words	43.15	14.27	75.11	11.37	--	--	
Total vocabulary							
Production (EOWPVT)							
Total words	55.27	12.77	78.11	9.43	71.08	8.68	
Home words	62.86	15.52	83.04	7.50	77.32	6.68	
School words	50.65	11.83	75.11	11.37	67.28	10.85	

*Note:* BPVS: British Picture Vocabulary Scale; EOWPVT: Expressive One Word Picture Vocabulary Test.

Figure 1

*Mean Scores of the Portuguese Language Minority Group and the Luxembourgish Language Majority Group on the Luxembourgish Nonword Repetition Task (LuNRep) According to Item Type*



## Appendix

## Additional Sample Information.

	Portuguese language minority group		Luxembourgish language majority group		Brazilian monolingual group	
	Freq.	%	Freq.	%	Freq.	%
<b>Sex</b>						
Girls	11	55	11	55	11	55
Boys	9	45	9	45	9	45
<b>Nationality</b>						
Portuguese	18	90	0	0	0	0
Cape Verdean	1	5	0	0	0	0
Brazilian	1	5	0	0	20	100
Luxembourgish	0	0	20	100	0	0
<b>Place of birth</b>						
Portugal	6	30	0	0	0	0
Luxembourg	14	70	20	100	0	0
Brazil	0	0	0	0	20	100
<b>Language(s) spoken at home</b>						
Portuguese only	16	80	0	0	20	100
Portuguese and Lux.	4	20	0	0	0	0
Luxembourgish only	0	0	20	100	0	0
<b>Main language(s) spoken with friends</b>						
Portuguese only	16	80	0	0	20	100
Portuguese and Lux.	4	20	0	0	0	0
Luxembourgish	0	0	20	100	0	0
<b>Child watches TV</b>						
Portuguese	15	75	0	0	20	100

Cross-linguistic and cross-cultural effects

Luxembourgish	2	10	19	95	0	0
German	17	85	20	100	0	0
French	9	45	2	10	0	0
Child reads/is read to						
Portuguese	18	90	0	0	20	100
Luxembourgish	1	5	19	95	0	0
German	2	10	14	70	0	0
French	9	45	0	0	0	0

*Note:* Data were obtained from caregivers using a Language and Social Background

Questionnaire designed for the purpose of this study.