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Article

The Interplay of Emotions, Executive Functions, Memory and Language: Challenges for Refugee Children

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Abstract: Refugee children tend to show low emotional well-being and weak executive functions that may have consequences on language and therefore complicate a potential diagnosis of Developmental Language Disorder (DLD) in this population. We assessed the performance of 140 children living in Switzerland aged 5 to 8 (20 monolinguals, 86 non-refugee bilinguals, 34 refugee bilinguals) on LITMUS language tasks (nonword repetition, sentence repetition, parental questionnaire), standardized language tasks, memory and executive function tasks. Parents also filled in the Child Behavior Checklist providing a measure of their child's emotional well-being. Results indicate that refugee children are more emotionally vulnerable and show weaker performance in memory and executive functions tasks compared to non-refugee children, in line with the existing literature. Moreover, when compared to non-refugee bilingual children with similar length of exposure to French, refugee children are disadvantaged on all language tasks. Whereas emotional well-being does not predict language performance, memory and executive functions show up as predictors of both LITMUS and standardized language tasks, although in an unsystematic way. It is concluded that refugee children are at risk across the board and that a better understanding of the complex interplay between well-being, executive functions, memory and language is needed in order to build more appropriate diagnostic tools for these children.

Keywords: refugees; bilingualism; emotional well-being; executive functions; memory; inhibition; LITMUS tasks; lexicon; morphosyntax

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1. Introduction

Over the last five years Europe has experienced a humanitarian crisis due to the massive number of migrants seeking asylum. More than a million people asked for asylum in Europe in 2015. In Switzerland, about 55,000 people were in the asylum process at the end of 2021 (Statistics from the Swiss State Secretariat for Migration). About half of them are children. Numerous studies have documented the high vulnerability of this special group, both at the level of their mental health (Bronstein and Montgomery 2011) and at the level of their cognitive development (Kim et al. 2020). However, little is known about their language development.

Learning the language of the host country[1] (L2) is essential for these children, as it conditions school achievement. Refugee children[2] benefit from school immersion in L2. Nevertheless, their emotional and cognitive vulnerability may constitute a significant obstacle to language learning (Kaplan et al. 2016). Recent studies have indeed reported that refugee children perform weakly in L2 language tasks (Abed Ibrahim et al. 2020; Hamann et al. 2020). When language difficulty is noticed, usually at school, children are typically directed to speech-language therapists to provide a diagnostic about the cause of the language difficulty and identify adequate intervention. The challenge for speech-language therapists is thus to tease apart the role of exogenous causes due to the child's life trajectory and psychological vulnerability from a potential developmental language disorder (DLD), which affects about 8% of school-aged children (Norbury et al. 2016).

Diagnosing a DLD in non-refugee bilingual children is already made difficult by the fact that the language profiles of L2 children and monolinguals with DLD are similar in the early phases of language acquisition (Paradis 2010). Refugee bilingual children constitute an additional challenge (Hertel et al. 2021). For bilinguals without a refugee background, research programs have identified tasks that are minimally sensitive to the bilingual status of the child, and maximally sensitive to DLD (Dos Santos and Ferré 2018; Tuller 2015; Fleckstein et al. 2018). However, it is unknown whether these tools are reliable for refugee children, given their specificities.

This study explores (i) the profiles of a sample of newly arrived refugee children in Geneva in regard to their emotional well-being, aspects of their cognitive functioning (memory and executive functions) and language, and (ii) the potential predictive role of well-being, memory and executive functions on language in a wider-scale sample of refugee and non-refugee children.

1.1. Diagnosing DLD in Bilingual Children

Developmental Language Disorders are diagnosed in the absence of intellectual disability and affect the main components of oral language: phonology, lexicon, morphosyntax and discourse (Bishop et al. 2017; DSM-5, American Psychiatric Association 2013), regardless of children's linguistic status (monolingual/bilingual, Tuller et al. 2015). Linguistic profiles of children with DLD are characterized by substantial heterogeneity (Bishop et al. 2017; Van Weerdenburg et al. 2006). Nevertheless, the areas of phonology and morphosyntax are commonly affected (Zesiger and Mayor 2020). Thus, children with DLD typically have difficulties with syntax and morphology; they tend to produce unconjugated verbal forms (Paradis and Crago 2000) and have difficulties with syntactic movement (Delage and Frauenfelder 2020; Durrleman et al. 2016; Jakubowicz and Tuller 2008), as revealed by impairment in complex structures, including passive clauses (Marinis and Saddy 2013; Stanford and Delage 2021), object relatives (Adani et al. 2014; Contemori and Garraffa 2010; Friedmann and Novogrodsky 2004), object wh-questions (Jakubowicz 2011; Marinis and van der Lely 2007; Van der Lely et al. 2011), as well as, for French-speaking children, accusative clitics (Delage and Durrleman 2018; Stanford and Delage 2020; Tuller et al. 2011). Finally, children with DLD also have difficulty producing embedded clauses (Friedmann and Novogrodsky 2004; Scheidnes and Tuller 2019; Hamann et al. 2007). Children with DLD also typically have difficulties in nonword repetition, a task which not only involves short-term memory (depending on task construction), but also phonological processing as attested by its sensitivity to phonological complexity (see Schwob et al. 2021, for a meta-analysis) but also in phonological awareness and identification (Ramus et al. 2013). Phonological complexity seems to be the most relevant variable for understanding their phonological difficulties (Zesiger and Mayor 2020). Studies conducted in various languages, including French, support the finding that neither the order of phoneme acquisition nor the errors observed in DLD children are different from those of younger typically developing children, suggesting the idea of slower acquisition without being deviant (Maillart and Parisse 2006; Parisse and Maillart 2007).

Identification of DLD in a sequential bilingual child, that is, a child learning a second language (L2) after the age of 3, is made difficult by the fact that the language profiles of L2 children and monolinguals with DLD are similar in the early phases of acquisition (Fleckstein et al. 2018; Paradis 2010). Bilingual acquisition is affected by a wide array of factors including the age at which children start to have sustained exposure to the L2, the length of exposure to the L2 (LoE), the amount of exposure and the linguistic richness, as well as the socioeconomic status (Armon-Lotem et al. 2011; Paradis 2011; Prevoo et al. 2014). The interrelations between these factors give rise to great variability in bilingual children's language development, and to a temporary overlap of their error patterns and errors used as clinical markers for DLD. Reliable language tasks have been designed for the diagnosis of DLD in sequential bilingual children, which minimize the impact of language exposure on performance and therefore reduce potential penalty due to bilingualism. These so-called

LITMUS tasks (Armon-Lotem et al. 2015) include a parental questionnaire (PABIQ, Tuller 2015) to collect information on the child's bilingualism and level in their native language (L1), a nonword repetition task (LITMUS-QU-NWR, Dos Santos and Ferré 2018) and a sentence repetition task (LITMUS-SR-French, Fleckstein et al. 2018). These tests were found to reliably allow for differentiating between children with and without DLD in the context of bilingualism. Nevertheless, recent research suggests that refugee children may still show poor performance to some of the LITMUS tasks. Although similar performance to heritage children was found on the German LITMUS-QU-NWR (regardless of age and input factors), refugee children performed below the cut-offs for DLD for younger heritage bilinguals on the LITMUS-SRT (Hamann et al. 2020).

1.2. Specificities of Refugee Children

1.2.1. Psychological Vulnerability

The World Health Organization defines mental health as 'a state of mental well-being that enables people to cope with the stresses of life, realize their abilities, learn well and work well, and contribute to their community' (World Health Organization 2022). Early negative experiences such as exposure to violence or the mental illness of a parent, but also factors like bullying and poverty all increase the risk of mental illness. More generally, emotional well-being involves multiple components like anxiety (state and trait), stress, depression (status and trait), anger, confusion, fatigue, negative affect, as well as self-perception and general satisfaction (Netz et al. 2005).

Refugee children are particularly exposed to stressors in their country of origin (insecurity, war, crimes, separations, food deprivation), during the migration journey (violence, displacement, settling in temporary refugee camps, lack of resources), and after the journey (culture shock, non-mastery of the language, social exclusion and discrimination, precarious situation and status, disillusion). All these contextual factors can cause psychological distress (Fazel and Stein 2002). Negative social perceptions, harassment, racism, and stigma from the host society have been shown to compromise the formation of refugee children's identity, and negatively impact their self-esteem (Fazel 2015). Parents also go through stressors susceptible to alter their own well-being due to the multitude of administrative obstacles they often encounter (linked to residency permit, accommodation and work), with impacts on their children (Reed et al. 2012).

The most prevalent psychopathological disorders in refugee children include post-traumatic stress disorder, depression and anxiety (Fazel and Stein 2002). These disorders lead to symptoms such as emotional and behavioral disturbance, sleep disorders, irritability, nightmares, social withdrawal and somatic ailments. Bronstein and Montgomery (2011) conducted a literature review that included 22 studies of 3000 refugee children and adolescents aged 3 to 25 years. They reported a high rate of depression (up to 30% in some studies, compared to a lower than 6% rate in non-refugee children) and a high rate of post-traumatic stress disorder (PTSD, ranging from 19 to 54% according to studies, compared to 2–9% in the general population). While the average level of depression in children drops significantly in the 5 years after migration, this is not the case for anxiety, post-traumatic stress disorder, or externalizing symptoms (Jensen et al. 2019). Specific risk factors include exposure to violence before and after migration, discrimination and lack of stability due to regular changes of domicile during the migration process as well as in the host country (Fazel et al. 2012). In addition, refugee families whose status is precarious often have difficulty accessing health services, which further impacts the psychiatric and psychological care of migrant children. The lack of training and awareness of migration issues in medical teams results in psychosocial care of variable quality, and opinions of carers on the issue of access and rights to health for migrants may also have a negative impact on the quality of the care provided to refugee children (Vanthuyne et al. 2013).

1.2.2. Cognitive Vulnerability

A number of studies have attested to the influence of emotional well-being on cognitive functions. Several of the symptoms of PTSD, anxiety, and depressive disorders can interfere with learning as they are typically associated with poor concentration, which has adverse effects on the acquisition of new information and cognitive skills (Streeck-Fischer and van der Kolk 2000). Intrusive memories of traumatic events may also cause the child to be distracted from the learning task and even to develop strategies of forgetting that inhibits spontaneous thought (Kaplan et al. 2016).

Studies have indeed shown the impact of emotional well-being on executive functions, i.e., a set of processes underlying the cognitive control of behavior and allowing for selecting and successfully monitoring behaviors to attain chosen goals (Miyake et al. 2000). Executive functions include basic cognitive processes such as attention, inhibition (the ability to inhibit or control automatic responses), and cognitive flexibility (the ability to see events from different perspectives and to switch between mental states, rule sets or tasks). Brain regions affected by trauma were found to be involved in executive functions (Kaplan et al. 2016; Malarbi et al. 2017), and indeed various studies report executive function disorders in children suffering from psychopathological conditions but also from milder conditions affecting their well-being. Children with PTSD perform below average on measures of executive functioning; they show attentional difficulties, heightened sensitivity to interference, and impaired memorization strategies (Samuelson et al. 2010). Medically healthy neglected children also have significant deficits in executive functions and memory with lower scores on measures of attention, verbal short-term memory, working memory and inhibition (Beers and De Bellis 2002). In the same way, exposure to violence or living in high-poverty neighborhoods cause weak executive functions (Haft and Hoeft 2017; McCoy et al. 2015). A large-scale study conducted on Palestinian young teenagers in the West Bank showed that those who are more exposed to political violence have lower levels of executive functioning (Buckner and Kim 2012). Finally, familial trauma was found to be associated with poorer children's performance on a variety of executive functions tasks (working memory, inhibition, auditory attention, processing speed) even after taking into account symptoms (anxiety and dissociation), socioeconomic status, and possible traumatic brain injury (DePrince et al. 2009).

Given their emotional vulnerability, refugee children may be at risk to develop executive function deficits. A comparison of executive function skills of Turkish and refugee preschool children in Turkey showed that although the two groups did not differ in regard to their abstraction capacities, refugee children had lower cognitive flexibility scores (Tuncer 2021). A wide-scale study of Syrian refugee children in Lebanon also showed that working memory and cognitive control scores, which executive functions can build upon, were lower in refugee children compared to other children in the class, even though refugee children were older than their classmates (Kim et al. 2020).

Some studies suggest that well-being and psychopathological disorders like PTSD may negatively impact language in children (De Bellis et al. 2009; Samuelson et al. 2010). The well-attested emotional vulnerability of refugee children may therefore be a source of difficulties in acquiring the language of the host country. Recent studies conducted in Germany found significant deficits in the performance of refugee children on measures of vocabulary and morphosyntax in comparison to younger heritage bilinguals, even on tests that were standardized for bilingual children (Abed Ibrahim et al. 2020; Hamann et al. 2020). Another study showed that refugee children not only performed more poorly than heritage bilinguals but also that they did not significantly differ from children with DLD on expressive grammar, reading and spelling (Hertel et al. 2021). Nevertheless, heritage bilinguals had more exposure to German than refugee children, a factor which was found to have a strong predictive role in performance. Interestingly, these studies show that in addition to L2 exposure, socioeconomic status also explains part of the variance in language performance. A study of newly arrived Syrian refugee children in Canada showed the role of the language environment, i.e., exposure to L2 (at school and at home), engagement in language-rich activities and parental education in the development of L2 English vocabulary and verbal morphology (Paradis et al. 2020). It is also to be noted that Syrian children were found to have less rich language environments compared to Canadian bilingual children (Paradis 2011; Paradis et al. 2017).

Like "typical" bilinguals, refugee children were found to be overrepresented in special education services (Kaplan 2009). However, refugee children are exposed to a key additional factor, emotional vulnerability, susceptible to impacting their performance on language tasks, and calling for a better understanding of the interplay between emotional well-being, executive functions and language, which is one of the purposes of the current study. In a recent study, Paradis et al. (2022) examined the influence of emotional well-being and adversity factors (time in refugee camps and low socioeconomic status) on L2 abilities of 117 Syrian refugee children after about 3 years of exposure to English. They found that externalizing problem behaviors (in conduct and hyperactivity) were negative predictors of L2 vocabulary and listening comprehension. As for other factors, longer periods of time in refugee camps tended to be associated with low morphosyntactic abilities and SES components predicted variance in L2. This recent study paved the way of a new line of research exploring the impact of emotional well-being on fine language measures. The current study follows up on that, bringing evidence regarding the interplay between language, well-being, and cognitive skills.

1.3. Goal of the Study

A number of studies have attested to the emotional vulnerability of refugee children and its consequences on cognitive development. In spite of these specificities of this population, very little research has focused on the language development of refugee children. The three combined LITMUS tools, i.e., the sentence repetition task (LITMUS-SR-French), the nonword repetition task (LITMUS-QU-NWR) and the parental questionnaire (PABIQ), are promising tools to reliably identify DLD in bilingual children. However, the case of refugee children brings a new challenge, as shown by research suggesting that some of the tasks may not adequately tease them apart from children with DLD (Hamann et al. 2020). LITMUS tasks were designed to minimize the impact of language exposure on task performance, the goal being to tease apart children with lack of L2 exposure from children with DLD. It is critical to keep in mind this factor that the tool is expected to control for, since it conditions its validity. Indeed, there are numerous other factors that LITMUS tools did not aim to control, which may turn out to affect performance. A tool may be valid for a population that is specific in regard to factor A, which has been controlled for, but not for another population that is specific in regard to factor B. In other words, LITMUS tools were shown to be valid to assess language in bilinguals who had relatively little exposure to the language, but this does not mean that the tool is valid to assess language in children with specificities on other aspects. If our results align with studies showing that refugee children are at risk in regard to emotional well-being and executive functions, and if LITMUS tools turn out to be particularly sensitive to one or both of these factors, that would call into question their validity for this particular population.

The goal of the present study is twofold. First, it aims at gathering empirical evidence about the specificity of newly arrived refugee children's profiles and determining whether they are at risk on three fronts: emotional well-being, memory/executive functions, and L2 French proficiency. We are not aware of any research conducted on these three aspects of refugee children and it is therefore important to start by determining whether similar profiles to those reported in the literature characterize our population. Second, the study aims at exploring more generally the association between language and emotional well-being and between language and memory/executive functions on LITMUS tasks as well as on standardized language tasks commonly used to assess language skills in French-speaking children. The finding of such associations would not only be relevant for the proper diagnosis of DLD in refugee children, but for all individuals showing vulnerability on these two fronts.

2. Materials and Methods

2.1. Participants

We collected data from 140 children: 20 monolingual children (age range: 5;0–7;9, *M* = 5;10, *SD* = 0;11), 86 non-refugee bilingual children (age range: 5;0–8;10, *M* = 6;6 years, *SD* = 0;1) and 34 refugee bilingual children (age range: 5;0–9;1, *M* = 7;2 years, *SD* = 1;4), tested in primary schools in the canton of Geneva, Switzerland, as well as in reception centers for migrants. Non-refugee bilingual children were mainly from Spain, Italy, Portugal and Germany. Refugee children were mainly from Eritrea, Syria and Afghanistan and spoke as native language Tigrinya, Farsi, Arabic and Kurdish. Refugee and non-refugee bilingual children had been in Switzerland for at least 8 months, and for about 2 years on average. Since not all children were tested on all tasks, length of exposure to French (LoE), age of acquisition (AoA) and age slightly varied according to the three test samples used for different data analyses. These variables are reported in the Results section, and their role was assessed and controlled in the statistical analyses (see Section 2.4).

2.2. Materials

2.2.1. Emotional Well-Being

Emotional well-being was assessed through the Child Behavior CheckList (CBCL, Aechenbach 1999) adapted to French (Capron and Duyme 2009). The CBCL is a component of the Achenbach System of Empirically Based Assessment (ASEBA). The ASEBA is used to detect behavioral and emotional problems in children and adolescents. It was well suited to our purpose of conducting a large-scale investigation as it does not require training to administer and yields quantitative scores that could be related to language and cognitive measures. The CBCL has been validated in more than 30 countries with multicultural comparisons of scores (e.g., Ang et al. 2012). Moreover, a wide-scale study comparing it to a similar tool, the Strengths and Difficulties Questionnaire, concluded that the CBCL appears as a stronger psychometric measure, with high reliability and validity (Dang et al. 2017).

The questionnaire contains a total of 112 statements for the version intended for children over the age of 6, and 52 for the version adapted to children below age 6. Both versions contain a variety of scales assessing major categories of child psychiatric disorders according to the 'Diagnostic and Statistical Manual of Mental Disorders' classification. Different spheres are investigated involving daily activities, social relations, school performance, and crucially behavioral and emotional components. Example items involve 'Often disputes or contradicts', 'Destroys things belonging to the family or other children', 'is not appreciated by other children', or 'does not want to sleep alone'. Parents had to indicate whether assessments about their child were not true (0 points), somewhat or sometimes true (1 point) or very true or often true (2 points). Higher scores indicate higher emotional vulnerability.

2.2.2. Memory and Executive Functions

- Digit span

The digit span is a subtest in the Wechsler Adult Intelligence Scale (WAIS-IV, Wechsler 2005). The child is orally presented with a random series of digits and asked to repeat them in either the order presented (forward span) or in reverse order (backward span). The two tasks are assumed to tap into distinct cognitive capacities: the forward span task involves verbal short-term memory, while the more complex backward span task involves an additional working memory or executive control component in order to reorder digits. Each task contains a total of 16 sequences. If the child responds correctly, the next trial presents a longer sequence. The task stops when the child successively fails two sequences of the same number of digits. The score corresponds to the number of sequences correctly repeated.

- NEPSY-II

NEPSY-II (Korkman et al. 2007) is a customizable cognitive assessment tool tailored for children aged 3 to 16. Three subtests were selected for the present study from the domain of executive measures: auditory attention, response set and design fluency. The subcomponents that are assessed include a combination of functions involving inhibition of learned and automatic responses, monitoring and self-regulation, vigilance, selective and sustained attention. Response set also involves the capacity to establish, maintain, and shift a response set, while design fluency involves planning and organizing a complex response as well as figural fluency.

Auditory attention. This task is designed to assess selective auditory attention and the ability to sustain it (i.e., vigilance). The child is presented with four colored circles (blue, red, black, yellow) and hears five series of 36 words presented by the experimenter, some of which being color words. The task consists of pressing the red circle when s/he hears the word 'red' and withholding pressing other circles when their colors are named.

Response set. This subtest is administered just after the previous one. The task is now to press the red circle when hearing 'yellow', the yellow circle when hearing 'red', and the blue circle when hearing 'blue'.

Design fluency. This subtest is a time-task designed to assess the behavioral productivity in the child's ability to generate unique designs by connecting up to five dots, presented in two arrays: structured and random. The structured part contains 35 identical dice-like arrays of 5 dots that the child needs to connect following different designs. The random part contains 35 arrays of 5 dots randomly positioned. For each part, the child has to connect as many arrays as possible in different designs within 60 s. Each array gives 1 point if at least 2 dots are connected with a straight line that does depart further than 2 mm from the dot.

Children's scores to the digit spans and to NEPSY-II tasks were converted into age-based, norm-referenced scaled scores (M = 10, SD = 3).

2.2.3. Language

- LITMUS tasks

Sentence Repetition (LITMUS-SR-French). This task consists of 30 sentences varying in syntactic complexity, with the presence of verbal inflections in the present/past, interrogative forms (questions) and complement and relative clauses (Fleckstein et al. 2018). The vocabulary used is maximally simplified to reduce influences from lexical knowledge. Sentences were pre-recorded. The score corresponds to the number of identical repetitions of the targeted sentences, as described in Fleckstein et al. (2018). Mispronunciation errors were not counted as errors.

Non-Word Repetition (LITMUS-QU-NWR). This task (Dos Santos and Ferré 2018) includes 71 nonwords to be repeated, varying in terms of number of syllables (1 to 3 syllables) and phonological complexity (presence of consonant clusters). Thirty nonwords were identified as language-independent because they have combinations of phonemes present in the majority of the world's languages, whereas the other 41 nonwords are considered language-dependent. The latter consisted in the same combinations of phonemes used in the bilateral onsets of the language-independent nonwords but with the additional presence of the/s/as the first member of trilateral onsets, which is specific to French. The child gets 1 point if the nonword is correctly repeated, and 0 otherwise, as in Dos Santos and Ferré (2018).

Parental questionnaire (LITMUS-PABIQ). The parental questionnaire (Tuller 2015) allows collecting different types of information about the bilingual child's language history and profile. Different indexes are provided, but the current study focuses on the no-risk index for language disorder (NRI), following previous work (e.g., Abed Ibrahim and Fekete 2019; Tuller et al. 2015). The NRI takes into account age of onset of the first word, age of onset of the first sentence, parental concerns and the presence of language difficulties in the family. A higher score indicates a lower risk for language disorder.

- Standardized language tasks

Word repetition. This task from the ELO test (Khomsi 2001) requires that the child repeats 32 words presented auditorily and progressively increasing in length and phonological complexity (e.g., "bateau" 'boat' and "chapeau" 'hat' for the two first words; "réfrigérateur" 'refrigerator' and "moissonneuse-batteuse" 'combine harvester' for the last two words). The score corresponds to the total number of words correctly repeated.

Lexical production. This picture naming task from the N-EEL (Chevrie-Muller and Plaza 2001) contains 57 pictures: 36 referring to concrete units and 21 referring to more abstract units (9 body parts, 6 colors, 6 shapes). The child gets 2 points if the word is correctly named, 1 point if the correct word is produced with a mild phonological modification, and 0 otherwise.

Lexical reception. This pointing task requires that the child points to the correct image corresponding to a target word among 6 images. Test words are the 57 items of the N-EEL production task. Each word is presented orally to the child, who has to select the correct picture presented together with 5 distractor pictures including one semantic distractor and one phonological distractor. The score corresponds to the number of correct selections.

Morphosyntactic production. This sentence completion task is also part of the N-EEL (Chevrie-Muller and Plaza 2001). The test contains 15 items. Each item consists of a sentence that is read by the experimenter, followed by the beginning of a second sentence that the child is asked to complete in order to prompt number agreement and person agreement, as well as past and future tense. Correct responses give 2 points, responses that involve either the correct verb or its correct inflection give 1 point, and 0 point is given when none of the two criteria is met. This task was only used with children beyond age 6.

Morphosyntactic reception. This sentence-picture matching is also part of the N-EEL (Chevrie-Muller and Plaza 2001). In the version for children aged 4–6 years, 6 sentences are presented involving reversible actives, determiners and nominative clitics. In the version for children older than 6;6, 16 sentences are presented involving past tense, future, passives, object clitics and possessive determiners. The score corresponds to the number of correct selections.

Children's scores to the five standardized language tasks were converted into z-scores. Since LITMUS tasks were not standardized, children's scores were used.

2.3. General Procedure

Testing took place in a quiet room of a school, a reception center for migrants, or the child's home. It was split in two sessions of 30–45 min. Experimental materials involved a computer, test notebooks, a stopwatch and a recorder. Two experimenters were present during testing. Tasks were presented in French, in the following order: sentence repetition (LITMUS-SR-French, SR), design fluency (DF), lexical production (LP), morphosyntactic production (MSP), digit spans (forward span, FWS; backward span, BWS), auditory attention (AA), response set (RS), word repetition (WR), morphosyntactic reception (MSR), lexical reception (LR), and nonword repetition (LITMUS-QU-NWR, NWR). At the end of each testing session, children were rewarded for their participation with a small gift (stickers, coloring books, pencils). At the end of the session, the CBCL questionnaire was completed in French by the parents with the assistance of the experimenter. Parents of bilingual children could either communicate with the experimenter in their mother tongue when this was possible (Arabic or Tigrinya), or benefit from the presence of a facilitator for translation otherwise. For language tasks, children's oral responses were recorded.

2.4. Data Analyses

Data coding and scoring quality was ensured by the four independent, linguistically trained native French speakers who collected the data. Each score was checked by at least one experimenter; when scoring differed, the two experimenters discussed about the final score to adopt and a third experimenter was solicited when needed. Since data could not be collected for all subtests on all children, analyses were conducted on three different data sets: (i) a sample involving children for whom a CBCL measure had been obtained

(*N* = 56), on the basis of which we assessed the predictive role of refugee status on emotional well-being and the predictive role of well-being on executive functions and language, (ii) a sample involving bilingual children only, with similar LoE for refugee and non-refugee children (*N* = 40), allowing us to assess the predictive role of refugee status on language measures, and (iii) a wider sample of children (including monolinguals, bilinguals refugees and non-refugees) for whom most measures of executive functions and language were available (*N* = 87), on the basis of which the predictive role of refugee status on executive functions as well as the predictive role of executive functions on language were explored. Outliers were kept in analyses, as the chances that they are due to incorrectly entered or measured data are weak (children's responses were encoded and checked by at least two experimenters) and they are an intrinsic characteristic of our population.

Two sets of analyses were conducted on raw scores for CBCL, memory, executive functions and the nonword repetition tasks, on standardized scores for standardized language tasks, and on proportions for the sentence repetition task. The first set of analyses aimed at determining whether refugee children are at risk. To assess their vulnerability with regard to emotional well-being, their score on the CBCL parental questionnaire was compared to that of non-refugee children using the non-parametric Wilcoxon–Mann–Whitney test for independent samples. To assess refugee children's vulnerability with regard to cognitive and language tasks, multiple linear regression models were conducted including as variables refugee status (with non-refugee as reference level) as well as age and LoE, since these tasks involved linguistic materials presented in French (logistic regressions were run for the sentence repetition task since data were proportions, fitting a quasi-binomial distribution allowing for data overdispersion). AoA was not introduced in the models because it correlated with LoE; to avoid collinearity, LoE alone was introduced. LoE was preferred to AoA as it failed to correlate with age, whereas AoA did. The second set of analyses explored relationships between tasks. We explored whether emotional well-being predicts language and cognitive functions, and whether cognitive functions predict language. Multiple linear regression models (or logistic regressions in the case of the sentence repetition task) were conducted with scores to the different tests as factors, as well as age and LoE. Model selection was done by means of a backward stepwise algorithm based on AIC for linear regressions, and of likelihood ratio tests comparing the likelihood of the data under the full model against that of reduced models in the case of logistic regressions. In the regression models, the reference level for refugee status was non-refugee. Additional, exploratory analyses were also conducted to assess other hypotheses addressed in the Discussion; they are not reported in the Results section. All analyses were conducted in R (R Core Development Team 2016).

3. Results

3.1. Are Refugee Children at Risk?

3.1.1. Emotional Well-Being

Data from CBCL were collected from parents of 56 children: 29 non-refugee children (*M* = 7;2, *SD* = 0;9, range: 5;6–8;8) and 27 refugee children (*M* = 7;7, *SD* = 1;1, age range: 5;3–8;11). Six of the parents filled in the version of the questionnaire for children below age 6 (2 non-refugee and 4 refugee children).

Results are illustrated in Figure 1. Refugee children showed significantly higher scores to the CBCL (*M* = 25.1, *SD* = 14.3) than non-refugee children (*M* = 18.8, *SD* = 12.3), as attested by the Wilcoxon–Mann–Whitney test ($W = 266$, $p = 0.040$), with a moderate effect size ($r = 0.275$). Since high scores indicate increased vulnerability, this result shows higher emotional vulnerability in refugee children.

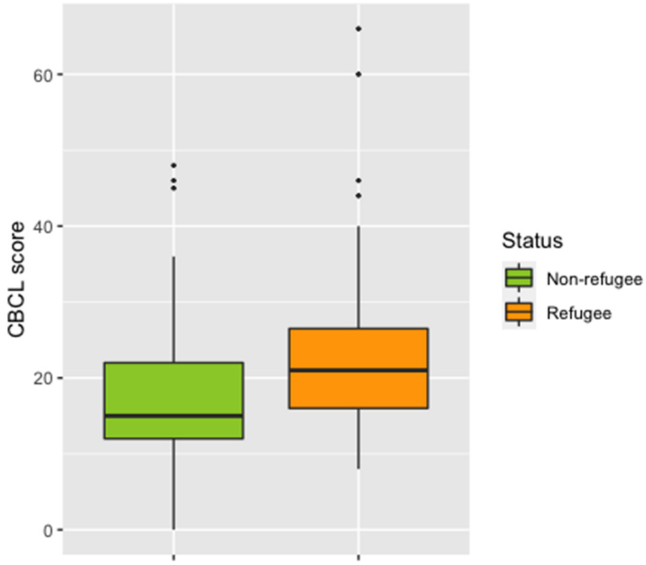

Figure 1. Distribution of refugee and non-refugee children's scores to the Child Behavior CheckList (CBCL).

3.1.2. Memory and Executive Functions

Measures of executive functions including the forward digit span (FWS), the backward digit span (BWS), the auditory attention test (AA), the response set test (RS) and the design fluency test (DF) were collected from 87 children: 61 non-refugee children (*M* = 7;6, *SD* = 0;7, range: 6;0–8;8) and 26 slightly older refugee children (*M* = 8;2, *SD* = 0;6, range: 7;3–8;11). The two groups differed in LoE (non-refugee: *M* = 5;4, *SD* = 1;9, range: 2;0–8;1; refugee: *M* = 2;2, *SD* = 1;7, range: 0;6–5;6) and in AoA (non-refugee: *M* = 2;2, *SD* = 1;11, range: 0;0–6;0; refugee: *M* = 5;10, *SD* = 2;0, range: 1;2–8;5). As AoA strongly correlated with LoE ($r = -0.95$, $p < 0.001$), only LoE was introduced in regression models, together with age.

Digit spans. Results are illustrated in Figure 2. The best model fitting FWS has refugee status as significant predictor ($F(1, 34) = 11.46$, $p = 0.002$, Adjusted $R^2 = 0.23$), which is significant ($\beta = -3.42$, $t(34) = -3.39$, $p = 0.002$). The best model fitting BWS also has refugee status as predictor ($F(1, 34) = 26.35$, $p < 0.001$, Adjusted $R^2 = 0.42$), also significant ($\beta = -4.79$, $t(34) = -5.13$, $p < 0.001$). Predictors involved in best fit models are summarized in Table 1.

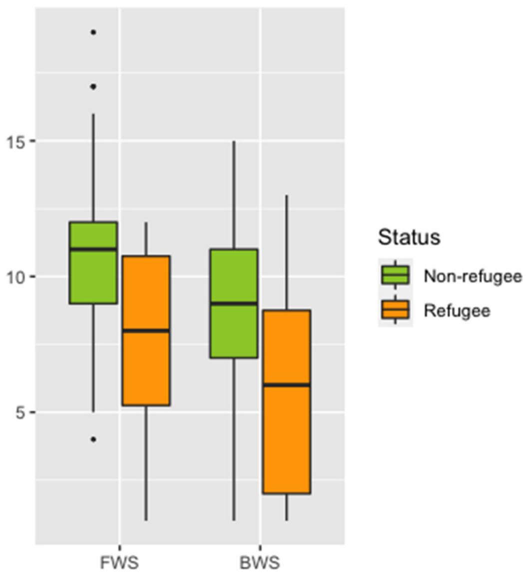

Figure 2. Distribution of refugee and non-refugee children's scaled scores to the forward span (FWS) and backward span (BWS).

Table 1. Summary of the predictors involved in best fit models assessing the role of refugee status and individual variables on executive functions.

Test	Refugee Status	Age	LoE
FWS	$p = 0.002$		
BWS	$p < 0.001$		
AA	$p = 0.019$	*ns*	
RS	$p = 0.071$		
DF	$p < 0.001$	$p = 0.005$	$p = 0.012$

Note: FWS, forward span. BWS, backward span. AA, auditory attention. RS, response set. DF, design fluency. LoE, length of exposure.

NEPSY-II. Results are illustrated in Figure 3. The best model fitting AA is marginally significant with refugee status and age as predictors ($F(2, 33) = 3.09$, $p = 0.059$, Adjusted $R^2 = 0.11$), but only refugee status significant ($\beta = -3.81$, $t(33) = -2.47$, $p = 0.019$). The best model fitting RS is marginally significant with refugee status as predictor ($F(1, 34) = 3.47$, $p = 0.071$, Adjusted $R^2 = 0.07$), marginally significant ($\beta = -2.37$, $t(34) = -1.86$, $p = 0.071$). The best model fitting DF has refugee status, age and LoE as predictors ($F(3, 32) = 7.24$, $p < 0.001$, Adjusted $R^2 = 0.35$), with refugee status significant ($\beta = -7.82$, $t(32) = -4.40$, $p < 0.001$), age significant ($\beta = 0.27$, $t(32) = 2.99$, $p = 0.005$) and LoE significant ($\beta = -0.08$, $t(32) = -2.67$, $p = 0.012$). Predictors involved in best fit models are summarized in Table 1.

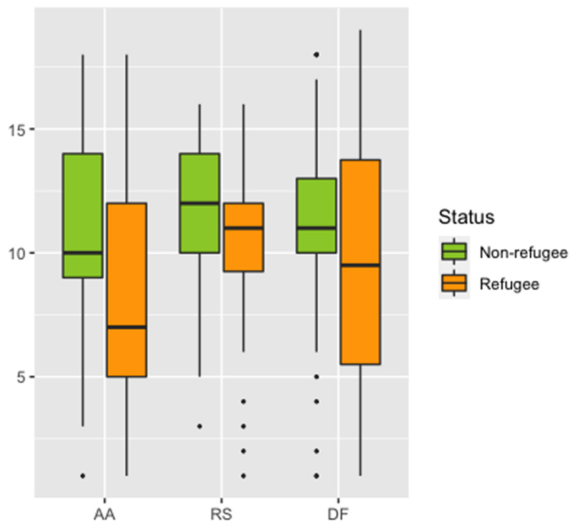

Figure 3. Distribution of refugee and non-refugee children's scales scores to auditory attention (AA), response set (RS) and design fluency (DF) tasks.

3.1.3. Language

Analyses were conducted on 40 children: 20 non-refugee bilingual children (M = 6;11, SD = 1;1) and 20 slightly older bilingual refugee children (M = 7;7, SD = 1;2). The two groups did not significantly differ in regard to LoE (non-refugees: M = 2;8 years, SD = 0;11, range = 12–66 months; refugees: M = 2;3 years, SD = 1;5, range = 8–47 months) and AoA (non-refugees: M = 4;2 years, SD = 1;6, range = 21–99 months; refugees: M = 5;3 years, SD = 1;11, range = 14–95 months). The regression models conducted to control for the effect of individual variables involved age and LoE, which did not correlate ($r = -0.07$, $p = 0.68$), but not AoA that correlated with both age ($r = 0.78$, $p < 0.001$) and LoE ($r = -0.56$, $p < 0.001$) and would therefore generate collinearity effects.

LITMUS *tests.* Results are illustrated in Figure 4. GLM model comparison showed that the best fit model for SR involves refugee status ($\beta = -1.21$, $t(37) = -3.35$, $p = 0.002$) and age ($\beta = 0.03$, $t(37) = 2.66$, $p = 0.012$). Backward stepwise multiple linear regressions showed that the best model fitting NWR involves refugee status and age ($F(2, 37) = 5.15$, $p = 0.011$, Adjusted $R^2 = 0.18$), with refugee status significant ($\beta = -7.33$, $t(37) = -2.18$,

$p = 0.036$) as well as age ($\beta = 0.35$, $t(37) = 2.92$, $p = 0.006$). The best fitting model for the no-risk index (NRI) includes refugee status and LoE ($F(3, 36) = 3.37$, $p = 0.029$, Adjusted $R^2 = 0.15$), with refugee status significant ($\beta = -2.48$, $t(36) = -2.26$, $p = 0.030$) as well as LoE ($\beta = -0.08$, $t(36) = -2.28$, $p = 0.029$). The negative contribution of LoE on the NRI suggesting that children exposed less to French have a lower risk factor is addressed in the Discussion section. Predictors involved in best fit models are summarized in Table 2.

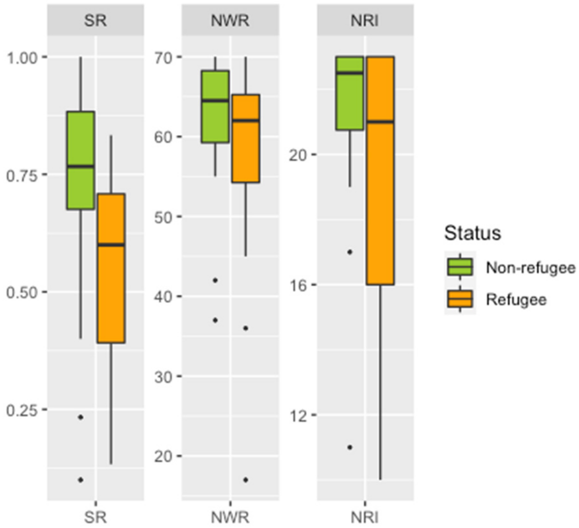

Figure 4. Distribution of bilingual refugee and non-refugee children's scores to the LITMUS tasks: LITMUS-SR-French (SR), LITMUS-QU-NWR (NWR), no-risk index (NRI).

Table 2. Summary of the predictors involved in best fit models assessing the role of refugee status and individual variables on language measures.

Test	Refugee Status	Age	LoE
SR	$p = 0.002$	$p = 0.012$	
NWR	$p = 0.036$	$p = 0.006$	
NRI	$p = 0.030$		$p = 0.029$
LP	$p < 0.001$		*ns*
LR	$p = 0.001$		$p = 0.018$
MSP	$p = 0.007$		*ns*
MSR	$p = 0.015$		
WR	$p = 0.047$	*ns*	

Note: SR, LITMUS-SR-French. NWR, LITMUS-QU-NWR. NRI, no-risk index. LP, language production. LR, language reception. MSP, morphosyntactic production. MSR, morphosyntactic reception. WR, word repetition. LoE, length of exposure.

Standardized language tasks. Results are illustrated in Figure 5. The best model fitting LP involves refugee status, age and LoE ($F(3, 36) = 11.24$, $p < 0.001$, Adjusted $R^2 = 0.44$), with only refugee status significant ($\beta = -2.23$, $t(36) = -4.17$, $p < 0.001$). The best model fitting LR involves refugee status and LoE ($F(2, 37) = 7.56$, $p = 0.002$, Adjusted $R^2 = 0.26$), with refugee status significant ($\beta = -7.81$, $t(37) = -3.45$, $p = 0.001$) as well as LoE ($\beta = -0.19$, $t(37) = -2.48$, $p = 0.018$). The best model fitting MSP involves refugee status and LoE ($F(2, 32) = 6.36$, $p = 0.005$, Adjusted $R^2 = 0.24$), with refugee status significant ($\beta = -1.42$, $t(32) = -2.86$, $p = 0.007$). The best model fitting MSR involves refugee status ($F(1, 38) = 6.44$, $p = 0.015$, Adjusted $R^2 = 0.12$), which is significant ($\beta = -1.69$, $t(38) = -2.54$, $p = 0.015$). The best model fitting WR involves refugee status and age ($F(2, 37) = 4.86$, $p = 0.013$, Adjusted $R^2 = 0.17$), with only refugee status significant ($\beta = -5.97$, $t(37) = -2.06$, $p = 0.047$). Predictors involved in best fit models are summarized in Table 2.

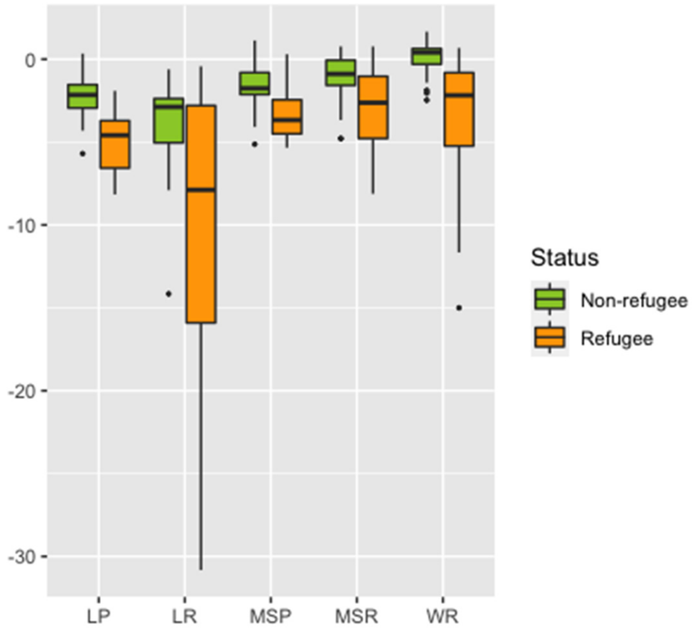

Figure 5. Distribution of bilingual refugee and non-refugee children's z-scores to the standardized language tasks: lexical Production (LP), lexical reception (LR), morphosyntactic production (MSP), morphosyntactic reception (MSR), word repetition (WR).

3.2. Do Emotional Well-Being and Executive Functions Affect Language Measures?

3.2.1. Predictive Role of Emotional Well-Being on Language and Executive Functions

Analyses were conducted on the sample described in Section 3.1.1 to explore the hypothesis of a predictive role of CBCL on language and on executive functions as well. Again, age and LoE were included in the models to control for their potential influence.

Predictive role of CBCL on language. CBCL failed to predict performance on any of the language tasks. GLM comparison showed that the best fit model for sentence repetition involves LoE and age as significant predictors ($\beta = 0.03$, $t(47) = 5.85$, $p < 0.001$ and $\beta = 0.04$, $t(47) = 2.20$, $p = 0.033$, respectively). Backward stepwise multiple linear regressions showed that the best model fitting NWR involves LoE and age ($F(2, 47) = 3.89$, $p = 0.027$, Adjusted $R^2 = 0.11$), with LoE significant ($\beta = 0.10$, $t(47) = 2.23$, $p = 0.030$) and age marginally significant ($\beta = 0.20$, $t(47) = 1.84$, $p = 0.072$). No model reached significance level for the NRI. The best model for LP contains LoE, age and CBCL ($F(2, 46) = 20.92$, $p < 0.001$, Adjusted $R^2 = 0.55$), with LoE significant ($\beta = 0.08$, $t(46) = 7.34$, $p < 0.001$) as well as age ($\beta = -0.07$, $t(46) = -2.65$, $p = 0.011$). The best model for LR contains LoE and CBCL ($F(2, 47) = 5.99$, $p = 0.005$, Adjusted $R^2 = 0.17$), with LoE significant ($\beta = 0.08$, $t(47) = 2.84$, $p = 0.007$). The best model for MSP contains LoE and age ($F(2, 37) = 26.34$, $p < 0.001$, Adjusted $R^2 = 0.57$), with LoE significant ($\beta = 0.05$, $t(37) = 5.96$, $p < 0.001$) and age marginally significant ($\beta = -0.05$, $t(37) = -1.98$, $p = 0.055$). The best model for MSR involves LoE ($F(1, 48) = 12.8$, $p < 0.001$, Adjusted $R^2 = 0.20$), significant ($\beta = 0.04$, $t(48) = 3.58$, $p < 0.001$). The best model for WR contains LoE and age ($F(2, 47) = 7.64$, $p = 0.001$, Adjusted $R^2 = 0.21$), with LoE significant ($\beta = 0.10$, $t(47) = 2.27$, $p = 0.028$) as well as age ($\beta = -0.32$, $t(47) = -2.10$, $p = 0.004$). Predictors involved in best fit models are summarized in Table 3.

Predictive role of CBCL on executive functions. Backward stepwise multiple linear regressions showed no predictive role of CBCL on memory tasks, but a significant influence on the three EF tasks, indicating that children with higher emotional vulnerability have weaker EF scores. For FWS, no model was significantly better than the null model. Model fitting for BWS involved LoE and age ($F(2, 18) = 4.44$, $p = 0.027$, Adjusted $R^2 = 0.26$), with LoE significant ($\beta = -0.07$, $t(18) = 2.87$, $p = 0.010$). Model fitting for AA involved CBCL ($F(1, 19) = 5.02$, $p = 0.037$, Adjusted $R^2 = 0.17$), significant ($\beta = -0.16$, $t(19) = -2.24$, $p = 0.037$). Model fitting for RS involved CBCL ($F(1, 19) = 11.31$, $p = 0.003$, Adjusted $R^2 = 0.34$), significant ($\beta = -0.02$,

$t(19) = -3.63$, $p = 0.003$). Model fitting for DF involved CBCL ($F(1, 19) = 4.75$, $p = 0.042$, Adjusted $R^2 = 0.16$), significant ($\beta = -0.15$, $t(19) = -2.18$, $p = 0.042$). Predictors involved in best fit models are summarized in Table 4.

Table 3. Summary of the predictors involved in best fit models assessing the role of CBCL and individual variables on language measures.

Test	CBCL	Age	LoE
SR		$p = 0.033$	$p < 0.001$
NWR		$p = 0.072$	$p = 0.030$
LP	*ns*	$p = 0.011$	$p < 0.001$
LR	*ns*		$p = 0.007$
MSP		$p = 0.055$	$p < 0.001$
MSR			$p < 0.001$
WR		$p = 0.004$	$p = 0.028$

Note: SR, LITMUS-SR-French. NWR, LITMUS-QU-NWR. LP, language production. LR, language reception. MSP, morphosyntactic production. MSR, morphosyntactic reception. WR, word repetition. CBCL, Child Behavior CheckList. LoE, length of exposure.

Table 4. Summary of the predictors involved in best fit models assessing the predictive role of CBCL and individual variables on executive functions.

Test	CBCL	Age	LoE
FWS			
BWS		*ns*	$p = 0.010$
AA	$p = 0.036$		
RS	$p = 0.003$		
DF	$p = 0.042$		

Note: FWS, forward span. BWS, backward span. AA, auditory attention. RS, response set. DF, design fluency. CBCL, Child Behavior CheckList. LoE, length of exposure.

3.2.2. Predictive Role of Executive Functions on Language

Analyses were conducted on the sample of children described in Section 3.1.2. Models tested involved scores to the memory and EF tasks as well as age and LoE. GLM comparison showed that the best fit model for sentence repetition involves FWS ($t(35) = 2.62$, $p = 0.013$), LoE ($t(35) = 3.03$, $p = 0.005$) and a non-significant component contribution of BWS. Backward stepwise multiple linear regressions showed that the best model fitting NWR includes FWS, AA and BWS ($F(2, 33) = 12.17$, $p < 0.001$, Adjusted $R^2 = 0.39$), with FWS significant ($\beta = 0.41$, $t(33) = 3.76$, $p < 0.001$) and AA significant ($\beta = 0.75$, $t(33) = 2.49$, $p = 0.018$). The best fit model for lexical production involves BWS, AA, age and LoE ($F(4, 31) = 15.27$, $p < 0.001$, Adjusted $R^2 = 0.62$) with significant effects of age ($\beta = -0.16$, $t(31) = -3.22$, $p = 0.003$) and LoE ($\beta = 0.04$, $t(31) = 3.09$, $p = 0.004$), and a marginal effect of BWS ($\beta = 0.02$, $t(31) = 1.97$, $p = 0.057$). Lexical reception showed a best fit model including FWS, AA, RS and age ($F(4, 31) = 14.43$, $p < 0.001$, Adjusted $R^2 = 0.61$), with significant effects of FWS ($\beta = 0.70$, $t(31) = 2.83$, $p = 0.008$), AA ($\beta = 0.53$, $t(31) = 2.41$, $p = 0.022$), and RS ($\beta = 0.52$, $t(31) = 2.05$, $p = 0.048$). The best model for morphosyntactic production Involves BWS, LoE, AA, RA and age ($F(5, 30) = 12.75$, $p < 0.001$, Adjusted $R^2 = 0.63$), with BWS significant ($\beta = 0.23$, $t(32) = 2.89$, $p = 0.008$) and LoE significant ($\beta = 0.04$, $t(32) = 3.85$, $p < 0.001$). The best model for morphosyntactic reception has BWS, RS and FWS ($F(3, 32) = 15.04$, $p < 0.001$, Adjusted $R^2 = 0.55$), with BWS significant ($\beta = 0.24$, $t(32) = 2.28$, $p = 0.029$) as well as RS ($\beta = 0.31$, $t(32) = 3.40$, $p = 0.002$). Finally, the best model for word repetition involves FWS, AA and age ($F(3, 32) = 9.11$, $p < 0.001$, Adjusted $R^2 = 0.41$), with FWS significant ($\beta = 0.99$, $t(32) = 2.19$, $p = 0.036$), AA significant ($\beta = 0.82$, $t(32) = 2.42$, $p = 0.021$) and age significant ($\beta = 0.53$, $t(32) = -2.64$, $p = 0.013$;). Predictors involved in best fit models are summarized in Table 5.

Table 5. Summary of the predictors involved in best fit models assessing the predictive role of executive functions and individual variables on language.

Test	FWS	BWS	AA	RS	Age	LoE
SR	$p = 0.013$	*ns*				$p = 0.005$
NWR	$p = 0.012$	*ns*	$p = 0.018$			
LP		$p = 0.057$	*ns*		$p = 0.003$	$p = 0.004$
LR	$p = 0.008$		$p = 0.022$	$p = 0.048$	*ns*	
MSP		$p = 0.006$	*ns*	*ns*	*ns*	$p < 0.001$
MSR	*ns*	$p = 0.029$		$p = 0.002$		
WR	$p = 0.036$		$p = 0.021$		$p = 0.011$	

Note: SR, LITMUS-SR-French. NWR, LITMUS-QU-NWR. LP, language production. LR, language reception. MSP, morphosyntactic production. MSR, morphosyntactic reception. WR, word repetition. CBCL, Child Behavior CheckList. LoE, length of exposure. FWS, forward span. BWS, backward span. AA, auditory attention. RS, response set. LoE, length of exposure.

4. Discussion

Our results have highlighted three major findings. First, refugee children are at risk on the three domains assessed: the emotional, cognitive and language domains. They show higher emotional vulnerability as well as weaker memory and executive functions when compared to non-refugee children, and when compared more specifically to bilingual, non-refugee children with similar length of exposure to French, they perform more poorly in LITMUS and standardized language tasks. Second, emotional well-being fails to predict language performance, while it plays a predictive role in executive function measures. Third, a substantial interplay of memory/executive functions and language performance was found. We discuss the three findings in turns.

4.1. Refugee Children Are at Risk

In line with results of Paradis et al. (2022), results show that the refugee children we assessed, aged 5 to 9 years old and who have been living in Switzerland for about 2 years, have enhanced emotional vulnerability, as attested by their higher score to the Child Behavior Checklist. The goal of this study was not to provide a fine and thorough examination of children's mental health, but rather to obtain a general score of vulnerability to relate to children's language (and executive functions) abilities. Finer analyses of the parental questionnaires could certainly be conducted, but this falls outside the scope of the current project. Nevertheless, our result aligns with the literature that reports high prevalence of post-traumatic stress disorder, depression and anxiety in refugee children (Bronstein and Montgomery 2011; Fazel and Stein 2002; Jensen et al. 2019). Refugee children are indeed exposed to numerous stressors not only before and during the migration journey, but also once the family has settled in the host country (see Fazel 2015; Fazel and Stein 2002; Reed et al. 2012). At the time the parents filled in the CBCL questionnaire, children may have started to experience the negative social perceptions reported in the literature impacting their identity and their self-esteem (Fazel 2015). The children tested were all coming from non-European countries. Hence, in comparison to non-refugee bilingual children, who for the most part came from European countries, refugee children may encounter enhanced racist and stigmatizing attitudes toward them (a current illustration comes from the difference between the way mass media treat Ukrainian migrants compared to migrants coming from Africa, Asia or the Middle East).

Refugee children also showed significantly weaker performance than non-refugee children in memory tasks: they had lower scores on both the forward digit span involving verbal short-term memory and the backward span involving an additional component of working memory. This finding is in line with the large-scale study showing lower memory scores of Syrian refugee children in Lebanon (Kim et al. 2020). Refugee children also showed weaker scores on the three tasks of the NEPSY-II tapping into executive functions. They obtained lower scores in the design fluency task tapping into planning and shifting abilities, in the auditory attention task, and in the response set task tapping into shifting and inhibition. This finding aligns with the report that refugee preschool children in Turkey have weaker cognitive flexibility than their classmates (Tuncer 2021). Executive functions disorders have been attested in children with psychopathological disorders like PTSD and in children exposed to violence or neglect, suggesting a potential causal link (Beers and De Bellis 2002; Buckner and Kim 2012; DePrince et al. 2009; Haft and Hoeft 2017; McCoy et al. 2015; Samuelson et al. 2010). In line with this possibility, our data showed that well-being predicted scores to the three executive functions tasks involving attention, inhibition and shifting, although it failed to predict memory performance.

It has been argued that a two-way relationship may link executive functions and well-being. Some studies have indeed suggested that executive functions may have an impact on emotional well-being, via two different mechanisms. On the one hand, a deficit in these functions has negative consequences on individuals' ability to regulate their emotions (Van der Linden 2004). On the other hand, weak executive functions impact school and academic success, which is likely to give rise to low self-esteem, anxiety and depression (Han et al. 2016). Additional exploratory analyses in our dataset show that performance on the three executive functions tasks, but not on digit span tasks, predict children's CBCL scores. Refugee children's weak executive functions may thus actually add up to the factors contributing to their low well-being. Further research with wider samples and adequate modeling tools is needed to better understand the relationship between well-being and EF, particularly in individuals who have weaknesses in these areas.

When compared to bilingual children matched in terms of length of exposure to L2 French, refugee children showed significantly weaker performance on all language tasks: word and nonword repetition, sentence repetition, lexical comprehension and production, as well as morphosyntactic comprehension and production. Data from the parental questionnaire also showed a significantly lower no-risk index of language disorder in refugee children. This index takes into account the age of onset of the first word, age of onset of the first sentence, parental concerns and the presence of language difficulties in the family. Our results thus show that refugee status similarly affects the LITMUS tasks and the standardized tasks more commonly used to assess children's language in French. These findings globally align with recent research attesting to the significantly poorer performance of refugee children on measures of vocabulary and morphosyntax relative to younger heritage bilinguals (Abed Ibrahim et al. 2020) even on tests that were standardized for bilingual children (Hamann et al. 2020), some even suggesting that refugee children may not significantly differ from children with DLD (Hertel et al. 2021).

The role of individual variables on bilingual children's language development has been assessed on three different data samples. Nevertheless, interpretation should be focused on the sample used to assess language performance of bilingual children only, since the other samples also contained monolinguals. Age affected performance on the two LITMUS tasks, older children performing better than younger children. In contrast, it failed to affect performance on the five standardized language tasks, as expected if standardization properly controls age variations. LoE played no role in performance on the two LITMUS tasks, bringing further evidence to the claim that these tasks are adequate to assess bilingual children who have not yet received substantial L2 exposure (Dos Santos and Ferré 2018; Tuller 2015; Fleckstein et al. 2018). Nevertheless, LoE negatively predicted both the no-risk index score of PABIQ and performance on the standardized lexical reception task; that is, the more children had been exposed to French, the higher was their risk factor and the lower was their lexical reception score. We suggest that these effects actually reflect the involvement of another variable, age of acquisition, which correlated negatively with LoE in our sample: children with weaker exposure were exposed at a later age. The finding that children who were exposed later to French showed better lexical comprehension is actually in line with various other studies that also controlled LoE, which have also shown that children exposed late are more advanced in their lexical and morphosyntactic development (Blom and Bosma 2016; Chondrogianni and Marinis 2011; Paradis 2011; Rothman et al. 2016). It has been suggested that the greater cognitive and linguistic maturity of older children may provide them with an advantage in L2 vocabulary development. The possibility that the no-risk index of PABIQ be to age of acquisition has not been investigated, to our knowledge. The finding that children exposed late to French have a higher risk factor, a measure that characterizes children's mastery of their native language and not of French, is puzzling. Age of exposition corresponds to age of migration; it may be the case that parents' responses are biased by their perception of their child's language vulnerability in L2 French, which may be increased for children who migrated older. A more thorough exploration of how parents' responses to various components of the PABIQ may be affected by variables like their perception of their child's competence in the host country, the nature of migration, parents' literacy and socio-economic status is out of the scope of this paper. Some authors have for example suggested that other indexes may be more appropriate for parents with low literacy (e.g., the Positive Early Development Index, Tuller et al. 2018). We leave the deeper exploration of this question to future research.

It is important to note that although this study shows that refugee children have across-the-board lower scores on cognitive and language tasks, it does not allow determining the cause(s) of their difficulties. One possible factor is families' socioeconomic status (SES), which was not measured, in contrast to Paradis and colleagues' study (2022). A number of studies have shown the impact of SES on bilingual language acquisition (Armon-Lotem et al. 2011; Hamann et al. 2020; Hertel et al. 2021; Paradis 2011; Prevoo et al. 2014). Maternal education, often used as an index of SES, may specifically affect refugee children coming from cultures where women have lower access to education. Recent studies indeed suggest that the richness of children's home language environments, that is, the amount of diverse and complex language input experience, may be poorer in refugee families (Paradis et al. 2020). Research has also highlighted the global association between poverty and cognition (Haft and Hoeft 2017; McCoy et al. 2015). A recent large-scale study conducted on Syrian refugee adolescents in Jordan even suggested that the positive link reported between executive functions and exposure to trauma may actually be mediated by poverty (Chen et al. 2019). Nevertheless, SES differences between refugee and the non-refugee bilingual children tested in our sample may be reasonably small. Indeed, data were for the most part collected in schools situated in economically low SES areas (Vernier, Meyrin). Parents of most non-refugee bilingual children tested were from Spain, Italy and Portugal who generally show lower socioeconomic status in Geneva (Liebig et al. 2012). Still, one cannot exclude the possibility that SES has played a role in our data, and more research is thus necessary to better understand the role of these factors in refugee children's bilingual and cognitive development.

Another possible factor explaining the higher vulnerability of refugee children compared to non-refugee bilingual children is that the former's native language(s) are typologically very different from French, whereas the latter had for the most part European as native languages, and the majority of them even Romance languages (Spanish, Italian and Portuguese). Research has shown that the typological proximity among the speaker's known languages and the new language may affect language learning (see Blom and Paradis 2015 for morphology, or Sorenson Duncan and Paradis 2016 for phonology).

4.2. The Interplay of Language and Well-Being

Our results do not validate the hypothesis that language is linked to emotional vulnerability since none of the language tasks showed sensitivity to the CBCL score of well-being. This finding aligns with a recent study showing no significant link between internalizing problem behaviors and language in refugee children (Paradis et al. 2022). Nevertheless, that study reported a significant link with externalizing problem behaviors and language, and suggested that the lack of an association with internalizing behaviors may be due to the fact that parents' reports are less reliable for such behaviors, for which self-reports are more appropriate.

Although data modelling in this study explored the possibility that well-being predicts language performance, the inverse relation may also be worth considering. Indeed, some studies on the emotional well-being of children with language disorders suggest that language weaknesses may impact their well-being. Early communication problems often disappear in primary school, but when they persist, language difficulties often become more salient, resulting in an increased gap between children who suffer from them and their typically developing classmates. This manifests in terms of literacy problems (Snowling et al. 2000) and difficulties with broader academic skills (Beitchman et al. 1996). Studies have shown that children with DLD often become targets of bullying during the school years (Conti-Ramsden and Botting 2004), and parents also perceive stigmatization of their children or themselves (Macharey and Von Suchodoletz 2008). It has been argued that up to 50% of children with DLD would suffer from emotional, behavioral and/or social difficulties, a rate which is three times that seen in children without such impairments (Beitchman et al. 1996). The weak mastery of the host country language in the early years following refugee children's arrival may therefore constitute an additional burden on their emotional well-being. Exploratory analyses on our data set making use of the same regression modelling tools as indicated in the Results section showed that lexical reception plays a significant role in modelling CBCL scores (while other language measures, LoE and age do not). More in-depth research involving a longitudinal follow up of different categories of emotionally vulnerable children (like refugees and DLDs) is needed to better understand the patterns of causal relations between emotional well-being and language.

Finally, CBCL score also failed to be associated with the major cognitive predictor of language found in this study, that is, memory. However, CBCL was significantly associated with scores to the three tasks of the NEPSY-II. Two of those, namely the auditory attention task and the response set task involving attention, inhibition and shifting, were found to be associated with various of the language tasks used. Hence, the possibility that well-being is, in fact, indirectly linked to language through its link to executive functions requires further investigation with more substantial data in order to explore these indirect links.

4.3. The Interplay of Language, Memory and Executive Functions

Our finding of an association between language and memory and, to some extent, executive functions aligns with various studies from the literature (see Delage and Frauenfelder 2019, 2020; Finney et al. 2014; Marini et al. 2020; Montgomery et al. 2018; White et al. 2017). The most salient predictive effects in our data come from the association between language and the forward and backward digit memory spans: all language tasks showed sensitivity to one of the two span tasks. It has been argued that whereas the forward span would be linked to lexical capacities in children, the backward span would rather be linked to syntactic comprehension (Engel de Abreu et al. 2011) and in particular to the production and comprehension of complex sentences (Delage and Frauenfelder 2019; Montgomery et al. 2008; Montgomery and Evans 2009). Our results globally align with that claim. We found that the forward span played a predictive role in modeling nonword repetition, word repetition and lexical reception whereas the backward span predicted morphosyntactic reception and production. However, sentence repetition was predicted by the forward span, not by the backward span (see Zebib et al. 2020 for similar results in typically developing children). This finding contrasts with the significant role of the backward span found in the morphosyntactic production task, and may suggest shallow syntactic processing in sentence repetition, which does not require that the child generates any new syntactic element. In contrast to previous studies, our study involves bilingual children, some of them with particularly weak memory spans. The possibility that memory differently affects performance of children who present profiles of vulnerability in regard to memory, as is the case of refugee children, challenges the validity of LITMUS tasks for that population, and deserves further exploration, with larger data samples.

Standardized language tasks showed more widespread sensitivity to executive functions than LITMUS tasks. Most standardized language tasks showed sensitivity to auditory attention and the majority of them also showed sensitivity to inhibition/shifting, while nonword repetition only showed sensitivity to auditory attention and sentence repetition showed no sensitivity at all to either of the EF tasks. Nevertheless, given the lack of a systematic pattern and the small data sample, we will refrain from diving into interpreting these effects. The clear predictive effects of memory, together with the scattered effects of executive functions, nevertheless raise the question of the cause of the observed links between performance in memory/executive functions tasks and performance in language tasks. Two non-exclusive possibilities should be distinguished. A first possibility is that this link reflects the fact that language processing is intrinsically dependent on these cognitive functions. A range of studies have attested to lower-than-expected performance on memory and executive function tasks in children and adolescents with DLD (Delage and Frauenfelder 2020; Ebert and Kohnert 2011; Kapa and Plante 2015; Stanford and Delage 2020), which is precisely why the early label of 'Specific Language Impairment' is now 'Developmental Language Disorder' (Bishop et al. 2016). Another possibility is that the involvement of memory/executive functions may specifically be involved in performance to the language tasks used to test children, such that some tasks may rely more on memory/executive functions than others. Existing language tasks are quite heterogeneous and therefore not directly comparable; they involve different linguistic material and different procedures whose analysis in terms of the cognitive functions they involve is shallow. For example, two tasks are highly similar in the protocol we used: word and nonword repetition. The nonword memory span is known to be smaller than the word memory span, which attests to the role of long-term memory representations (i.e., lexical knowledge) in short-term memory tasks (Hulme et al. 1995; Majerus and Van der Linden 2003). Hence, it is plausible that nonword repetition involves higher memory demands than word repetition. In line with this possibility, we found that the backward memory span played a role in fitting the model of nonword repetition, but not the model of word repetition. Additional evidence comes from a side finding from the nonword repetition task (not reported in the Results section), which is that memory tends to play a stronger role for language-dependent nonwords (containing typical French consonant clusters) than for language-independent ones (respecting universal phonotactic constraints). A wider data set would be necessary to fully validate this finding; however, it supports the hypothesis that long-term representations of lower level, phonotactic units, which are weak in the bilingual children of our sample, also play a role in the task (see Gathercole et al. 1999 for effects of phonotactics on memory in monolinguals). This reasoning illustrates the kind of fine functional analysis of the tasks used to assess language that we believe should be conducted, based on research exploring the cognitive specificities of these tasks through systematic, minimal comparisons.

In sum, bi-directional relations have been reported between language and memory/executive functions in the literature. However, researchers typically focus on only one directionality of the relation. Understanding more precisely these relations indeed requires wide data sets, appropriate modeling tools, but more importantly precise theoretical hypotheses about the mechanisms underlying these relations, which are largely undefined to-date. Riches (2020) as well as Marshall (2020) highlighted the difficulty of disentangling these relationships and notably the need for large-scale longitudinal (or intervention) studies and the use of language-independent measures of memory. A few studies using longitudinal designs indeed suggest bidirectional relations between language and short-term memory and/or executive functions, evolving with age (Diaz et al. 2021; Gathercole et al. 1992; Gooch et al. 2016; Jones et al. 2020). At the clinical level, however, it is important to tease apart the respective role of these functions and language in task performance. Indeed, identifying the precise locus of the child's difficulty should help determine the component to be worked on in therapy. Some studies have suggested that executive functions as well as working memory are malleable and can successfully be trained in children with DLD (Holmes et al. 2015; Delage et al. 2021; Stanford et al. 2019; Vugs et al. 2017), with additional positive transfer effects on language (Delage et al. 2021; Stanford et al. 2019). A precise diagnostic can therefore determine whether this kind of rehabilitation program is needed or not.

5. Conclusions

Our study has attested to increased emotional vulnerability, weaker executive functions, and overall poorer language skills of newly arrived refugee children in Switzerland. Lower levels of L2 French as compared to similarly exposed non-refugee bilingual children were manifest across LITMUS tasks and standardized language tasks whatever the language domain considered: phonology, lexicon and morphosyntax. Although well-being does not account for their lower levels of language performance, refugee children's weaker executive functions and in particular memory may be responsible for at least part of their language difficulty.

Multiple factors may account for refugee children's cognitive and language disadvantages, involving socioeconomic status, the richness of the language environment, maternal education and cultural background. However, regardless of the exact cause of these across-the-board difficulties, our findings should receive attention from (i) the research community, to better understand the interplay between language, memory and executive functions, (ii) the speech-language therapists in charge of refugee children, to interpret with caution their observations and avoid language disorder over-diagnosis, and (iii) authorities in charge of this target population, to develop enriched language education programs for children, improve refugee families' living conditions, and develop policies against discrimination in order to improve the well-being of this vulnerable population.

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Notes

1 Following common practice in the field, 'L2' will be used to refer to the newly learned, host country language, even though children may have more than one language.

2 The generic term 'refugee' is used in this paper to refer to forced migrants, independently of their legal status.

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