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ARTICLE

Internal and external factors contributing to variability in consonant accuracy of Arabic–French simultaneous bilingual children

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Abstract

This study aims to describe the relationships between child-internal and child-external factors and the consonant accuracy of bilingual children. More specifically, the study looks at internal factors: expressive and receptive vocabulary, and external factors: language exposure and language status, of a group of 4-year-old bilingual Arabic–French children. We measured the consonant accuracy of the children by the percentage of correct consonants in a Picture-Naming Task and a Non-Word Repetition Task in each language. The results suggest a significant relationship between vocabulary and consonant accuracy. A cross-language correlation was observed between the expressive vocabulary level of the majority language (French) and the consonant accuracy of the minority language (Arabic). Also, a significant correlation was found between Arabic language exposure and Arabic consonant accuracy. Finally, consonant accuracy was significantly higher in French tasks than in Arabic, despite the individual differences of the children.

Keywords: children; bilingual; phonology; Arabic; French

Introduction

As with monolingual children, there is variability in language acquisition in bilingual children (Davison, 2009). Several internal and external factors influence bilingual development in general: interaction between languages (e.g., Meziane & MacLeod, 2021), the age of language acquisition, the amount of language exposure, the relationship between the languages of learning, the social context of language acquisition, and the social status of the language (Birdsong, 2006). The amount of language exposure is reported to affect language dominance (Cooperson, Bedore & Peña, 2013). In monolingual children, the interactions between different domains of language such as phonology and vocabulary also support language acquisition (Cooperson et al., 2013). Bilingual language development may be best understood by accounting for the influences between child-external factors like the macrosystem (e.g., society), the exosystem (e.g., community), and the microsystem (e.g., child's family), and child-internal factors (e.g., child's age, language

abilities) (Bird, Trudeau & Sutton, 2016). Similarly, for speech acquisition, Davis and Bedore (2013) describe how factors internal to the child (e.g., perception) interact with factors external to the child (e.g., ambient phonology). Studies have examined the influence of internal and external factors on the phonological development of monolingual children (e.g., Stoel-Gammon, 2011) and recently of bilingual children (e.g., Goldstein, Fabiano & Washington, 2005; Kehoe & Havy, 2019; Sorenson Duncan & Paradis, 2016). For bilingual children, an understanding of how child-internal and external factors influence the rate of L2 acquisition can serve two purposes: supporting educators and clinicians in interpreting evaluations of academic achievement and speech-language assessments, and advising parents regarding language use at home and at school (Paradis, Genesee & Crago, 2011).

In 2019, the number of migrants in the world was about 272 million people (United Nations, n.d.), which also leads to a greater number of people who speak more than one language. In Canada, for example, the increase of immigrants and refugees has led to increases in the number of bilingual children attending school, including increases in Arabic-speakers, which represents the second largest minority language spoken in Québec (Statistiques Canada, 2017). It is therefore becoming critically important that we understand the factors associated with phonological development to better identify a speech sound disorder in this community. In addition, research that focuses on simultaneous bilingual children is needed as previous work has tended to focus on sequential bilingual children (Cooperson et al., 2013). We conducted a first study on the phonological development of three-year-old simultaneous bilingual Arabic–French children (Meziane & MacLeod, 2021). Eight children in the present study were also in the previous study at age 3 years old (Meziane & MacLeod, 2021). This previous study described an influence between the languages that resulted in a positive transfer for the consonant accuracy of consonants shared by both languages. Language interaction was found, supporting previous cross-linguistic work on bilingual phonological acquisition (e.g., Fabiano-Smith & Goldstein, 2010). Given individual differences within the group, the present study aims to understand the role of child-internal and child-external factors on consonant accuracy. Specifically, we have focused on the following factors: between-language interaction, expressive and receptive vocabulary (child-internal factors), amount of exposure to each language, and the sociolinguistic context of languages (child-external factors). A summary of the literature on these factors is presented below.

Child-Internal factors

The present study will focus on between-language interaction and vocabulary as a key child-internal factor that influences phonological development.

Between-language Interactions

Research on bilingual phonological development has highlighted interaction effects between languages. Phenomena of acceleration and deceleration are described when analyzing bilingual phonological development (e.g., Fabiano-Smith & Goldstein, 2010; Meziane & MacLeod, 2021). The acceleration is observed by a better consonantal accuracy for consonants shared by both languages (e.g., Meziane & MacLeod, 2021). The deceleration is observed by a lower consonantal accuracy for the consonants specific to each language of the bilingual child, and by using specific phonemes from one language

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in the other language (e.g., Meziane & MacLeod, 2021). A previous study with a portion of this cohort of children (8 children) revealed that the consonantal accuracy of shared consonants is higher than that of specific consonants. This is also expected for this larger cohort of children. In order to measure the interaction between the languages, it is necessary to identify the similarities and differences between the phonological systems of Algerian Arabic and Quebec French. We find that the two languages share 17 consonants /p, b, t, d, k, g, f, v, m, n, s, z, ʃ, ʁ, l, w, j/. On the other hand, there are 14 consonants that exist in Algerian Arabic, but not in French: /θ, h, ħ, χ, ð, tˤ, ðˤ, sˤ, dˤ, ʕ, ʔ, q, r/. Conversely, the 3 consonants in French that are not present in Arabic are /ɲ, ɥ, ʒ/. When comparing the syllabic structures of the two languages, we note that French allows the grouping of more than 2 consonants in the same syllable (e.g., /scʁipt/) whereas Arabic only allows consonantal clusters of 2 consonants (e.g., /nasr/, which means victory).

Vocabulary

Since there are fewer studies on cohorts of bilingual children, we first present what research has established about the relationship between vocabulary and phonology in monolingual children. Indeed, in her commentary in 2011, Kehoe noted that current research had not addressed the relationship between phonological and lexical development in bilingual children to the same extent as it has in monolingual children, or as in other domains such as lexical and grammatical development. Research on the development of phonology in monolingual children shows that phonological production abilities influence lexical acquisition (expressive and receptive vocabulary) (e.g., Kehoe, Patrucco-Nanchen, Friend & Zesiger, 2018; Stoel-Gammon, 2011). It is important to note that phonological development is measured in different ways: some studies focus on phoneme accuracy in real words, while others focus on phonological working memory in non-word repetition tasks.

Receptive vocabulary

Researchers have studied the relationship between lexical and phonological development by considering receptive vocabulary in monolingual children (e.g., Bowey, 2001; Gathercole, Service, Hitch, Adams & Martin, 1999). For monolingual children, Gathercole and Baddeley (1989) show that non-word repetition measured at age 4 predicted receptive vocabulary at age 5. This interaction between the two systems can be explained by the connectionist model of two representations in lexical processing. In this model, a lexical representation corresponds to the vision of a word as a whole unit, while the phonological representation corresponds to the sequence of individual sounds composing the word. The lexical representation may play a role in how the word is perceived and produced, while the phonological representation may affect how the word is produced, encoded and processed (Cummings & Barlow, 2011). This model shows a close link between mental lexicon representation and phoneme representation. Overall, Bowey (2001) proposes that the capacity component of non-word repetition contributes directly to vocabulary in young children. Research has suggested that an increase in receptive vocabulary leads to finer phonological representations and, subsequently, an increased ability to represent phonological information that results in better performance on nonword repetition tasks (Hoff, Core & Bridges, 2008).

In bilingual children, there has been less research on the relationship between phonological and lexical development (Kehoe, 2015, 2011; Meziane & MacLeod, 2017;

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Vihman, 2016, 2002). For example, Sorenson Duncan and Paradis (2016) found that English receptive vocabulary size had a positive and significant effect on non-word accuracy for a cohort of 75 typically developing English language learners aged 5;0 to 6;9 years old. Larger vocabularies were associated with more accurate productions for sequential bilinguals. Regarding the receptive vocabulary, research shows us that receptive vocabulary size appears to be an important individual difference factor that can affect non-word repetition performance in bilingual children, particularly in the early stages of language learning (Masoura & Gathercole, 1999; Thordardottir & Brandeker, 2013). In contrast, Summers, Bohman, Gillam, Peña and Bedore (2010) studied the Spanish–English bilingual children aged four to six years on a non-word repetition task. They found that the children's performance was related to measures of morphosyntax but not to lexical measures in each language (Summers et al., 2010). Only one study described the relationship between receptive vocabulary and consonant accuracy in a picture-naming task (Meziane & MacLeod, 2017). This study found no significant correlation between receptive vocabulary and consonant accuracy in a group of bilingual six-year-old children.

Expressive vocabulary

In monolingual children, our understanding of the relationship between lexical and phonological accuracy is based more on expressive vocabulary. Studies in monolingual acquisition document a clear relationship between the number of expressive words in a child and phonological ability (e.g., Bortolini & Leonard, 2000; Kehoe, Chaplin, Mudry & Friend, 2015; Petinou & Okalidou, 2006). Researchers suggest that children produce words based on their phonological abilities, particularly when they have a small vocabulary (e.g., Petinou & Okalidou, 2006; Smith, McGregor & Demille, 2006). Children build the phonological repertoire that provides a foundation for word production (Kehoe et al., 2018; Vihman, DePaolis & Keren-Portnoy, 2014). Babbling, when well established, may support the memory of similar sequences from the language "input" (Stoel-Gammon, 2011). On the other hand, expressive vocabulary may also be a component that could influence the development of phonology. Wiethan, Mota and Moraes (2016) indicate that children with a large vocabulary have a more complex phonological system than those with a small vocabulary because the higher number of words produced requires a more complex phonological system. It is true for the production of real words and the production of non-words. Non-word repetition studies have shown that vocabulary size is a better predictor of non-word accuracy than chronological age or articulatory skills (Edwards, Beckman & Munson, 2004; Zamuner, 2009). The association between vocabulary size and phonological production has been observed in a variety of languages: French, English, Cypriot Greek, Italian, and Cantonese (Bortolini & Leonard, 2000; Fletcher, Chan, Wong, Stokes, Tardif & Leung, 2004; Kehoe et al., 2018; Petinou & Okalidou, 2006).

In bilingual children, there appear to be strong within-language correlations between phonological and expressive vocabulary development (Kehoe, 2011; Meziane & MacLeod, 2017), although this relationship is less important than between morphosyntax and phonology (Cooperson et al., 2013). It has been shown that, like the monolingual children in the studies cited above, bilingual children produce words that contain the acquired phonemes and avoid those that are more difficult for them to acquire (Stoel-Gammon, 2011). Bilingual children use a phonological strategy that influences lexical selection patterns similarly in both languages (Vihman, 2002; Yavas, 1995). Like

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monolingual children, they choose to produce words based on the avoidance of difficult phonological features.

Some studies have looked at the inter-linguistic role of expressive vocabulary on the phonological development of bilingual children (e.g., Cooperson et al., 2013; Kehoe & Havy, 2019; Parra, Hoff & Core, 2011). There is evidence that children with a larger vocabulary had higher accuracy in their phonology than children with a smaller vocabulary size. Parra et al. (2011) studied the phonological accuracy of Spanish–English bilingual children on non-word repetition tasks at 22 months of age and the size of their vocabulary at 25 months of age. The results showed significant relationships between non-word repetition task scores and measures of vocabulary within and across languages. In a group of 5-year-olds, Cooperson et al. (2013) described a non-significant inter-linguistic relationship between vocabulary and phonology, but a significant intra-linguistic relationship. By measuring the words known in both languages spoken by bilingual children, Kehoe and Havy (2019) found that a bilingual child's total expressive vocabulary played a major role in their phonological performance on a French picture-naming task in French-speaking simultaneous bilingual children aged 2;6 years. However, they did not find the same results when only vocabulary in French was considered. These researchers suggest that the relationship between total vocabulary and phonological scores in French provides evidence of correlations between the children's languages such that knowledge (and production) of words in one language facilitates phonological production in the other language, probably because of the common phonological structures of both languages (Kehoe & Havy, 2019). However, the relationship across both languages remains poorly understood as these children were only assessed in French. In addition, reduced lexical abilities in French were not necessarily associated with reduced phonological abilities, since some children with low vocabulary in French still had above-average phonological accuracy scores. These studies suggest interesting inter-linguistic relationships between the phonology and lexical abilities of bilingual children, but more research is needed to better understand them.

Overall, studies tend to show a relationship between lexical, whether receptive or expressive, and phonological performance. It should also be noted that the variables that affect expressive vocabulary acquisition should also affect receptive vocabulary acquisition (Maekawa & Storkel, 2006). Also, advanced phonological skills are generally observed in the dominant language of bilingual children, suggesting that phonological development is correlated with lexical development on a language-specific basis (Kehoe, 2011).

Child-External factors

Child-external factors have also been studied to understand the individual variability of phonological performance between bilingual children. The most studied factors are socioeconomic level and language experience (e.g., Kehoe & Havy, 2019; Parra et al., 2011). The present study focuses on language exposure and the sociolinguistic context to understand the differences between the results of different studies of bilingual children.

Language exposure

Language exposure is a common factor in studies of bilingual children. Cooperson et al. (2013), for example, show that there is a small correlation between language exposure and

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phonology competence of bilingual English-Spanish five-year-old children who were exposed to Spanish from birth. In their study, language exposure was calculated by the percentage of English input/output at home and school, combined with the age of first English exposure. The phonology competence was measured by the Bilingual English-Spanish Assessment phonology subtest – a single-word test of articulation in English and Spanish (Cooperson et al., 2013). Another study looked at the link between phonology and language experience, language exposure was measured by the balance of English and Spanish at home, and phonological competence was observed through a non-word repetition task (Parra et al., 2011). The percentage of children's home language exposure in English was positively related to their non-word repetition accuracy for English but less for Spanish (Parra et al., 2011). The authors suggest that language exposure resulted in the children building mental representations of the phonemes and phonotactics of each language. Summers et al. (2010) also found a significant correlation between the number of non-word repetitions and cumulative language experience, measured as a combination of language input and output, for bilingual children in Texas. Thordardottir and Brandeker (2013) obtained different results depending on the language tested for a group of English–French bilingual 5-year-old children. Specifically, they observed an effect between the amount of English exposure since birth and the performance on English non-word repetition, but no effect was observed between French exposure and French non-word repetition. Their results suggest that the strength of the association between non-word repetition in English and exposure is considerably weaker than previously reported for receptive vocabulary, and even weaker for expressive vocabulary (Thordardottir & Brandeker, 2013). Few studies have addressed this issue directly; however, existing research tends to show that phonological performance is related to language exposure. Specifically, greater phonological accuracy has been observed for the dominant language (Summers et al., 2010). Evidence of the influence of language experience includes findings that children show better memory for sound sequences in real words than in non-words (Chiat & Roy, 2007).

Sociolinguistic context of languages

Beyond language experience measured by time, there is also a difference in language experience depending on the sociolinguistic context of the language. In a sociolinguistic framework, we can identify differences in prestige and power between the languages spoken in a community and between a majority and a minority language. A majority language is the official or standard language used by society, while a minority language is a language used by a subgroup of the society (Paradis et al., 2011). The minority language usually relies solely on the family or on some structures available outside the home to support that language; thus, the child has fewer opportunities to use the minority language compared to the majority language (MacLeod, Fabiano-Smith, Boegner-Pagé & Fontolliet, 2013). Lack of use of the minority language often leads to attrition of the minority language (Ricento, 2005) and can result in language dominance in the majority language for many bilingual children.

The research reviewed above highlights the complex roles that are played by child-internal factors (i.e., language interactions, receptive and expressive factors) and child-external factors (i.e., language exposure and the broader sociolinguistic context) in bilingual phonological development. Research shows that children produce different patterns of acquisition for shared and non-shared consonants across their two languages (e.g., Meziane & MacLeod, 2021). Research on receptive vocabulary is inconsistent, as not

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all studies show a relationship between receptive vocabulary and non-word repetition (e.g., Summers et al., 2010), and few studies have focused on phonology in real words. It seems that phonological capability may be less associated to lexical knowledge (Cooperson et al., 2013; Summers et al., 2010). Conversely, research on expressive vocabulary suggests a clear intra-linguistic link with phonological abilities measured in non-word repetition (Storkel, 2006) and real words (Kehoe & Havy, 2019). However, the inter-linguistic link between expressive vocabulary and phonological accuracy is less clear (e.g., Kehoe & Havy, 2019). Language experience as a child-external factor is studied more in bilingual children. The language that the child hears and uses most frequently is usually their dominant language, and many studies show that the dominant language of a bilingual child is associated with better phonological accuracy (e.g., Law & So, 2006; Mayr, Howells & Lewis, 2015). Finally, research on language sociolinguistic context shows the difficulty of acquiring a language with minority status in society (MacLeod et al., 2013; Ricento, 2005).

Current study

In addition to contributing to the literature on the link between internal and external factors and phonology in bilingual children, this study goal of this study is to address four of the gaps in the literature. First, while previous studies measure phonological accuracy often focus on non-word repetition tasks, we also use a picture-naming task. The picture-naming task is used to more accurately estimate the early phonological abilities of children by spontaneous speech (Kehoe & Havy, 2019). The non-word repetition task is used to better separate the role of lexical knowledge from phonological knowledge since it is less influenced by the children's previous linguistic experience (Thordardottir & Brandeker, 2013). Secondly, it is not clear whether phonological accuracy and receptive vocabulary are indeed related, as is the inter-linguistic relationship between expressive vocabulary and phonology. This study aims to re-evaluate these two hypotheses. Thirdly, other studies have been interested in these factors (e.g., Goldstein et al., 2005) but mainly by distinguishing the different factors. Our study explores them together as has been done in more recent research (Kehoe & Havy, 2019; Sorenson Duncan & Paradis, 2016). Finally, previous studies have not explicitly looked at the sociolinguistic context of a language and phonology in the same study.

This study will integrate between-language interaction, receptive and expressive vocabulary, language experience, and sociolinguistic context as factors and phonological performance of bilingual children in both languages. Specifically, this study will analyze these links in a group of four-year-old children exposed to Algerian-Arabic and Québecois-French. The data from our sample will allow us to answer the following research question: Are there relationships between internal and external factors and the phonology in bilingual children? By analyzing the relationship between these different factors and the consonantal accuracy of each language, we can determine whether the relationships are equivalent depending on the language studied. Do these relationships correspond to general cross-linguistic patterns that could be applicable to other languages? Studying these relationships in a cohort of bilingual children thus allows us to understand the interaction between languages. It also allows us to study the relationships between domains of language in the same language and to observe if these relationships vary according to the language studied.

For child-internal factors, we hypothesize a greater accuracy for the consonants shared by the two languages (acceleration phenomenon) than for the unshared consonants.

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We also hypothesize that receptive vocabulary will result in a weak correlation between children's accuracy on non-word repetition tasks (e.g., Vihman, 2016) or picture-naming tasks (Cooperson et al., 2013). In contrast, we hypothesize that expressive vocabulary will result in a significant correlation between children's accuracy on picture-naming task (Kehoe & Havy, 2019) and non-word repetition task (e.g., Parra et al., 2011). To evaluate Kehoe and Havy's (2019) inter-linguistic hypothesis, we hypothesize that the inter-linguistic correlation between expressive vocabulary and consonant accuracy will only be significant between French vocabulary (majority language) and Arabic consonant accuracy (minority language). For child-external factors, we predict a significant relationship between the amount of exposure to a language and the child's consonant accuracy with a higher correlation for real words (Chiat & Roy, 2007), and significantly higher scores in the phonology tasks in French, the majority language, than in Arabic, the minority language.

Methods

The present study was approved by the university ethics board, *Comité d'éthique de la recherche en éducation et en psychologie*, project # 17-177-CERES-D.

Participants

For this study, 23 bilingual participants from Greater Montréal were recruited by social media and the social network of the first author. Eight children among the participants participated in a longitudinal study from three years to four years and 6 months. Their performance at three years of age is reported in Meziane and MacLeod (2021), while the other 15 children participated only at the age of four. A video recording was made for each session and used for the analysis. All children were between 4 and 5 years old (mean age= 4;5 year-old), had been exposed to French and Arabic by 18 months of age, and were exposed to a minimum of 20% input for each language (Fabiano-Smith & Goldstein, 2010). We use the working definition of "simultaneous bilinguals" to refer to their bilingual development because these children had been exposed to two languages before three years of age (Genesee & Nicoladis, 2006). All the children were born in Canada except participant #18, who arrived in Canada 18 months before the start of the research project. We had three groups of siblings: two sisters (#4 and #8), a brother and sister (#16 and #23), and twin girls (# 19 and #20). All children except #19, 20, and 21 attended daycares. Children #19 and 20 attend a school preparation activity half a day per week, and child #21 stayed at home with his mother. All children watched media in French, with 9 of them watching media in Arabic, and 5 of them also watching media in English. The 5 children exposed to more than 50% Arabic daily were exposed 100% to media in French or 70% to media in French compared to 30% in Arabic. Table 1 provides demographic information about 23 children. We included the percentage of language exposure measured by interaction opportunities in each language as well as passive media exposure to better understand the linguistic portrait of the child's individual language context. Only children whose parents had completed the consent form were eligible to participate in the research project.

Data collection

The 23 children were evaluated in French by a trained research assistant and in Arabic by the first author, a native speaker of this variety of Arabic. Parents were present during

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Table 1. Demographic information of bilingual participants

Child ID	Gender	Age (months)	Percentage of Exposure in French (%)	Percentage of Media in French (%)	Percentage of Media in Arabic (%)	Percentage of Media in other language (%)
001	M	54	70.8	50	0	50
002	F	48	62.1	90	10	0
003	F	54	26	70	30	0
004	F	48	74.8	100	0	0
005	M	48	86.1	100	0	0
006	M	54	76.7	100	0	0
007	F	54	43.2	100	0	0
008	F	48	74.8	100	0	0
009	F	51	59.2	80	0	20
010	F	55	55.7	70	30	0
011	F	51	72.5	70	30	0
012	M	54	71.2	100	0	0
013	F	54	73.8	90	10	0
014	M	53	70.8	80	20	0
015	M	54	72.1	95	50	0
016	M	59	79.0	70	0	30
017	F	52	81.4	90	0	10
018	F	53	59.2	100	0	0
019	F	50	18.7	70	30	0
020	F	50	18.7	70	30	0
021	M	59	46.0	100	0	0
022	M	53	78.2	100	0	0
023	F	57	79.0	70	0	30
Moy	**9M/14F**	**53**	**63.0**	**85.4**	**10.4**	**6.1**
SD		**3**	**19.8**	**15.1**	**15.2**	**13.4**

these sessions. The majority of the sessions took place in a child-friendly lab, except for sessions for 6 children. The parents of these 6 children were unable to come to University, so the meetings took place in their homes to accommodate them. We asked the parents to allow us to conduct the meeting at a time of day when the child has limited distractions (e.g., absence of siblings) and in a quiet place (e.g., in the bedroom). Furthermore, we did not note any difference between the children's results according to the assessment condition (in the laboratory or at home). Each child completed four speech and language tasks: expressive and receptive vocabulary tasks, a picture-naming task, and a non-word repetition task. A fifth task, the spontaneous play, took place but was not included in the

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current analyses. Each session (one in Arabic and one in French) lasted on average for 60 minutes. Also, parents completed the Canadian Questionnaire of Use and Exposure in Bilinguals designed by Andrea MacLeod at the first session.

Instruments

Phonology

We administered two phonological tests in each language: one picture-naming task and one non-word repetition task. The picture-naming task was chosen to analyze the consonant accuracy in real words and the non-word repetition task was chosen to analyze the consonant accuracy with reduced lexical influence (Gathercole, 2006).

The French tasks were the *Évaluation sommaire de la phonologie chez les enfants d'âge préscolaire* (ESPP; MacLeod, 2014) and the *Tâche de répétition de non-mot de Courcy* (Courcy, 2000). The ESPP targets 40 words that include the majority of consonants in French except the consonant /ŋ/. The *Tâche de répétition de non-mot de Courcy* is a French task with 40 non-words that have 2 to 5 syllables.

The Arabic tasks were the picture-naming task drawn from the work of Amayreh and Dyson (1998) and the Arabic Pseudo Word Repetition Task (Saiegh-Haddad & Ghawi-Dakwar, 2017). Amayreh and Dyson's task targets 58 words that include the majority of consonants in Algerian Arabic in all positions except /p, v/ because it was designed for Jordanian Arabic. Indeed, we were not able to identify a task for Algerian Arabic. This task integrates 14 shared consonants by the two languages (b, t, d, k, m, n, f, s, z, ʃ, ʁ, j, w, l/) and 14 Arabic specific consonants (/q, ʔ, tˤ, dˤ, r, θ, ð, ðˤ, sˤ, χ, ħ, ʕ, h, ʤ/). The Arabic Pseudo Word Repetition Task has 56 targets with 1 to 4 syllables.

Vocabulary

The children's vocabulary was assessed using standardized vocabulary tasks that are parallel in Arabic and French. The receptive vocabulary abilities were measured using the Évaluation de vocabulaire en images Peabody (ÉVIP) in French (Dunn, Thériault-Whalen & Dunn, 1993) and an adaptation of the Arabic Picture Vocabulary Test (APVT) in Arabic (Shaalan, 2010). The ÉVIP Test is used from 2; 6 years up to 18 years and has 170 images. The APVT is an Arabic-language task developed in Qatar and consists of 132 pictures. To adapt the test, we identified possible responses that were appropriate for the different Algerian dialects by consulting several community members. In both languages, we showed the children a page with four illustrations and asked them to point to the picture that illustrates the word produced by the examiner. We set the floor item as the first item for both tasks. A ceiling criterion was employed for the two tests such that when the child reached 6 consecutive errors on 8 stimuli, the task was terminated.

The expressive vocabulary abilities were measured using the French adaptation of the Expressive One Word Picture Vocabulary Test (EOWPVT) (Gardner, 1990; Groupe coopératif en orthophonie – Région Laval, Laurentides, Lanaudière, 1995) and the Arabic Expressive Vocabulary Test (AEVT) (Khater, 2016). In both tasks, children were asked to name the picture they see. In Arabic, we accepted the production of words in classical Arabic or Algerian regional dialects. As with the receptive tasks, we began with the first item. The ceiling criterion for the two tests was 6 consecutive errors.

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Questionnaire

The language exposure to languages was determined by a questionnaire for parents: the Canadian Questionnaire of Use and Exposure in Bilinguals (C-QUEB) and supplemented the task with additional questions. Parents were asked to identify their first language(s), the language(s) they used with their child, the languMacLeodage(s) their child used with them, and the age at which their children were first exposed to each language. Based on a typical 12-hour weekday and 12-hour weekend day, we asked parents to estimate the amount of language exposure to each language the child receives from a significant adult (e.g., parent, educator). The questionnaire also provides other data on language exposure, including the language of media viewing (television, iPad, telephone). The additional questions asked included what dialect of Algerian was spoken by the family, how long they had lived in Canada, and in what country their child was born.

Transcription and analyses

Phonology

Based on video recordings of the sessions, children's productions in the phonological tasks were transcribed phonetically using the International Phonetic Alphabet (IPA). The first author transcribed all the data, two students trained in neurolinguistics transcribed 40% of the French data, and a third student trained in speech-language pathology transcribed 40% of the Arabic data. The inter-judge agreement average was 93% in French and 85% in Arabic for consonant transcription. The lower rate for Arabic was likely due to less experience with phonetic transcription of Arabic for the research assistant, although her first language was Arabic. Also, the Arabic phonological tasks included more items than French tasks. We used the software *Phon* (Hedlund & Rose, 2019), to analyze the consonant accuracy in each phonology task. Consonant accuracy was computed automatically for each child using the query function in Phon and gave the percentage of correct consonants (PCC).

Vocabulary

For the receptive and expressive tasks, we recorded the number of correct responses to obtain a score for each task. This measure allows us to compare the children in the group with each other. The standard scores and the percentiles of the tests were not used, as these were not representative of our bilingual group.

Questionnaire

The C-QUEB allowed us to collect information about language exposure to each of the languages. We used the same strategy for calculating the language exposure rate as precedents (Meziane & MacLeod, 2017, 2021). Through the answers to the questions, we calculated the amount of active exposure to each language by adults. Therefore, we asked each parent to identify the adult's significance in the child's life (grandparents, educators, etc.), what language they used when interacting with the child, and how much time was spent with the child on an average weekday and an average weekend day. Table 2 presents an example of the calculation of the language exposure rate for child #9.

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Table 2. Example of proportion calculation for participant #009

Weekday	Weekend	Weekly totals
Mother French = 5 hours (60%)	Mother French = 12 hours (60%)	
Father French = 0 hours	Father French = 0 hours	
Shared time in French = 2.5 hours X 5 days X 0,6 = 7.5 hours	Shared time in French = 6 hours X 2 days X 0.6 = 7.2 hours	Total French = 7.5 hours +7.2 hours+ 35 hours = 49.7 hours
Mother Arabic = 5 hours (40%) Father Arabic = 5 hours (100%) Shared time in Arabic = (2.5 hours X 5 days X 0.4) + (2.5x 5 days) = 17.5 hours	Mother Arabic = 12 hours (40%) Father Arabic = 12 hours (100%) Shared time in Arabic = (6 hours X 2 days X 0.4) +(6 hours x 2 days) = 16.8 hours	Total Arabic = 17.5 hours + 16.8 hours = 34.3 hours
Daycare French = 7 hours X 5 days = 35 hours		
Proportion of exposure to French: 49.7 hours / 84 hours => .592	Proportion of exposure to Arabic: 34.3 hours / 84 hours => .408	

Statistical analyses

Pearson correlation analysis was performed to explore the relationship between internal and external factors and phonological performance. Correlation analyses were chosen based on sample size, variability, and distribution. The following correlations were performed using SPSS statistical software for each language and each phonology test: receptive vocabulary and percentage of correct consonants; expressive vocabulary and percentage of correct consonants, amount of exposure to the language, and percentage of correct consonants. A student's T-Test was performed to compare the phonological performance (PCC) in French (majority language) and Arabic (minority language). Finally, we used a student's T-Test to compare the consonantal accuracy of shared and specific consonants in picture-naming tasks. This analysis could not be performed for the non-word repetition tasks because there are no French-specific consonants in the French Non-Word Repetition task and a low variety of consonants in the Arabic Non-Word Repetition task.

Results

Descriptive results

A summary of results is presented in Table 3 for consonant accuracy, vocabulary, and language exposure. Children produced high consonant accuracy in French picture-naming (mean=91.7, SD=5.5) and non-word repetition (Mean=89.1, SD=9.5), but somewhat lower accuracy in Arabic picture-naming (Mean=79.9, SD=7.6) and non-word repetition (Mean=73.6 SD=9.0). We note that the children's performance was always better for the picture-naming task than for the non-word repetition task in Arabic and for the majority of children in French. For example, child #5 scored 89.4% on the French picture-naming task and 66.2% on the French non-word repetition task. Similarly, he obtained 67.4% in the Arabic picture-naming task and 48.5% in the Arabic Non-Word

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Table 3. Task Results

Tasks	French Mean (SD)	Arabic Mean (SD)
Picture-naming task PCC (%)	91.7% (5.5%)	79.9% (7.6%)
Non-word repetition task PCC (%)	89.1% (9.5%)	73.6% (9.0%)
Receptive vocabulary (Raw Score)	37 (16)	28 (13)
Expressive vocabulary (Raw Score)	34 (14)	7 (8)
Exposure input (%)	63.0% (19.8%)	36.9% (19.8%)

Repetition task. The children's accuracy in French was higher than in Arabic, except for child #19, who had a 4% difference between her picture-naming tasks with Arabic being a higher score. She had a consonant accuracy of 88% on the French picture-naming task and 92% on the Arabic picture-naming, and 92% on the Courcy's task with 87% on the Arabic non-word repetition task. Note that child #19 was exposed only to Arabic at home, with total exposure to French of less than 20%.

The score on the receptive vocabulary was mostly higher in French (mean=37, SD=16) than in Arabic (mean=28, SD=13) except for 7 children, while the score on the expressive vocabulary tasks was higher in French (mean=34, SD=14) than Arabic (mean=7, SD=8) for all children. The lowest French expressive vocabulary score was 15, and the highest French score was 64; while the lowest Arabic score was 0, and the highest Arabic score was 25. The score on the Arabic expressive vocabulary task was very low, with 14 children having identified fewer than 5 words, including 7 who didn't identify any words. This result suggests a number of children who are passive bilinguals despite the early and continued exposure to Arabic at home. All children who scored below 5 also had less than 30% exposure to Arabic, except for one child with 37.9% exposure to Arabic.

The average language exposure to French was 63% (SD=19.8), while that to Arabic was 36.9% (SD=19.8). The majority of children were more exposed to French than to Arabic, except for 3 children who were more exposed to Arabic and 2 with a balanced exposure to both languages. Child #5 was the least exposed to Arabic with an exposure rate of 13.9%, and children #19 and #20 were the most exposed to Arabic with a rate of 81.3%. We had 3 groups of siblings: two sisters (#4 and #8), a brother and sister (#16 and #23), and twin girls (# 19 and #20). Sisters #4 and #8 were 75% exposed to French, brother and sister #16 and #23 were 79% exposed to French, and twins #19 and #20 were 18.7% exposed to French. Some had different consonant accuracy scores despite the fact that each sibling group had the same language exposure. For example, we note that sisters #4 and #8, both with 75% exposure to French, had different consonant accuracy for the French Non-Word Repetition Task: 87.5% for child #4 and 78.6% for child #8. Conversely, siblings #16 and #23 performed almost identically on all phonology assessment tasks (e.g., both had a percentage of correct consonants of 99% on the French picture-naming task and 72% on the Arabic picture-naming task).

Since the overall objective of the study is to understand the factors that influence the phonological performance of a group of bilingual children, the next tables summarize the results of a test of correlation between children's phonological performance and vocabulary (Table 4) and language experience (Table 5 and 6).

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Table 4. Correlations between percentage of correct consonants and vocabulary

		French picture-naming task	Arabic picture-naming task	French non-word repetition task	Arabic non-word repetition task
French receptive vocabulary	Pearson correlation	.367	.338	.453*	.457*
Arabic receptive vocabulary	Pearson correlation	.009	.690**	.254	.561**
French expressive vocabulary	Pearson correlation	.522*	.467*	.480*	.534**
Arabic expressive vocabulary	Pearson correlation	-.052	.723**	.205	.537**

*The correlation is significant at the 0.05 level (bilateral).

**The correlation is significant at the 0.01 level (bilateral).

Table 5. Correlations between percentage of correct consonants and French exposure

		French picture-naming task	French non-word repetition Task
French exposure	Pearson correlation	.301	–.221

Table 6. Correlations between percentage of correct consonants and Arabic exposure

		Arabic picture-naming task	Arabic non-word repetition task
Arabic exposure	Pearson correlation	.622**	.548**

**The correlation is significant at the 0.01 level (two-way).

Child-internal factors

When we compare the consonantal accuracy of shared consonants to specific consonants for the picture-naming task, we find that the average PCC is always higher for shared consonants in both languages. The average PCC for shared consonants in the French and Arabic task is 94% while the average PCC for French specific consonants is 68% and for Arabic specific consonants is 47%. A T-Student test shows a significant difference between shared consonants and specific consonants in both languages with p value <0,000.

A positive correlation was found between receptive vocabulary and phonological performance in each language. The correlation is significant for both Arabic phonological tasks, but only for the French non-word repetition task. There was a significant positive correlation between expressive vocabulary and phonological performance in each

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language. Correlations between percent consonant correct and expressive vocabulary were greater than those for receptive vocabulary.

We also tested Kehoe and Havy's (2019) hypothesis concerning the inter-linguistic link between the expressive vocabulary of one language and the phonological accuracy of the other language of the bilingual child. We noted a significant positive correlation between the level of expressive vocabulary in French and the percentage of correct consonants in Arabic in picture-naming and in non-word repetition. There was no significant correlation between Arabic expressive vocabulary and French phonological tasks.

Child-external factors

We performed a correlation analysis between the external factor – the language experience – and the consonant accuracy of each language. The results, as shown in Table 4, indicate that there is no significant correlation between language exposure in French and the percentage of correct consonants in the picture-naming task in French. The same observation was noted for the non-word repetition task in French. On the other hand, there is a strong positive significant correlation between language experience in Arabic and consonant accuracy in Arabic phonological tasks. We used a T-Student test to analyze the influence of the second external factor, the sociolinguistic context of the language. There was a significant difference in phonological performance with a higher score in French than Arabic for the picture-naming task, $t(22) = 6.91$, $p<0.0001$, and for the non-word repetition task $t(22)=10.71$, $p<0.0001$.

Discussion

The overall goal of this study was to answer the following research question: are there relationships between internal and external factors and the phonology of bilingual children? The literature review has described individual differences in bilingual phonological acquisition, but few studies have assessed both languages of the child to better understand these differences. Moreover, the factors studied are often not comparable across studies. Specifically, this study aimed to describe the relationship between the consonant accuracy of consonants and child-internal factors (between-language interaction, receptive vocabulary, expressive vocabulary) and child-external factors (language experience, and the sociolinguistic context).

When we compared the children's averages for each task, we note that they had more accurate consonant production in French than in Arabic. This observation holds true for all children on non-word repetition tasks, and all but two children (#3, #19) on picture-naming tasks. The difference between the French and Arabic tasks ranged from 4% to 30% for picture-naming and non-word repetition tasks. The children also had higher vocabulary scores in French and higher exposure to French than Arabic. Despite these general tendencies, we observed variability in the results of the phonology and vocabulary tasks in both languages, except for the French picture-naming task (most children had high scores), and the Arabic expressive vocabulary task (most children had low scores).

Child-internal factors

With regard to internal factors, we explored four hypotheses. First, we hypothesized a greater accuracy for the consonants shared by the two languages than for the unshared

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consonants. We observe that consonantal accuracy of shared consonants in the French picture-naming task is the same as for the Arabic task (94%). This shows that children have better consonant production skills when producing shared consonants. A similar result was observed in three-year-old Arabic–French speakers (Meziane & MacLeod, 2021). The between-language interaction effect also can explain the high phonological accuracy in French. The high phonological accuracy in French may be related to the greater number of consonants that are present in both French and Arabic, thus facilitating their acquisition through phonological transfer between the two languages.

Second, we hypothesized that receptive vocabulary would result in a weak correlation between children's accuracy on phonological tasks and that we would find a positive correlation between receptive vocabulary and phonological performance in each language and each task. These hypotheses were only partially supported. The correlation between receptive vocabulary in French and the percentage of correct consonants in French was significant for the non-word repetition task, but not for the picture-naming Task. These results corroborate the findings of previous research on receptive vocabulary and the non-word repetition task (Kehoe, 2015, 2011; Stokes & Klee, 2009; Vihman, 2016, 2002). The lack of correlation between receptive vocabulary and the picture-naming task, ESPP, was also observed in the study by Meziane and MacLeod (2017) with a sample of bilingual children who were 6 years old. This lack of correlation for picture-naming may be due to the high accuracy across all children, despite variability in their receptive vocabulary. We targeted this French picture-naming task because it was designed for preschool children, although studies of monolingual children observe scores close to the ceiling by 4;6 years old (Meziane & MacLeod, 2017). In sequential bilinguals, children are close to ceiling by the age of 6;0 years (Meziane & MacLeod, 2017). The results from the present study indicate that simultaneous bilingual children who are four-year-old can score close to ceiling on this task, similar to their monolingual French-speaking peers.

Third, we hypothesized that expressive vocabulary would result in a significant correlation between children's accuracy on picture-naming and non-word repetition tasks. In contrast with the findings for receptive vocabulary, expressive vocabulary was positively correlated with consonant accuracy in each of the languages and tasks. These results are consistent with previous studies that have measured phonological accuracy in a real word task (Kehoe & Havy, 2019), and those that have measured phonological accuracy in Non-Word Repetition tasks (Parra et al., 2011). Furthermore, the correlation between expressive vocabulary and phonological performance was higher than the correlation between receptive vocabulary and phonological performance. The stronger correlation may reflect the greater contribution of accessing and producing words, and thus their phonological components, on the development of phonology (Meziane & MacLeod, 2017; Stoel-Gammon, 2011). In her summary of the literature, Stoel-Gammon (2011) reports that children have some knowledge of their production abilities and choose to produce vocabulary words that match their phonological abilities. Thus, for children to have a rich expressive vocabulary, they must be able to rely on a variety of consonants and vowels and have acquired a greater inventory of 'building blocks' that can be recruited for the production of words. The findings from the present study support this hypothesis that expressive vocabulary, more than receptive vocabulary, is related to phonological accuracy.

Fourth, we hypothesized that the inter-linguistic correlation between expressive vocabulary and consonant accuracy will only be significant between French vocabulary (majority language) and Arabic consonant accuracy (minority language). We observed an inter-linguistic relationship between vocabulary and consonants accuracy. Although few

studies consider inter-linguistic relationships, we were able to look at relationships between both majority and minority languages due to the study design. For example, this hypothesis has been studied by Kehoe and Havy (2019) but they did not assess the inter-linguistic relationship between minority language vocabulary and phonological accuracy in the majority language, French. Cooperson et al. (2013) and Parra et al. (2011) have studied this hypothesis by assessing the child's two languages (English, Spanish) as we did, and had different conclusions: Cooperson et al. (2013) did not describe a significant inter-linguistic relationship, whereas Parra et al. (2011) did. In the present study, we observed an inter-linguistic link between expressive vocabulary in the majority language, French, and consonant accuracy of the minority language, Arabic, but not in the other direction. For example, child #5 with the lowest consonant accuracy on the Arabic phonology task also scored the lowest on the French expressive vocabulary task; or child #1, who had the highest consonant accuracy in Arabic and had high expressive vocabulary in French. A lack of an inter-linguistic link between French consonant accuracy and Arabic expressive vocabulary can be illustrated by child #23, who obtained the highest consonant accuracy in the French phonology tasks despite a score of 0 on the Arabic expressive vocabulary task. Other children with a score of 0 on the Arabic expressive vocabulary task also performed well overall on the French phonology tasks. We note that it is then difficult to compare our results with previous studies given the differences between the tasks used and the age of the participants. It is possible that the sociolinguistic context of French and Arabic also played a role; this will be explored in the following section.

Child-external factors

With regard to external factors, we explored two hypotheses related to language exposure and language statue and children's consonant accuracy. First, we predict a significant relationship between the amount of exposure to a language and the child's consonant accuracy with a higher correlation for real words (Chiat & Roy, 2007). Second, we expected significantly higher scores in the phonology tasks in French, the majority language, than in Arabic, the minority language. In the present study, low language ability in the minority language, Arabic, was associated with low exposure to that language. The following results help us understand the role of language experience and the sociolinguistic context of language in acquiring consonant accuracy.

Two unanticipated findings were that there is no significant correlation between the quantity of French language exposure and the consonant accuracy in French and that the relationship was inverted for the non-word task in French. These results suggest that with regards to the amount of exposure, phonology and vocabulary function differently at this age for French. For example, Child #19 had a consonant accuracy of 88% on the picture-naming task and 92% on the non-word repetition task, even though her daily exposure to French was less than 20%. In contrast, child #5 obtained a consonant accuracy of 89% on the picture-naming task and 66% on the non-word repetition task, even though her daily exposure to French was 86%. It is also noteworthy that child #19 with low exposure to French performed well on Arabic phonological tasks (92% and 87%), suggesting that his phonological skills in Arabic allowed him to achieve better consonant accuracy in French. In contrast, we observed a significant positive correlation between the amount of Arabic language exposure and Arabic consonant accuracy in both picture-naming and non-word tasks. This correlation was not observed for all children. For example, we note that child

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#1 and #14, both with 29.2% exposure to Arabic, had different consonant accuracy for the Arabic phonology tasks: 93% and 83% for the picture-naming task and the Non-Word Repetition Task for child #1, and 77% and 64% for child #14. Thus, despite high levels of language exposure, we observed individual differences between children. This observation can be explained by the positive transfer between languages, and that shared consonants between both languages in a bilingual child are produced with greater accuracy (e.g., Meziane & MacLeod, 2021). Lleó, Kuchenbrandt, Kehoe and Trujillo (2003) also show that German coda production had a positive effect on Spanish coda production in German–Spanish bilingual children, even though some children had German as their dominant language and others did not. The results of the Kehoe and Havy study (2019) showed that high phonological scores can be obtained even when the percentage of language exposure is low. They noted that other variables such as low vocabulary skills and low socioeconomic status contributed to phonological development in these children. Taken together, the results of the present study suggest that the amount of exposure to a language influences phonological accuracy, but perhaps a threshold effect also occurs for phonology above which phonological development is less tethered to exposure.

In addition to transfer and vocabulary, differences between the role of language experience on consonant accuracy in Arabic and French may also be explained by the sociolinguistic context of both languages. Language exposure can also explain the difference between the consonantal accuracy of specific consonants in French and specific consonants in Arabic. The amount of direct language exposure by significant adults may be more important for phonological abilities in a minority language context, while child-internal factors, such as vocabulary, potentially play a more important role in the majority language. For example, children in the present study were often exposed to media in French, even in homes where Arabic was the dominant language. Paradis (2011) has also shown that child-internal factors explain more of the variance of English L2 children's acquisition outcomes (vocabulary and verb morphology) than child-external factors in sequential bilingual children aged 4 to 7 years from immigrant families in Canada. The sociolinguistic context may also explain differences in inter-linguistic relationships observed in the present study and previous research. Previous studies of children's phonology were conducted in Florida (Parra et al., 2011) and Texas (Cooperson et al., 2013), two states in the United States where Spanish is spoken by a large proportion of the population. If we consider minority languages as existing on a continuum, Spanish may be somewhat more privileged in those contexts due to the larger population of speakers in those states, whereas Arabic is somewhat less privileged due to the small population of speakers in Québec. The children in this study generally had opportunities for interaction in Arabic that were limited to their microsystem, their family. These limited opportunities may partly explain why their expressive vocabulary in Arabic was low. Although the assessment task used included simple vocabulary pictures (e.g., ball, shoes, banana, hand, key), children quickly encountered images that they could not name. There are two possible reasons for this. Exposure to these words in a single context (home) may limit their ability to generalize certain words to other contexts. Parents often mentioned that these words were frequently used at home, but the child may have been unsettled by the context of testing and not retrieved this word knowledge. A second reason for the difficulty in naming certain words (e.g., pen) may be linked to vocabulary categories such that children are most familiar with words related to the home context (e.g., food, fruits and vegetables, items of clothing). This difference between our study and previous studies may explain why we observed an

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inter-linguistic link between expressive vocabulary in the majority language, French, and consonant accuracy of the minority language, Arabic, but not in the other direction. While the focus of the studies and languages were different, this research suggests that, while the duration of exposure is an important factor in bilingual acquisition, the broader context for language exposure likely plays an important role.

Overall, these findings support our hypothesis that phonological abilities would be stronger in the majority language, French, than in the minority language, Arabic. Despite individual differences in children's language skills and differences in language exposure, consonant accuracy was higher in French for all children than their corresponding abilities in Arabic except for child #19, who had a 4% difference between their picture-naming tasks with Arabic being a higher score. We want to highlight that while children's Arabic consonant accuracy was lower, they were still well on their way to building a strong phonological system, could take part in tasks, and were understood by their family.

Limitations and future directions

The present study has three main limitations. First, we used a picture-naming task to assess consonant accuracy. Our results show that children have a very high percentage of correct consonants, as we note at the same age in monolingual French-speaking children (MacLeod, Sutton, Trudeau & Thordardottir, 2011). The ceiling effect may have influenced the lack of relationship between French language exposure and PCC. A future study would be necessary to evaluate this same relationship with a conversation task. Second, despite a narrow focus on a specific bilingual language pairing and age range, the small sample size of the study limits the generalizability of the findings. Specifically, a future study with a larger sample size would allow for capturing variability in family structure, such as the presence of older siblings, and thus be able to measure the quantity of output as a language exposure factor. In the present study, we limited ourselves to the amount of input provided by significant adults because it allowed us to better compare the children with each other. In addition, it would be interesting to measure the effect of passive media exposure on phonological development. In our present study, we note significant exposure to French media at home, which decreases the amount of interaction in Arabic for children. Previous studies find no relationship between vocabulary development and L2 acquisition (e.g., Hudon, Fennell & Hoftyzer, 2013) or a negative relationship between television viewing time and expressive language skills (Sorenson Duncan & Paradis, 2019). Furthermore, no study has examined the relationship between knowledge acquisition and media viewing. Third, we used assessment tests designed for monolingual children. This may have influenced the results, especially for the children's expressive vocabulary. Bilingual children are not exposed to the same type of vocabulary for both languages. For example, they are exposed to the vocabulary of food or specific cultural words (e.g., mosque) at home in the minority language and the vocabulary of school materials at daycare in the majority language. Finally, we captured a moment in the children's development, but it is not clear to what extent this represents the relationship between vocabulary, exposure, and phonology throughout development. We are conducting a longitudinal study that will provide insight regarding how these factors develop together during preschool years in bilingual children.

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Conclusion

The present study focused on four-year-old children who were bilingual speakers of Algerian-Arabic and Québecois-French. To better understand how child-internal and child-external factors influence consonant accuracy in bilingual children, we were interested in possible correlations between the following factors: receptive vocabulary, expressive vocabulary, language exposure, and the percentage of correct consonants in two phonological tasks in French and Arabic. Three key results were obtained. First, there was a significant relationship between receptive vocabulary, expressive vocabulary and consonant accuracy for both French and Arabic, except French receptive vocabulary and consonant accuracy in French Non-Word Repetition Task. Second, a between language correlation was observed between the expressive vocabulary level of the majority language (French) and the consonant accuracy of the minority language (Arabic). Finally, a significant correlation was found between Arabic language exposure and Arabic consonant accuracy. The lack of a significant correlation between French language exposure and French consonant accuracy may be due to positive transfer between the two phonological systems of a bilingual child (Fabiano-Smith & Goldstein, 2010; Meziane & MacLeod, 2021). Moreover, consonant accuracy was significantly higher in French tasks than in Arabic despite the individual differences of the children. The present study contributes to our understanding of the relationship between different areas of language and the role of exposure and sociolinguistic status. This knowledge can also help us assess whether the low phonological ability is a possible contributor to risk for language impairment in the bilingual population (Cooperson et al., 2013).

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References

Amayreh, M. M., & **Dyson, A. T.** (1998). The acquisition of Arabic consonants. *Journal of Speech, Language, and Hearing Research*, **41**(3), 642–653. doi:10.1044/jslhr.4103.642

Bird, E. K. R., **Trudeau, N.**, & **Sutton, A.** (2016). Pulling it all together: The road to lasting bilingualism for children with developmental disabilities. *Journal of Communication Disorders*, 63, **63**-78. doi:10.1016/j.jcomdis.2016.07.005

Birdsong, D. (2006). Age and second language acquisition and processing: A selective overview. *Language learning*, **56**, 9–49. doi:10.1111/j.1467-9922.2006.00353.x

Bortolini, U., & **Leonard, L. B.** (2000). Phonology and children with specific language impairment: status of structural constraints in two languages. *Journal of Communication Disorders*, **33**(2), 131–150. doi:10.1016/S0021-9924(99)00028-3

Bowey, J. A. (2001). Nonword repetition and young children's receptive vocabulary: A longitudinal study. *Applied Psycholinguistics*, **22**(3), 441–469. doi:10.1017/s0142716401003083

Chiat, S., & **Roy, P.** (2007). The Preschool Repetition Test: An evaluation of performance in typically developing and clinically referred children. *Journal of Speech, Language, and Hearing Research*, **50**(2), 429–443. doi:10.1044/1092-4388(2007/030)

Cooperson, S. J., **Bedore, L. M.**, & **Peña, E. D.** (2013). The relationship of phonological skills to language skills in Spanish–English-speaking bilingual children. *Clinical linguistics, & phonetics*, **27**(5), 371–389. doi:10.3109/02699206.2013.782568

Courcy, A. (2000). Conscience phonologique et apprentissage de la lecture (Phonological awareness and reading acquisition) (Unpublished doctoral dissertation). Université de Montréal, Montreal, Quebec, Canada.

Cummings, A. E., & **Barlow, J. A.** (2011). A comparison of word lexicality in the treatment of speech sound disorders. *Clinical linguistics, & phonetics*, **25**(4), 265–286. doi:10.3109/02699206.2010.528822

Davis, B., & **Bedore, L.** (2013). *An emergence approach to speech acquisition*. New York, NY: Psychology Press.

Davison, M. D. (2009). Defining bilingualism: Factors contributing to variability in language and literacy development of Spanish–English bilingual children. *Perspectives on Communication Disorders and Sciences in Culturally and Linguistically Diverse (CLD) Populations*, **16**(2), 38–44. doi: 10.1080/10888430902769541

Dunn, L., **Thériault-Whalen, C. M.**, & **Dunn, L.** (1993). *Échelle de vocabulaire en images Peabody. Adaptation française du Peabody Picture Vocabulary Test*. Toronto: PSYCAN.

Edwards, J., **Beckman, M. E.**, & **Munson, B.** (2004). The interaction between vocabulary size and phonotactic probability effects on children's production accuracy and fluency in nonword repetition. *Journal of Speech, Language, and Hearing Research*, **47**, 421–436. doi:10.1044/1092-4388(2004/034)

Fabiano-Smith, L., & **Goldstein, B. A.** (2010). Phonological acquisition in bilingual Spanish–English speaking children. *Journal of Speech, Language, and Hearing Research*, **53**(1), 160–178. doi: 10.1044/1092-4388(2009/07-0064)

Fletcher, P., **Chan, C.**, **Wong, P.**, **Stokes, S.**, **Tardif, T.**, & **Leung, S.** (2004). The interface between phonetic and lexical abilities in early Cantonese language development. *Clinical Linguistics, & Phonetics*, **18**(6-8), 535–545. doi:10.1080/02699200410001703655

Gardner, M. F. (1990). EOWPVT-R: Expressive One-word Picture Vocabulary Test, Revised. *Academic Therapy Publications*. doi:10.1007/978-0-387-79948-3_1544

Gathercole, S. E. (2006). Nonword repetition and word learning: The nature of the relationship. *Applied Psycholinguistics*, **27**(4), 513–543. https://doi.org/10.1017/S0142716406060383

Gathercole, S. E., & **Baddeley, A. D.** (1989). Evaluation of the role of phonological STM in the development of vocabulary in children: a longitudinal study. *Journal of Memory and Language*, **28**, 200–213. doi: 10.1016/0749-596X(89)90044-2

Gathercole, S. E., **Service, E.**, **Hitch, G. J.**, **Adams, A. M.**, & **Martin, A. J.** (1999). Phonological short-term memory and vocabulary development: Further evidence on the nature of the relationship. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition*, **13**(1), 65–77. doi: 10.1002/(SICI)1099-0720(199902)13:1<65::AID-ACP548>3.0.CO;2-O

Genesee, F., & **Nicoladis, E.** (2006). Bilingual first language acquisition. In E. Hoff, & M. Shatz (Eds.), *Blackwell handbook of language development* (pp. 324–42). West Sussex: Wiley Blackwell.

Goldstein, B. A., **Fabiano, L.**, & **Washington, P. S.** (2005). Phonological skills in predominantly English-speaking, predominantly Spanish-speaking, and Spanish–English bilingual children. *Language, Speech, and Hearing Services in Schools*, **36**(3), 201–218. doi:10.1044/0161-1461(2005/021)

Groupe coopératif en orthophonie – Région Laval, Laurentides, Lanaudière. (1995). Test de dénomination EOWPVT-R de Gardner, adaptation française du Expressive One-Word Picture Vocabulary Test-R [Expressive OneWord Picture Vocabulary Test]. Montréal, Québec, Canada: Ordre des orthophonistes et audiologistes du Québec.

Hedlund, G., & **Rose, Y.** (2019). Phon 3.0 \[Computer Software\]. Retrieved from https://phon.ca.

Hoff, E., **Core, C.**, & **Bridges, K.** (2008). Non-word repetition assesses phonological memory and is related to vocabulary development in 20- to 24-month-olds. *Journal of Child Language*, **35**, 903–916. http://doi.org/10.1017/S0305000908008751

Hudon, T. M., **Fennell, C. T.**, & **Hoftyzer, M.** (2013). Quality not quantity of television viewing is associated with bilingual toddlers' vocabulary scores. *Infant Behavior and Development*, **36**(2), 245-254. https://doi.org/10.1016/j.infbeh.2013.01.010

Kehoe, M. (2011). Relationships between lexical and phonological development: a look at bilingual children–a commentary on Stoel-Gammon's 'Relationships between lexical and phonological development in young children'. *Journal of Child Language*, **38**(1), 75–81. doi:10.1017/S0305000910000474

Kehoe, M. (2015). Lexical-phonological interactions in bilingual children. *First Language*, **35**(2), 93–125. doi: 10.1177/0142723715574398

Kehoe, M., **Chaplin, E.**, **Mudry, P.**, & **Friend, M.** (2015). La relation entre le développement du lexique et de la phonologie chez les enfants francophones. *Rééducation Orthophonique*, **263**, 61–85.

Kehoe, M., & **Havy, M.** (2019). Bilingual phonological acquisition: the influence of language-internal, language-external, and lexical factors. *Journal of child language*, **46**(2), 292–333. doi:10.1017/S0305000918000478

Kehoe, M., **Patrucco-Nanchen, T.**, **Friend, M.**, & **Zesiger, P.** (2018). The relation between phonological and lexical development in French-speaking children. *Clinical linguistics, & phonetics*, **32**(12), 1103–1125. doi:10.1080/02699206.2018.1510984

Khater, M. (2016). The relationship between nonword repetition, root and pattern effects, and vocabulary in Gulf Arabic speaking children (Unpublished Doctoral thesis). City, University of London, London, UK.

Law, N., & **So, L.** (2006). The relationship of phonological development and language dominance in bilingual Cantonese–Putonghua children. *International Journal of Bilingualism*, **10**, 405–428. doi:10.1177/13670069060100040201

Lleó, C., **Kuchenbrandt, I.**, **Kehoe, M.**, & **Trujillo, C.** (2003). *Syllable final consonants in Spanish and German monolingual and bilingual acquisition*. N. Müller (ed.), 191–220. doi:10.1075/hsm.1.08lle

MacLeod, A. A. (2014). Évaluation sommaire de la phonologie chez les enfants d'âge préscolaire. Montréal, QC: Université de Montréal.

MacLeod, A. A., **Fabiano-Smith, L.**, **Boegner-Pagé, S.**, & **Fontolliet, S.** (2013). Simultaneous bilingual language acquisition: The role of parental input on receptive vocabulary development. *Child Language Teaching and Therapy*, **29**(1), 131–142. doi:10.1177/0265659012466862

MacLeod, A. A., **Sutton, A.**, **Trudeau, N.**, & **Thordardottir, E.** (2011). The acquisition of consonants in Québécois French: A cross-sectional study of pre-school aged children. *International Journal of Speech-Language Pathology*, **13**(2), 93–109. doi: 10.3109/17549507.2011.487543

Maekawa, J., & **Storkel, H. L.** (2006). Individual differences in the influence of phonological characteristics on expressive vocabulary development by young children. *Journal of Child Language*, **33**(3), 439. doi:10.1017/s0305000906007458

Masoura, E. V., & **Gathercole, S. E.** (1999). Phonological short-term memory and foreign language learning. *International Journal of Psychology*, **34**(5-6), 383–388. doi:10.1016/0749-596X(91)90040-Q

Mayr, R., **Howells, G.**, & **Lewis, R.** (2015). Asymmetries in phonological development: The case of word-final cluster acquisition in Welsh-English bilingual children. *Journal of child language*, **42**(1), 146–179. doi:10.1017/S0305000913000603

Meziane, R. S., & **MacLeod, A. A.** (2017). L'acquisition de la phonologie en français langue seconde: le profil phonologique d'enfants allophones en maternelle. *Canadian Journal of Applied Linguistics/Revue canadienne de linguistique appliquée*, **20**(2), 1–17. doi:10.7202/1042673ar

Meziane, R. S., & **MacLeod, A. A.** (2021). Evidence of phonological transfer in bilingual preschoolers who speak Arabic and French. *International Journal of Bilingualism*, 136700692110342. https://doi.org/10.1177/13670069211034232

Paradis, J. (2011). Individual differences in child English second language acquisition: Comparing child-internal and child-external factors. *Linguistic approaches to bilingualism*, **1**(3), 213–237. doi:10.1075/lab.1.3.01par

Paradis, J., **Genesee, F.**, & **Crago, M. B.** (2011). *Dual Language Development, & Disorder: A Handbook on Bilingualism, & Second Language Learning*, Second Edition (pp. 88–108). Baltimore, Maryland: Brookes Publishing.

Parra, M., **Hoff, E.**, & **Core, C.** (2011). Relations among language exposure, phonological memory, and language development in Spanish–English bilingually developing 2-year-olds. *Journal of experimental child psychology*, **108**(1), 113–125. doi:10.1016/j.jecp.2010.07.011

Petinou, K., & **Okalidou, A.** (2006). Speech patterns in Cypriot-Greek late talkers. *Applied Psycholinguistics*, **27**(3), 335. doi:10.1017/S0142716406060309

Ricento, T. (2005). Problems with the 'language-as-resource' discourse in the promotion of heritage languages in the USA. *Journal of Sociolinguistics*, **9**(3), 348–368. doi:10.1111/j.1360-6441.2005.00296.x

Saiegh-Haddad, E., & **Ghawi-Dakwar, O.** (2017). Impact of Diglossia on Word and Non-word Repetition among Language Impaired and Typically Developing Arabic Native Speaking Children. Frontiers in Psychology, 8. https://doi.org/10.3389/fpsyg.2017.02010

Shaalan, S. (2010). Investigating Grammatical Complexity in Gulf Arabic Speaking Children with Specific Language Impairment (Unpublished doctoral dissertation). University College London, London, UK.

Smith, B. L., **McGregor, K. K.**, & **Demille, D.** (2006). Phonological development in lexically precocious 2-year-olds. *Applied Psycholinguistics*, **27**(3), 355. doi:10.1017/S0142716406060310

Sorenson Duncan, T. S., & **Paradis, J.** (2016). English language learners' nonword repetition performance: The influence of age, L2 vocabulary size, length of L2 exposure, and L1 phonology. *Journal of speech, language, and hearing research*, **59**(1), 39–48. doi:10.1044/2015_JSLHR-L-14-0020

Sorenson Duncan, T. S., & **Paradis, J.** (2019). *Using Television to Boost Native-Speaker Input for L2-Learning Children: A Cautionary Tale*, Proceedings of the 43rd Boston University Conference on Language Development, ed. Megan M. Brown and Brady Dailey, 639-652. Somerville, MA: Cascadilla Press.

Statistiques Canada. (2017). *Recensement de 2016: Les langues immigrantes au Canada. https://www150.statcan.gc.ca/n1/pub/11-627-m/11-627-m2017025-fra.htm*

Stoel-Gammon, C. (2011). Relationships between lexical and phonological development in young children. *Journal of child language*, **38**(1), 1. doi:10.1017/S0305000910000425

Stokes, S. F., & **Klee, T.** (2009). Factors that influence vocabulary development in two year-old children. *Journal of Child Psychology and Psychiatry*, **50**(4), 498–505. doi:10.1111/j.1469-7610.2008.01991.x

Storkel, H. L. (2006). Do children still pick and choose? The relationship between phonological knowledge and lexical acquisition beyond 50 words. *Clinical linguistics, & phonetics*, **20**(7-8), 523–529. doi: 10.1080/02699200500266349

Summers, C., **Bohman, T. M.**, **Gillam, R. B.**, **Peña, E. D.**, & **Bedore, L. M.** (2010). Bilingual performance on nonword repetition in Spanish and English. *International Journal of Language, & Communication Disorders*, **45**(4), 480–493. doi:10.3109/13682820903198058

Thordardottir, E., & **Brandeker, M.** (2013). The effect of bilingual exposure versus language impairment on nonword repetition and sentence imitation scores. *Journal of Communication Disorders*, **46**(1), 1–16. doi: 10.1016/j.jcomdis.2012.08.002

United Nations. (n.d.). *Migrations*. United Nations. https://www.un.org/fr/sections/issues-depth/migration/index.html

Vihman, M. (2002). Getting started without a system: from phonetics to phonology in bilingual development. *International Journal of Bilingualism*, **6**, 239–54. doi:10.1177/13670069020060030201

Vihman, M. (2016). Prosodic structures and templates in bilingual phonological development. *Bilingualism: Language and Cognition*, **19**(1), 69–88. doi:10.1017/S1366728914000790

Vihman, M., **DePaolis, R. A.**, & **Keren-Portnoy, T.** (2014). The role of production in infant word learning. *Language Learning*, **64**(s2), 121–140. doi:10.1111/lang.12058

Wiethan, F. M., **Mota, H. B.**, & **Moraes, A. B.** (2016). Correlations between vocabulary and phonological acquisition: number of words produced versus acquired consonants. *CoDAS*, **28**(4), 379–387. doi: 10.1590/2317-1782/20162015108

Yavas, M. (1995). Phonological selectivity in the first fifty words of a bilingual child. *Language and Speech*, **38** (2), 189–202. doi:10.1177/002383099503800204

Zamuner, T. S. (2009). Phonotactic probabilities at the onset of language development: Speech production and word position. *Journal of Speech, Language, and Hearing Research*, **52**(1), 49–60. doi:10.1044/1092-4388(2008/07-0138)

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