Susan Rvachew
School of Communication Sciences and Disorders, McGill University, Montréal, QC, CANADA
Centre for Research on Brain, Language and Music, Montréal, QC, CANADA

Phaedra Royle
École d'orthophonie et d'audiologie, Université de Montréal, Montréal, QC, CANADA
Centre for Research on Brain, Language and Music, Montréal, QC, CANADA

Laura Gonnerman
School of Communication Sciences and Disorders, McGill University, Montréal, QC, CANADA

Brigitte Stanké
École d'orthophonie et d'audiologie, Université de Montréal, Montréal, QC, CANADA

Alexandra Marquis
École d'orthophonie et d'audiologie, Université de Montréal, Montréal, QC, CANADA
United Arab Emirates University, Abu Dhabi, UNITED ARAB EMIRATES

Alexandre Herbay
School of Communication Sciences and Disorders, McGill University, Montréal, QC, CANADA

# Development of a Tool to Screen Risk of Literacy Delays in French-Speaking Children: PHOPHLO

# Développement d'un outil pour dépister le risque de retard dans l'acquisition des habiletés de littératie chez les enfants francophones : PHOPHLO

Susan Rvachew
Phaedra Royle
Laura M. Gonnerman
Brigitte Stanké
Alexandra Marquis
Alexandre Herbay

## Abstract

Literacy is crucial for success, both professionally and personally. Oral language skills are closely related to literacy development in children. When a child has weak oral language skills, they will have difficulty achieving reading and writing competencies within the expected time frame. In this paper, we present results from a longitudinal and cross-sectional study of the relationship between oral language skills in pre-literate children, and one aspect of their literacy skills in early elementary school—specifically, spelling. The study was conducted with French-speaking children and French-language learners from Quebec, a population that has been understudied in this area. We developed a predictive tool that will allow teachers and other professionals to assess oral language skills in young children and to predict those children at risk for literacy difficulties. Specifically, we screened children's speech perception, speech production, phonological awareness, and morphology production abilities at entry to first grade and predicted spelling skills at the end of second grade. The screening tool that we developed proved to have a sensitivity of 71% and a specificity of 93% as a screen for poor spelling abilities.

Abrégé

La littératie est un élément crucial du succès à la fois professionnel et personnel. Les habiletés de langage oral sont intimement liées au développement de la littératie chez les enfants. En effet, lorsqu'un enfant a de faibles habiletés de langage oral, il aura plus de difficulté à développer ses habiletés de lecture et d'écriture dans les délais prévus. Nous présentons les résultats d'une étude longitudinale et transversale qui explore les liens entre les habiletés de langage oral chez des enfants n'ayant pas appris à lire ou à écrire et leurs habiletés de littératie au premier cycle du primaire. Cette étude a été menée auprès d'enfants franco-québécois natifs et non natifs, une population peu étudiée dans ce domaine. Nous avons créé un outil prédictif qui permettra aux enseignants et autres professionnels d'évaluer les habiletés de langage oral des enfants et de prédire ceux qui sont à risque de présenter des difficultés de littératie. Plus spécifiquement, nous avons évalué les habiletés de perception et de production de la parole, de conscience phonologique et de production morphologique d'enfants débutant leur première année du primaire. Nous avons prédit leurs habiletés d'orthographe à la fin de leur deuxième année (fin du premier cycle du primaire). L'outil développé a démontré une sensibilité de 71% et une spécificité de 93% pour dépister les faibles habiletés d'orthographe.

Literacy skills are essential for success in modern life, at the level of the individual and at the level of broader society. Stronger literacy skills are associated with a greater likelihood of school completion (Hernandez, 2011); furthermore, individuals with higher literacy skills have an employment and earnings advantage even after controlling for educational attainment (Organization for Economic Cooperation and Development [OECD], 2011). Literacy is also an important social determinant of mental and physical health (Dewalt, Berkman, Sheridan, Lohr, & Pignone, 2004; Marcus, 2006). At the society level, communities with a greater proportion of highly literate individuals enjoy a greater quality of life, not only in economic terms but also through enhanced social cohesion, as literacy is associated with greater civic participation (OECD, 2011). Speech-language pathologists (S-LPs) play a pivotal role in ensuring these positive outcomes for individuals and society, because oral language skills are the foundation of literacy and because S-LPs are key members of the team of professionals responsible for literacy outcomes in the school environment (Justice, 2006; Lefebvre, Trudeau, & Sutton, 2008; Roth & Baden, 2001). In this paper, we highlight the close relation between oral and written language skills and introduce a new screening tool to identify French-speaking children who are at risk for literacy delays without additional support. In Quebec, high dropout rates from secondary school are recognized as "a major problem" that is correlated with poor written language performance (Fortin, Royer, Potvin, Marcotte, & Yergeau, 2004). Screening, assessment and intervention tools that are adapted for the particular needs of the Canadian French-speaking population are urgently needed.

## Written language skills in Quebec school children

With respect to literacy, French-speaking Canadian children tend to underperform compared to their English-speaking counterparts across Canada, as revealed by the *Programme international de recherche en lecture scolaire* (PIRLS; Labrecque, Chuy, Brochu, & Houme, 2012), which tracks fourth-grade reading competence on a regular basis, permitting comparisons across language groups, genders, and provinces. PIRLS results from 2011 show that Canada as a whole and Quebec as a province score significantly higher than the world average. However, Quebec students from French-language school boards underperform compared to the Canadian average and the average of students in English-language schools in Quebec. (As an aside, students in minority French-language school boards elsewhere in Canada underperform compared to the Canadian French-language average). The state of literacy in Quebec has been a major concern for some years now, since a government report revealed significant difficulties in children's writing abilities in primary and secondary school (Gouvernement du Québec, 2006). Even more worrying, students' writing skills at the end of sixth grade were statistically weaker in 2005 than those of their peers five years earlier (Jalbert, 2007). Subsequently, the Ministère de l'éducation [Ministry of Education] introduced a new approach to literacy education in Quebec that included a competency-based approach to the teaching and assessment of reading and writing.

The literacy skills of Quebec school children are assessed through obligatory province-wide writing assessments administered in primary school (fourth and sixth grade), with additional tests in secondary school. Over several days, the students read and discuss a variety of texts and then write a narrative (in primary school) or explanatory text (in secondary school). These written texts are graded for relevance, organization, syntax and punctuation, vocabulary, and orthography. Each of these five areas is rated separately as very satisfactory, satisfactory, acceptable, somewhat satisfactory, or unsatisfactory, according to specific criteria. For example, syntax and punctuation is scored globally, so that an "unsatisfactory" rating indicates that sentence structure and punctuation rarely met expectations throughout the text. However, orthography is scored by counting the exact number of errors on a word-by-word basis, taking into account spelling and grammatical errors at the word level; scoring grids are provided by grade and text length, such that a "very satisfactory" fourth-grade text would contain less than 4% incorrect words. Provincial reports focus on rate of success (percentage of students receiving at least "acceptable" ratings), as well as percentage of "unsatisfactory" ratings, which indicate the need for special resources in the system.

A report on recent student performance on the obligatory writing tests from June 2009 (Charest, 2010) revealed that boys scored significantly lower than girls on average and across all scoring criteria. The rate of success declined with age (from 81% to 68%). The decline with age was particularly marked for orthography; furthermore, for both younger and older children, the disparity between boys and girls was most noticeable in this area. In the primary grades, the lowest rate of success was for syntax and punctuation but "unsatisfactory" ratings occurred most often for orthography. The distribution of scores in the orthography category was noticeably bimodal, with many children achieving "very satisfactory" scores but a substantial group showing "unsatisfactory" performance in this area (grade school: 3% of girls and 9% of boys; high school: 5% of girls and 10% boys). Motivation to read was

a significant predictor of outcomes for younger children, and perceived competence in reading and writing were significant predictors of outcomes for older children.

In this report we will focus on spelling as the literacy skill of interest given that it emerged as a particular area of difficulty on the obligatory literacy assessment in Quebec (Charest, 2010). Furthermore, it is an early marker of more generalized difficulties with writing and literacy overall. Spelling may be a particularly sensitive indicator of literacy problems; several studies have shown that at-risk children who have poor reading skills are usually poor at spelling, whereas some children are poor spellers while having relatively good reading skills (Holm, Farrier, & Dodd, 2008; Lewis, Freebairn, & Taylor, 2000; Pennala et al., 2010). Furthermore, follow-up of participants being treated for dyslexia indicates the persistence of spelling and writing difficulties long after resolution of the reading impairment, in children (Berninger, Nielsen, Abbott, Wijsman, & Raskind, 2008) and in adults (Connelly, Campbell, MacLean, & Barnes, 2006). Finally, some studies have demonstrated a positive impact of spelling instruction on reading and other literacy skills (Graham & Santangelo, 2014; Weiser & Mathes, 2011).

## Oral language foundations of literacy

Literacy includes a host of interconnected skills involving print: letter and letter-sound knowledge, decoding and sight word reading, spelling, grammatically correct and coherent writing of sentences and passages, reading fluency, reading comprehension, and ultimately the ability to gain new knowledge and solve problems using print materials, whether in paper or digital form. These written language skills are learned through direct teaching and practice, beginning in preschool but with particularly explicit attention devoted to the teaching of reading and writing during the early school years. However, the foundation for literacy is formed during the preschool period with the acquisition of oral language skills, beginning with language-specific shaping of perceptual knowledge during the first year of life. Every aspect of literacy has been shown to be closely correlated with oral language skills, including decoding, reading fluency, and reading comprehension (Durand, Loe, Yeatman, & Feldman, 2013). Furthermore, children who have speech and language impairments are at risk for delayed acquisition of literacy (Puranik, Petcher, Al Otaiba, Catts, & Lonigan, 2008).

Longitudinal studies have linked oral language development during the preschool period to the acquisition of literacy skills after school entry (Cooper, Roth, Speece, & Schatschneider, 2002; Dickinson, McCabe, Anastasopoulos, Peisner-Feinberg, & Poe, 2003; Dickinson & Porsche, 2011; Hulme, Nash, Gooch, Lervag, & Snowling, 2015; Sénéchal & LeFevre, 2002; Snowling & Melby-Lervåg, 2016; Speece, Roth, Cooper, & de la Paz, 1999; Storch & Whitehurst, 2002). These studies show that oral language skills exert both indirect and direct effects on literacy. First, phonological awareness emerges from accumulating knowledge in the phonological and lexical domains; in turn, phonological awareness (which emerges implicitly) and letter-sound knowledge (which must be taught explicitly) combine to underpin the child's acquisition of decoding skills. In this way, oral language skills exert an early indirect effect on the earliest stages of literacy acquisition. Later, when the child is "reading to learn", oral language abilities—such as vocabulary, syntax, and oral narrative abilities—directly support written language comprehension (Griffin, Hemphill, Camp, & Palmer Wolf, 2004; Nation & Snowling, 2004). An indirect effect remains because speed and automaticity in the decoding process support comprehension when reading sentence and passage level text. Oral language skills also support the child's writing abilities at every level, including spelling, syntax, and narrative structure (Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998).

## Prediction of spelling abilities

Given the heightened and continuing concern about the written language skills of French-speaking children in Quebec, a targeted funding program was implemented to encourage research in this area. Consequently, we embarked on a project to develop a screening tool that could be used to identify children at school entry who would potentially be at risk for slower acquisition of writing, or more specifically in this context, spelling at the end of second grade. For predictors, we chose four aspects of oral language abilities that are known to be correlated with spelling specifically and literacy more generally. These predictors are discussed in turn below: speech perception, speech production, phonological awareness, and morphology production.

Speech perception skills are a known correlate of emergent literacy skills, reading ability, and spelling (Anthony, Lonigan, Driscoll, Philips, & Burgess, 2003; Boets, Wouters, van Wieringen, De Smedt, & Ghesquière, 2008; Overby & Bernthal, 2008). For example, the ability to discriminate short versus long vowels was found to be associated with literacy skills in Finnish children, with second-grade spelling abilities being the strongest correlate (Pennala et al., 2010). A speech perception test that uses a word identification procedure appropriate for young

children, and which was previously validated as a predictor of phonological awareness and emergent literacy skills in English—the Speech Assessment and Interactive Learning System (SAILS)—was modified for the French context and used in this study (Rvachew & Grawburg, 2006).

Speech production accuracy also influences children's spelling abilities. For example, articulatory similarity of vowels explains spelling confusions in English and in French (Caravolas & Bruck, 2000; Ehri, Wilce, & Taylor, 1987). Furthermore, underlying organization of phonological structure also explains common error patterns in early spelling (Bourassa & Treiman, 2001), such as, for example, the omission of word-internal nasals or liquids that are represented as vocalic rather than consonantal elements (e.g., "hand" → "had"). Many studies have shown that children who present with a speech sound disorder are at risk for future difficulties with spelling, even when their language abilities are within the average range (Bird, Bishop, & Freeman, 1995; Lewis, Freebairn, & Taylor, 2002; Overby, Masterson, & Preston, 2015). Therefore, we included a test of speech production accuracy that has been used to describe the speech abilities of monolingual and bilingual children in primary school (the *Test de Dépistage Francophone de Phonologie* [TDFP]; Rvachew et al., 2013), as well as the speech errors produced by preschoolers with a phonological disorder (Brosseau-Lapré & Rvachew, 2014; Paul, 2009). Moreover, performance on this test has been shown to be closely related to phonological awareness performance (Brosseau-Lapré & Rvachew, 2017).

Phonological awareness is well recognized as an excellent predictor of reading and spelling abilities (Holm et al., 2008; Schneider, Roth, & Ennemoser, 2000). For example, Speece et al. (1999) found that strong phonological skills in kindergarten were associated with strong spelling abilities in first grade. We selected a measure of implicit phonological awareness skills, requiring no spoken responses, so that the children's performance would be independent of their speech accuracy. The English version of this test predicts reading and spelling ability (Bird et al., 1995; Rvachew, 2007). The French version—the *Test de Conscience Phonologique Préscolaire* (TCPP)—has previously been used to describe and differentiate phonological awareness skills of children receiving speech therapy from children with normally developing speech and language skills (Rvachew & Brosseau-Lapré, 2015; Brosseau-Lapré & Rvachew, 2017).

The fourth target of our screening protocol was knowledge of grammatical morphemes, specifically the past tense. As previously mentioned, aspects of grammar

were particularly difficult for French-speaking children on their writing tests. Furthermore, expressive morphology is an aspect of structural language development that has been previously linked to literacy development in general (Speece et al., 1999). Morphological awareness emerges in early primary grades to aide reading and writing (Duncan, Colé, & Casalis, 2009; Pacton & Deacon, 2008; Wolter, Wood, & D'zatko, 2009). For example, Sénéchal, Basque, and Leclaire (2006) showed that morphological awareness was correlated with the ability to spell morphological and lexical words in grade 4 French-speaking children. Metalinguistic knowledge of inflectional and derivational morphology is particularly helpful to spelling, but explicit morphological awareness is more reliably assessed in second and third grade compared to early first grade (Bédard, Marquis, Royle, Gonnerman, & Rvachew, 2013). Therefore, we included a measure of productive morpheme knowledge that we have used previously to describe the development of morphology in young Quebec children with and without language impairments (*Jeu de Verbes*; Marquis, Royle, Gonnerman, & Rvachew, 2012; Royle, 2007; Royle & Thordardottir, 2008). This test assesses the child's ability to produce French verbs in the *passé composé* (perfect past) form, using the auxiliary *avoir* ("to have") or *être* ("to be") and a past participle of the verb. We used this specific structure because it is acquired early (Thordardottir & Namazi, 2007) and it can be reliably elicited in children as young as age 3;2 (years;months; Royle, 2007). In contrast, many aspects of morphology are highly irregular or are variably produced in oral French (Kresh, 2008; Legendre et al., 2009). Other aspects of morphology that involve allomorphy (e.g., liaison, elision, and contraction; Béchara, 2015) were not tested because they confound morphological and phonological processes.

We chose spelling at the end of second grade as our outcome, given that spelling is an area of particular weakness, and spelling may be an early indicator of the writing difficulties identified throughout the school years on the province-wide literacy competency assessment. Therefore, word and phrase level spelling was tested from dictation, using the *Batterie d'évaluation de lecture et d'orthographe* (BELO; George & Pech-Georgel, 2006), as the final outcome at the end of second grade. The BELO was standardized on a sample of 371 early-grade children and found to have excellent reliability and convergent validity. In particular, the BELO was validated against the Alouette (Lefavrais, 2006) on 100 children (Pech-Georgel & George, 2010). This task was chosen because it is adapted to the age level and language of our participants and evaluates phono-orthographic abilities (non-word syllables), basic orthographic abilities for known words

(real words), and basic grammatical abilities (sentences). Although the test is based on dictation rather than free narrative (as is developmentally appropriate for second-grade spellers; see Alamargot, 2007), the coding is similar to that used in the provincial writing assessment, in that each word is scored as spelled correctly or incorrectly, capturing spelling and grammatical abilities simultaneously.

## Overview and objectives

The screening test was developed in a two-phase process. This research project will be described in relation to the objectives for each of the two phases, as follows:

**Phase I, Objective 1:** Administer the full battery of assessments to kindergarten and first-grade children in order to test whether our measures of speech perception, speech production, phonological awareness and morphology production would differentiate children likely to differ in writing abilities as consequence of variations in grade, language background, perceived risk, and overall test performance.

**Phase I, Objective 2:** Using item-level discriminability and difficulty statistics, select a smaller set of items from among these measures to form a screening test, which is hypothesized to predict future spelling abilities while being shorter than the full test battery.

**Phase II, Objective 3:** Administer the screening test, *Prédiction des Habiletés Orthographiques Par des Habiletés Langage Oral* (PHOPHLO), to first-grade children, followed by a spelling test, BELO, to the same children in second grade, in order to determine the specificity and sensitivity of the PHOPHLO as a predictor of BELO performance.

**Phase II, Objective 4:** Examine the contribution of each of the four subtests in the screener to the identification of children who proved to have poor spelling performance at the end of second grade, with the expectation that the test as a whole and the individual subtests will contribute to the prediction of spelling abilities.

## General Method

Testing protocols were approved by the internal review boards from both the Université de Montréal and McGill University Faculties of Medicine. The children were recruited from their school by sending letters home and asking parents to return a signed consent form if they agreed to their child's participation.

The study participants were drawn from a French public school board located in a suburb of Montréal in the province of Quebec (Canada). The particular area from which the children were recruited, according to the most recent census, is an area of high immigration with 61% of the total population speaking French as the mother tongue and 28% speaking neither English nor French as the mother tongue. Less than 13% of the population speaks English regularly at home. By law, immigrant children must be educated in French in Quebec.

All children in the kindergarten and first-grade classrooms were eligible for participation regardless of their language background or the presence of developmental difficulties, as long as the parent consented and the child assented and was able to cooperate with the testing procedures. A telephone interview was conducted with each child's parent to obtain demographic, literacy, health, and language information via standard questionnaires. Parents identified possible developmental concerns for some children but we did not verify these concerns via diagnostic testing or by obtaining confirmatory documentation. Language status was based on parental reports of their own language use with and around their child, siblings' language use, other caregivers' language use, and radio and television exposure. A 90% criterion of French exposure from birth was used to determine monolingual status of children placed in the monolingual (ML) group. The remaining children were placed in the bilingual (BL) group (i.e., either simultaneous BL with exposure to two languages from birth, or sequential BL with no French exposure until preschool). The languages represented besides French were diverse, including English, Arabic, Spanish, Haitian Creole, Italian, Greek, Lao, Polish, Romanian, Asu, and Khmer. Teachers were also asked to rate each child as being "at-risk" or "not-at-risk" for developing writing difficulties, on the basis of their own opinion with no specific criteria provided (for more information about the teacher ratings, see Kolne, Gonnerman, Marquis, Royle, & Rvachew, 2016).

Children were tested individually in a quiet room inside the school. The assessment protocol in both phases was administered by native French-speaking graduate level research assistants under the supervision of a post-doctoral fellow, the fifth author. All scoring, transcription, and reliability coding was subsequently completed by native French-speaking graduate students in speech-language pathology with training in clinical phonetics and phonology, under the supervision of the first and second authors.

## Phase I: Development of screening test

### Method

The Phase I experiment involved cross-sectional

assessments of children in kindergarten and first-grade classrooms. The children were tested at the end of the school year. Although the final screening test is intended to identify children who may be at risk for written language problems prior to onset of formal reading instruction, a group of children who were expected to have beginning reading skills were included in the Phase I sample (that is, children at the end of the first-grade year). This was so that the items for the screener could be selected that discriminated performance across a broad range of skill levels.

## Participants

The children recruited to the Phase I experiment comprised 43 children from kindergarten classrooms with a mean age of 6 years and 1 month, including 21 boys (22 girls) and 24 ML (19 BL) speakers of French. From a first-grade classroom, 18 children were recruited with a mean age of 7;2, including 11 boys (seven girls) and 12 ML (six BL) speakers of French. On average, the number of years of maternal education was 14.48 (*SD* = 2.06). Developmental diagnoses were suspected but not confirmed by professional assessments for four kindergarten children (autism spectrum disorder, intellectual disability, and attention deficit disorder). A heart defect was reportedly diagnosed for one child and language impairment for another. Parents reported concerns about hearing due to otitis media for five children and about fine motor skills for three children.

## Procedure

The four different language assessment tasks were administered over two separate sessions pairing phonological awareness and speech perception in one 20-minute session, and morphology production and phonological production in another 20-minute session, with order counterbalanced within session and across participants. Evaluation sessions occurred within a maximum of two weeks from each other. Sessions were recorded with a Zoom1 stereo digital recorder at a sampling frequency of 44 kHz and a quantization rate of 24 bits. Responses to the speech perception and phonological awareness tasks were automatically recorded by the test device, whereas responses to the speech production and morphology production tasks were transcribed from audio recordings. Subsequently, 16% of all audio recordings for these two production tasks were retranscribed to obtain estimates of transcription reliability. Following data collection and coding, the children's performance on each test item was examined to reveal item difficulty and item discrimination scores when differentiating risk status

(according to the teacher rating) and grade (kindergarten versus grade 1) and overall performance (using a split-half procedure for total test score regardless of child's age or grade or risk status).

**Speech perception.** The Speech Assessment and Interactive Learning System (SAILS; Rvachew, 2009) assesses speech perception with a two-alternative, forced-choice word identification task. The child hears natural speech recorded from adults and typically developing children. The words are presented in blocks of 10 items, five representing the target and five representing a misarticulated version of the target word. The child listens to each word and points to a picture of the target when a correct pronunciation is heard and an X when a misarticulation is heard. A laptop was used to run the software that ensures random ordering of stimuli within blocks. The child listened to the stimuli over headphones, presented at the loudest comfortable level. The examiner used a mouse to activate the hotspot selected by the child on the computer screen and responses were recorded automatically by the software. A reinforcement image was presented after each response, regardless of whether the child's response was correct or not. An experimental French version of SAILS was developed for this study, which included two blocks of *gris* ([gʁi] – "grey") stimuli recorded from preschool-aged children, two blocks of *serpent* ([sɛʁpã] – "snake") stimuli recorded from adults, and two blocks of *poisson* ([pwasɔ̃] – "fish") stimuli recorded from adults. Erroneous tokens represented commonly occurring misarticulations, including omissions (e.g., *gris* → [gi], *poisson* → [pasɔ̃], *serpent* → [sɛpã]) and substitutions of consonants (e.g., *gris* → [gji], *poisson* → [bwasɔ̃]) and vowels (e.g., *serpent* → [sɛʁpɑ]). Each test was preceded by 10 practice trials involving an easy contrast (e.g., [gʁi] versus [mi]), during which the examiner could help the child to understand the task. The test comprises 60 items, of which 30 are practice items. The test is scored as percentage of items correct out of the remaining 30.

**Speech production.** The *Test de Dépistage Francophone de Phonologie* (TDFP), described in complete detail in Rvachew et al. (2013), comprises eight colour photos, presented digitally with verbal prompts used to elicit 30 spoken words from the child. The words were selected to be known by children aged 2 to 8 and to be representative of the distribution of phonemes, syllable shapes, and word lengths characteristic of Quebec French. Consonants appear in four syllable positions: singleton syllable onset (e.g., the first consonant in *niche* [niʃ] – "doghouse"), branching onsets (e.g., the two consonants at the beginning of the word *clown* [klun] – "clown"), glide in the nucleus (e.g.,

glide following the /v/ in *avion* [avjɔ̃] – "plane") and the coda (e.g., the /ʁ/ in the words *serpent* [sɛʁpɑ̃] and *hélicoptère* [elikɔptɛʁ] – "helicopter"). The test is scored as percentage of consonants correct with every consonant in every word considered, therefore 94 consonants within 30 words. Inter-rater point-by-point transcription agreement for narrow transcription of consonants was 95.9%.

**Phonological awareness.** The *Test de Conscience Phonologique Préscolaire* (TCPP; Brosseau-Lapré & Rvachew, 2008) was modeled on the phonological awareness test developed by Bird et al. (1995), adapting it for French and implementing it on a computer using HTML software code. It consists of three subtests but only the first (rime matching) and third subtests (onset segmentation and matching) were administered to the children in this study. (The second subtest also targets onset matching and was omitted to reduce testing time because this is a very long assessment). In the rime matching subtest, the child is presented with an animal and its name, and told that it "likes things that sound like his name". In the onset and segmentation subtest the child is told the animal "likes things that start with the same sound as his name". For each trial the child is presented with four pictured items (the target and three distractors) and these items are named for the child on every trial. There are five practice items at the beginning of each subtest during which corrective feedback can be provided as necessary. The task was presented by computer although the examiner provided extra support, especially during the practice items. The child responded by touching the appropriate picture and the software recorded responses automatically. The total test score is the number of correct items out of 24 (14 rime matching and 10 onset segmentation, excluding practice trials).

**Morphology production.** The children's ability to produce *passé composé* forms was assessed with an elicited production task for verbs using an interactive Android platform. The application simulated a storybook where the children are asked to complete short stories by responding to questions from the experimenter. The adults would read three short sentences presenting the target verb in order to induce the perfect past. For example, along with an image of a girl hiding her dolls under a box, the script presented was: *Marie va cacher ses poupées. Marie cache toujours ses poupées. Qu'est-ce qu'elle a fait hier Marie?* ("Marie will hide (infinitive) her dolls. Marie hides (present, 3rd person singular) her dolls every day. What did she do yesterday, Marie?") The tasks had four types of verbs with seven items each (four of which were used as practice items): seven verbs with a past participle in –*é* (/e/; e.g., *caché* – "hidden"); seven with a participle in –*i* (/i/;

e.g., *fini* – "finished"); seven with a participle –*u* (/y/; e.g., *mordu* – "bitten"); and seven with other non-paradigmatic, or opaque, forms (e.g., *ouvert* – "opened"). All items are conjugated with *avoir*. The expected pronoun is *il* ("he") or *elle* ("her"), but was not counted as incorrect if a gender error occurred. The items are described in more detail in Marquis et al. (2012). One point was given for each correct production of the full *passé composé* (i.e., the pronoun clitic, auxiliary, and past participle; for example, (*Marie*), *elle a caché* – (Marie), she AUX hid.pp). The total score was out of 24. Coding reliability for correct production of 25% of tested children was 98.8%.

## Results and Discussion

The children's performance, on average, for the four oral language tests, is shown in Table 1 by subtest for the full group and for contrasting subgroups, specifically kindergarten versus first-grade children, boys versus girls, BL vs. ML children, at-risk versus not-at-risk children according to teacher report, and low-scoring versus high-scoring children. The low- versus high-scoring subgroups were identified by transforming the scores on all four tests to *z*-scores, taking the mean of the *z*-scores across the four tests, and then splitting the whole group (kindergarten and first grade combined) at the median *z*-score. Differences in means across pairs of subgroups were assessed against the standard deviation of subtest scores for the full group of children. If one considers a half-standard deviation difference in means to be of interest, Table 1 shows that the tests were generally discriminating. Specifically, the speech perception test (SAILS) differentiated sub-groups on the basis of grade and overall test score (i.e., low vs. high scores). Speech production accuracy (TDFP) also differentiated kindergarten from first-grade children and the low-scoring from high-scoring subgroups. Phonological awareness (TCPP) differentiated groups well with differences between mean scores sometimes more than a standard deviation apart and differences apparent between grades, risk subgroups and low- versus high-scoring subgroups. Morphology production (*Jeu de verbes*) differentiated the BL versus ML subgroups.

Given that each of the four domains assessed proved to have some value for differentiating subgroups of children who might be expected to present with varying oral language skills, it was decided to include all four subtests after item analyses to reduce the length of testing. Detailed item analyses, including discriminability and difficulty indexes and item-total correlations, were used to select a smaller subset of items from each subtest to create a pilot screening tool that could be administered in a

## Table 1. Results Obtained for the Four Oral Language Tests Administered in Phase I by Subgroup

| Subgroup | N | Speech Production | | Speech Perception | | Phonological Awareness | | Morphology Production | |
|---|---|---|---|---|---|---|---|---|---|
| | | M | SD | M | SD | M | SD | M | SD |
| All children | 61 | 87.32 | 8.24 | 90.69 | 6.84 | 17.11 | 5.24 | 13.61 | 7.27 |
| Kindergarten, vs. | 42 | **85.97** | 8.94 | **89.60** | 7.48 | **15.23** | 5.01 | 12.74 | 7.42 |
| First grade | 18 | **90.56** | 5.14 | **93.28** | 4.07 | **21.61** | 2.15 | 15.67 | 6.63 |
| Boys, vs. | 29 | 86.88 | 6.81 | 90.31 | 6.47 | 17.16 | 5.23 | 14.59 | 7.01 |
| Girls | 32 | 87.82 | 9.68 | 91.10 | 7.31 | 17.07 | 5.25 | 12.52 | 7.52 |
| L2 French, vs. | 36 | 85.73 | 9.74 | 88.96 | 7.91 | 15.92 | 5.51 | **11.52** | 7.41 |
| L1 French | 25 | 88.43 | 6.95 | 91.89 | 5.80 | 17.94 | 4.96 | **15.16** | 6.90 |
| At-risk, vs. | 29 | 85.40 | 9.78 | 89.17 | 6.18 | **14.48** | 5.11 | 14.03 | 7.44 |
| Not-at-risk | 32 | 89.06 | 6.21 | 92.06 | 7.30 | **19.50** | 4.16 | 13.22 | 7.21 |
| Low score, vs. | 23 | **82.32** | 4.79 | **88.35** | 7.53 | **15.43** | 5.14 | 13.26 | 7.60 |
| High Score | 38 | **90.35** | 8.46 | **92.11** | 6.05 | **18.13** | 5.11 | 13.82 | 7.16 |

*Note.* Speech Perception is scored as percent correct over 30 items; Speech Production is scored as percent correct over 30 words and 94 consonants; Phonological Awareness is scored as number correct over 24 items; Morphology Production is scored as number correct over 24 items. Bold lettering highlights subgroup means that differ by more than one-half standard deviation (calculated from all children by test).

single test session. Specifically, items with relatively poor discriminability and difficulty indexes were eliminated from each subtest, using the top and bottom quarter of the sample, based on total subtest scores (Burton, 2001; Kelley, 1939; Gelman & Park, 2001). For example, with respect to the speech perception test, many of the *poisson* items were identified correctly by all of the children and therefore did not discriminate high- and low-scoring subgroups; in contrast, the five items that were ultimately selected for identification as incorrect exemplars of the word *gris* were associated with an average discrimination index of 0.37. Similarly, when considering the morphology production test, the verb item *couvrir* ("to cover") was eliminated with a discrimination index of 0.15, reflecting the extreme difficulty of this item for both high- and low-scoring children; by contrast, the item *remplir* ("to fill") was retained with a discrimination index of 0.85. This process was applied to each item in all four subtests, with the result described below by subtest.

The game *Écoute* ("Listen") tests speech perception with a 10-item word recognition procedure targeting the word *gris* in which five items are correctly produced ([gʁi]) and five items are misarticulations as follows: [gi], [gi], [gi], [gji], [ŋgi]. All items are produced by different child talkers so that even though some items are phonetically the same, each item is acoustically distinct. A practice block of 10 trials precedes the test block. A screenshot of a single practice trial is shown in Figure 1. During test trials, caterpillars turn into butterflies with each completed item, providing noncontingent feedback that helps the child gauge progress toward game completion.

The game *Qu'est-ce que c'est?* ("What is it?") tests speech production accuracy by presenting children with colour drawings of 10 items for naming. There are no practice trials but additional verbal prompts are available if the child does not know the name of the item. Specifically, if the child produces no response or the wrong word, the first
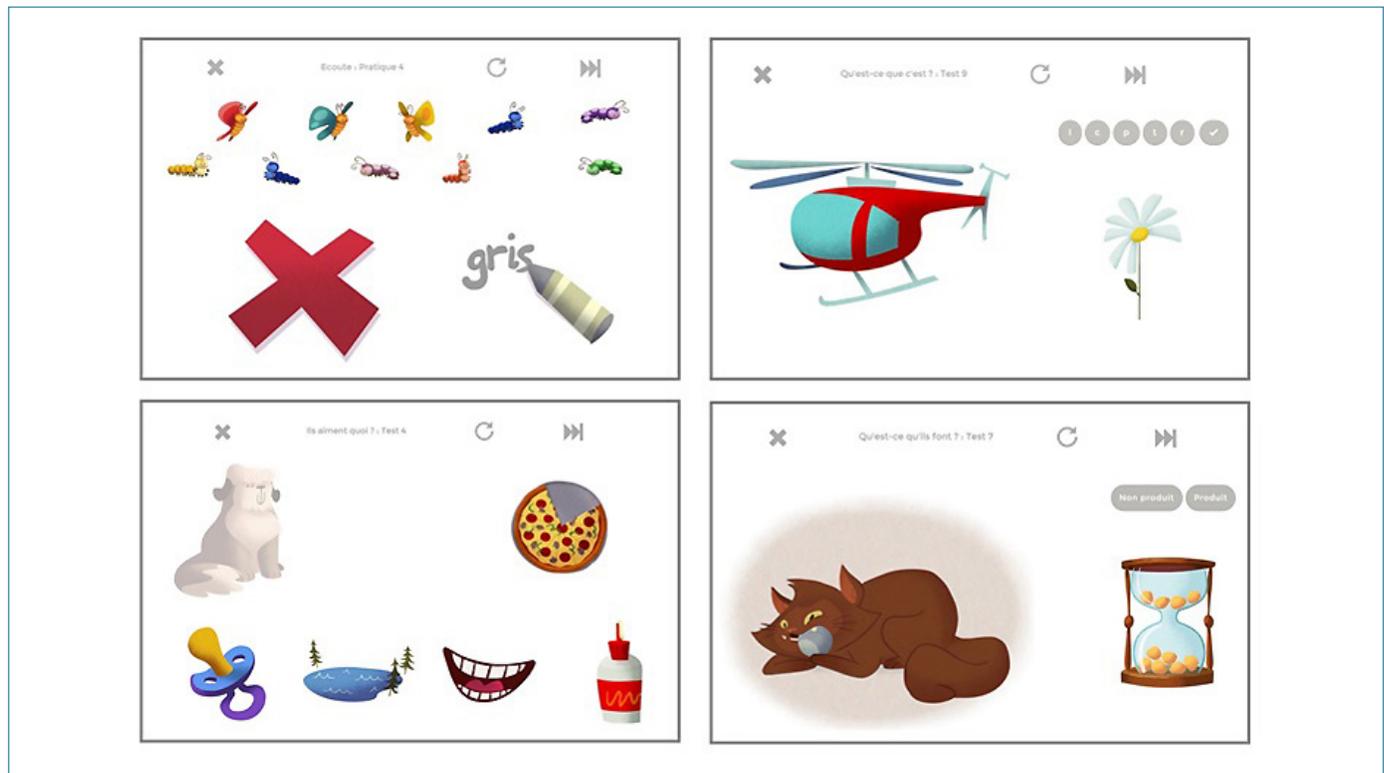
Figure 1. Screen shots from the four PHOPHLO subtests: Speech Perception, *Écoute* "Listen" (top left); Speech Production, *Qu'est-ce que c'est?* "What is it?" (top right); Phonological Awareness, *Ils aiment quoi?* "What do they like?" (bottom left); and Morphology Production, *Qu'est-ce qu'ils font?* "What are they doing?" (bottom right).

prompt provides a semantic hint and the second hint prompts for delayed imitation of the target word. The consonants in the word are presented on screen so that the examiner can then identify consonants that were misarticulated by the child, or, alternatively, the entire word can be marked as correct. The software provides a response grid to the examiner for recording production errors, yielding a count of correctly produced consonants out of 36 in total. The 10 items are *niche, tournevis* ("screwdriver"), *serpent, clown, araignée* ("spider"), *enveloppe* ("envelope"), *garde-robe* ("closet"), *parapluie* ("umbrella"), *hélicoptère*, and *camion* ("truck"). A screenshot of the item *hélicoptère* is shown in Figure 1. Daisy petals are added with each item to help the child gauge progress toward completion of the game.

The game *Ils aiment quoi?* ("What do they like?") tests rime awareness using the procedure previously described in which the child identifies the item that matches the rime of the name of the animal. Five practice trials using the names *Guy* ([gi]) and *Jeanne* ([ʒan]) are provided for teaching the task. Subsequently, 14 test items target the names *Lou* ([lu]), *Paul* ([pɔl]), *Lucas* ([luka]), and *Plé* ([plɛ]), in each case with four pictures shown representing the answer and three distractors. The software records the child's picture touch responses and sums correct responses for the test items. A

screenshot showing the layout from one of the test items is shown in Figure 1. Disappearing pizza slices mark progress toward the end of the game, indicating trial completion without regard for response accuracy.

The game *Qu'est-ce qu'ils font?* ("What are they doing?") prompts production of *passé composé* verb forms using the procedure previously described. Ten items target the verbs *rire* ("to laugh"), *sentir* ("to smell"), *remplir, ouvrir* ("to open"), *conduire* ("to drive"), *battre* ("to beat/win"), *défendre* ("to defend"), *perdre* ("to lose"), *mordre* ("to bite"), and *boire* ("to drink"), most ending in –i or –u and one having an idiosyncratic form. Tablet icons permit the examiner to indicate which parts of the child's response were correct (subject + auxiliary + participle). The software provides detailed information about the child's performance (i.e., subject, auxiliary, and participle for each item), but the total score tabulated by the software reflects the number of complete items produced correctly, out of 10. Scoring thus reflects the child's ability to produce not only the past participle morpheme but to produce it in context including the subject and auxiliary. Again, feedback marking trial completion is noncontingent except for the practice trials. One trial from this game is shown in Figure 1 (specifically the trial that elicits *Il a mordu* – "He bit").

This process of item selection by subtest resulted in a 64-item screener (44 test trials and 20 practice trials) that correlated with the full test battery, $r = .89$, $p < .0001$. Test order is fixed but item order may be randomized within each test. The screener was subsequently developed as an integrated software tool that can be accessed and implemented on multiple digital platforms (Android or iPad tablets, or Windows or Macintosh computers). All visual and auditory stimuli are presented by the software, noncontingent visual feedback is provided for every child response, and these are recorded and tabulated by or with the assistance of the software. After the screening is complete, a complete record of the child's responses is provided along with an indication of whether the child passed or failed according to the criteria developed in Phase II of the project.

### Phase II: Testing of an oral language screen as a longitudinal predictor of spelling

#### Method

The Phase II experiment involved longitudinal assessments of children tested during the first term of grade 1, using the PHOPHLO screener that was developed in Phase I, and again during the final term of grade 2, using the BELO test of spelling.

#### Participants

The children recruited to the Phase II experiment comprised 91 children from first-grade classrooms with a mean age of 6;9, including 36 boys (55 girls) and 52 ML (39 BL) speakers of French, with mean maternal education 14.55 years ($SD = 2.08$). Concerns about the children's development were raised in several areas, specifically language learning (three children), hearing (two children), attention deficits (four children), fine motor skills (three children), dyslexia (three children), social problems with peers (one child) and anxiety (one child). At the end of the second grade, 78 children were located to receive the outcome assessment. Some children were lost to follow-up because they moved out of the school district. Some children were included in a pilot study that involved first-grade administration of the BELO (Kolne et al., 2016), and therefore these children were excluded from the Phase II experiment. The 78 remaining participants were aged 8;2 on average, with the group composed of 30 boys (48 girls) and 45 ML (33 BL) speakers of French, and mean maternal education 14.46 years ($SD = 2.09$).

#### Procedure

At the beginning of first grade, the children were assessed with the PHOPHLO screening test, described as the outcome of the Phase I study, in a single session lasting approximately 20 minutes. As the children were approaching the end of second grade, the BELO (George & Pech-Georgel, 2006) was administered to the children in small groups of three or four, in order to assess their spelling ability. A standard dictation procedure was used: the examiner presented the items live-voice; the children wrote down what they heard on paper marked with familiar primary school line markings. The test was not timed and therefore each item was presented when the entire group had completed their transcription of the previous item. In the first section there were 10 non-word items: five single-syllable items (e.g., *fir*) and five two-syllable items (e.g., *palon*). Next, 15 real word items were presented, including 10 high-frequency words and five low-frequency words with simple (e.g., *fam* in *famille* – "family"), complex (e.g., *ille* in *famille*), and contextual grapho-phonemic correspondences (e.g., g in *rouge* [ʁuʒ] – "red"). A third writing task elicited four sentences that were seven to 11 words in length, for a total of 35 words in sentences. The final score was calculated as the percentage of words spelled completely and correctly out of a total of 60.

#### Results and Discussion

Table 2 describes the children's performance, in first grade, on the four subtests of the PHOPHLO. Speech perception performance, expressed as perception trials correct, ranged from random selection of response alternatives to perfect accuracy. Speech production accuracy, presented as percent consonants correct, was very high on average—as is expected for French—but some children scored very far below the mean. Phonological awareness, shown as number of correct items out of 14, also ranged from random guessing to perfect performance. The morphology test resulted in the full range of possible scores from 0 to 10 items produced completely correct. Therefore, with the exception of the speech production test, the effective floor and ceiling was observed in the children's responding but the mean scores were not at floor or ceiling.

Table 3 describes the performance of the 78 children who wrote the spelling test at the end of second grade. In this case, some children achieved a perfect score on one or more subtests but no child achieved a perfect total score of 60 points. All children were able to spell some non-words and real words correctly. The descriptive data presented in Tables 2 and 3 were used to define pass and fail criteria for PHOPHLO subtests and for BELO performance specifically for this sample, so as to take into account the particular characteristics of this sample including demographics, varied language background—more specifically Quebec

## Table 2. Children's Performance in First Grade on PHOPHLO Subtests (*n* = 91)

| Game | Construct | Min | Max | *M* | *SD* | Cut-Off Score |
|------|-----------|-----|-----|-----|------|---------------|
| Écoute | Speech perception | 50 | 100 | 91.10 | 13.94 | 80 |
| Qu'est-ce que c'est? | Speech production | 78 | 100 | 96.94 | 3.97 | 91 |
| Ils aiment quoi? | Phonological awareness | 5 | 14 | 11.95 | 2.14 | 10 |
| Qu'est-ce qu'ils font? | Morphology production | 0 | 10 | 7.00 | 2.99 | 3 |

*Note.* The four games comprise the screening test *Prédiction des Habiletés Orthographiques Par des Habiletés Langage Oral* (PHOPHLO), with each scored as follows: Speech Perception was scored as percent correct over 10 items; Speech Production was scored as percent correct over 10 words and 36 consonants; Phonological Awareness was scored as number correct over 14 items; Morphology Production was scored as number correct over 10 items (excluding 20 practice items overall). The cut-off scores are approximately 1.25 standard deviations below the mean, with rounding and some adjustments for skewed distributions.

## Table 3. Children's Performance in Second Grade on BELO Subtests (*n* = 78)

| BELO Subtest | Min | Max | *M* | *SD* | *M* - 1.25 *SD* |
|--------------|-----|-----|-----|------|-----------------|
| Nonwords | 3 | 10 | 8.60 | 1.26 | 7.03 |
| Words | 2 | 15 | 10.88 | 3.07 | 7.04 |
| Words in Sentences | 9 | 35 | 28.15 | 4.68 | 22.30 |
| Total Score | 14 | 59 | 47.55 | 8.23 | 37.26 |

*Note.* The subtests comprise the spelling test *Batterie d'évaluation de lecture et d'orthographe* (BELO; George & Pech-Georgel, 2006).

French as first or second language—and the literacy teaching practices in the province. Subsequently, we examined BELO performance as a function of PHOPHLO performance more directly. In Table 4, number of children who passed or failed each PHOPHLO subtest is shown along with the corresponding mean score, using the cut-off score for each PHOPHLO subtest as shown in Table 2 (children who obtained a score below the cut-off failed the subtest). Ultimately 68 children passed the PHOPHLO screen (i.e., passed at least three subtests) and 10 children failed (i.e., failed two or more subtests).

Table 4 shows the mean and the standard deviation of the BELO score for the children who passed the PHOPHLO and the children who failed the PHOPHLO in first grade, with a total score of 38 (approximately -1.25 *SD* below the mean) being the cut-off for passing the spelling test (in

other words, all children who scored 38 or above passed and all children who scored 37 or below failed). The risk of significantly poor spelling performance at the end of second grade, given poor PHOPHLO performance at the beginning of first grade, is shown. For example, the last row of Table 4 indicates that 68 children passed the PHOPHLO in first grade, achieving a mean score of 49 on the BELO in second grade with only 3% of this group failing the BELO. In other words, two children who passed the PHOPHLO in first grade failed the BELO in second grade; in contrast, 10 children failed the PHOPHLO in first grade and five of these 10 (50%) also failed BELO in second grade.

As indicated in Table 4, BELO performance is lower for children who failed than for children who passed the PHOPHLO subtests. The mean differences were submitted to nonparametric randomization tests

Table 4. Second-Grade BELO Performance as a Function of Passing or Failing PHOPHLO in First Grade

| Game | Construct | Spelling Performance (BELO Scores) in Second Grade | | | | | | | |
| | | Pass PHOPHLO | | | | Fail PHOPHLO | | | |
| | | M | SD | n* | Fail BELO n,% | M | SD | n† | Fail BELO n,% |
|---|---|---|---|---|---|---|---|---|---|
| Écoute | Speech perception | 48.17 | 6.97 | 70 | 4, 6% | 42.13 | 15.12 | 8 | 3, 38% |
| Qu'est-ce que c'est? | Speech production | 48.40 | 7.13 | 68 | 5, 7% | 41.80 | 12.63 | 10 | 2, 20% |
| Ils aiment quoi? | Phonological awareness | 48.35 | 8.15 | 65 | 4, 6% | 43.54 | 7.74 | 13 | 3, 23% |
| Qu'est-ce qu'ils font? | Morphology production | 48.97 | 6.86 | 63 | 3, 5% | 41.60 | 10.83 | 15 | 4, 27% |
| PHOPHLO | Fail 2 or more subtests | 49.01 | 3.37 | 68 | 2, 3% | 37.60 | 12.32 | 10 | 5, 50% |

Note. PHOPHLO = *Prédiction des Habiletés Orthographiques Par des Habiletés Langage Oral;* BELO = *Batterie d'évaluation de lecture et d'orthographe;* * *this column indicates the number (*n*) of students who passed the PHOPHLO (sub)test and is the denominator for the percentage (%) of students who failed the BELO, given that they passed the PHOPHLO (sub)test in first grade; †this column indicates the number (*n*) of students who failed the PHOPHLO (sub)test and is the denominator for the percentage (%) of students who failed the BELO, given that they failed the PHOPHLO (sub)test in first grade.

(Edgington & Onghena, 2007) because the sample sizes were very different and therefore the assumption of homogeneity of variance was not met, precluding parametric tests. For the subtest *Écoute*, $t = -0.641$, $p = .26$, $d = 0.374$; for *Qu'est-ce que c'est?*, $t = -2.44$, $p = .01$, $d = 0.413$; for *Ils aiment quoi?*, $t = -1.96$, $p = .04$, $d = 0.298$; for *Qu'est-ce qu'ils font?*, $t = -3.31$, $p = .002$, $d = 0.476$; and for the PHOPHLO, $t = -4.60$, $p < .001$, $d = 0.779$. Therefore, it can be seen that the mean differences in BELO performance were statistically significant for three subtests: those targeting speech production, phonological awareness, and morphology production. The largest effect size was obtained when total screening test performance was taken into account.

The information about the probability of passing the BELO, given a failure on the PHOPHLO approximately 18 months prior, yields a sensitivity of 71% (i.e., proportion of true positives identified) and specificity of 93% (i.e., proportion of true negatives identified) for the PHOPHLO as a screen for spelling difficulties in this sample. The data for these calculations are provided in Table 5, along with the likelihood ratio, indicating that a second-grade poor speller was 10 times more likely to have failed the PHOPHLO in first grade than a good speller.

Some details about the children who failed either the PHOPHLO screening in first grade or the BELO spelling test in second grade are shown in Table 6. It is instructive to consider the cases of successful and unsuccessful prediction separately, especially in relation to the language background of the students. Although this group of children is very small, some patterns in these data inform hypotheses for future research.

Considering the children who failed the PHOPHLO and the BELO (the true positives), three of the children demonstrated difficulties with phonological representations, specifically failing the speech perception test along with either the speech production or phonological awareness subtests. The remaining two children had difficulty with phonological and non-phonological language skills, that is, the phonological awareness and morphology production subtests of the PHOPHLO. Three of the five children were male and all were monolingual speakers of French. The parents of three children reported concerns that the children might be at risk for dyslexia due to a family history, and a fourth child had reported issues with conductive hearing loss. In first grade, the average teacher rating of risk for future writing problems

## Table 5. Performance of the PHOPHLO as a Screening Tool

|  | Fail BELO | Pass BELO | Row Totals |
|---|---|---|---|
| Fail PHOPHLO | 5 | 5 | 10 |
| Pass PHOPHLO | 2 | 66 | 68 |
| Column Totals | 7 | 71 | 78 |
| Likelihood Ratio | 0.71 | 0.07 | 10.14 |

*Note.* PHOPHLO = *Prédiction des Habiletés Orthographiques Par des Habiletés Langage Oral;* BELO = *Batterie d'évaluation de lecture et d'orthographe.*

## Table 6. Test Scores of Children who Failed the BELO or the PHOPHLO

| BELO Status | BELO Total | Speech Perception | Speech Production | Phonological Awareness | Morphology Production | PHOPHLO Status | Language |
|---|---|---|---|---|---|---|---|
| Fail | 32 | 100 | 100 | 7 | 0 | Fail | ML |
| Fail | 30 | 90 | 100 | 7 | 1 | Fail | ML |
| Fail | 37 | 60 | 100 | 9 | 8 | Fail | ML |
| Fail | 14 | 70 | 86 | 10 | 0 | Fail | ML |
| Fail | 26 | 50 | 78 | 11 | 10 | Fail | ML |
| Fail | 32 | 100 | 100 | 10 | 0 | Pass | ML |
| Fail | 30 | 100 | 94 | 11 | 9 | Pass | ML |
| Pass | 52 | 50 | 100 | 12 | 2 | Fail | ML |
| Pass | 49 | 50 | 91 | 8 | 0 | Fail | BL |
| Pass | 43 | 90 | 89 | 7 | 0 | Fail | BL |
| Pass | 52 | 100 | 89 | 8 | 1 | Fail | BL |
| Pass | 41 | 90 | 94 | 8 | 0 | Fail | BL |

*Note.* PHOPHLO = *Prédiction des Habiletés Orthographiques Par des Habiletés Langage Oral;* BELO = *Batterie d'évaluation de lecture et d'orthographe;* ML = monolingual; BL = bilingual; blue shading indicates that the child failed the subtest by scoring below the cut-off scores shown in Table 2.

was 2.8, higher than the mean rating of 1.6 for monolingual children in this study (see Kolne et al., 2016 for details of the teacher ratings).

Two other children failed the BELO in second grade despite passing the PHOPHLO in first grade. The parents of these male children reported concerns about their child, specifically a history of language comprehension problems that were treated in preschool in one case and significant concerns about social problems with peers and aggressive behavior with respect to the other child. The teacher ratings of concern about future writing difficulties were relatively high at 3.5.

Five other children failed the PHOPHLO but passed the BELO in second grade: all five failed the morphology production subtest of the PHOPHLO and four failed the phonological awareness subtest. Four of the five children were drawn from the BL subsample, in other words speaking a language that was not French at home. The parents of these five female children reported no concerns about their development. Their teachers provided a mean rating of concern about their future writing skills of 3.2, however— higher than the mean rating for BL children of 2.0.

Table 6 shows that the failures of sensitivity occurred within the subgroup of ML children such that two of seven MLs who failed the BELO were not identified by the PHOPHLO. These two children who proved to be poor spellers after passing the PHOPHLO screen highlight the fact that this screening test does not measure the child's performance in all domains of knowledge that are known to predict literacy outcomes.

The failures of specificity were largely due to BL language exposure. It seems that children who are not fully competent in their French language skills at school entry can achieve good spelling skills by second grade. This may occur because ML and BL children have received similar exposures to written language instruction whereas these two groups have had quite different experiences in the oral language domain. It is not certain that the BL children who failed the PHOPHLO at school entry will be successful on the provincial literacy exam in fourth grade given that it requires integration of written language skills across a variety of areas including reading comprehension as well as overall coherence, syntax, punctuation, spelling, and grammar when writing a narrative.

### General Discussion

Oral language skills are readily observable at or before the onset of formal reading and writing instruction and may predict the child's future response to formal instruction in school, independently of variations in access to direct literacy instruction in the home or preschool environment. Therefore, we conducted a two-phase study to develop a screening procedure that is focused on oral language abilities for the purpose of identifying children who may struggle to learn to read and spell in the early school years. In this study, we screened children's speech perception, speech production, phonological awareness, and morphology production abilities at entry to first grade and predicted spelling skills at the end of second grade. The results of the study will be discussed in relation to our objectives first. Subsequently, the limitations of the study will be discussed in detail.

### Development and performance of the PHOPHLO

**Objective 1.** Given that oral language abilities predict the acquisition of literacy skills in general and spelling in particular (Pennala et al., 2010; Speece et al., 1999), the first objective was to examine the role of speech perception, speech production, phonological awareness, and morphology production in differentiating children who should differ in literacy skills. In Phase I, we tested 61 children with the full versions of our tests, and found that certain subtests differentiated children with higher versus lower performance overall. Phonological awareness performance was especially discriminating but speech perception and production were also effective. ML versus BL children performed differently on the morphology production test. Therefore the Phase I results suggested that it was prudent to continue the development of the screener with all four constructs represented.

**Objective 2.** A second important objective in the first phase was to reduce the total number of items to create a screening test that could be administered in a much shorter period of time while covering the same four constructs. Ultimately the number of items was reduced from 152 to 64 items in a screener that contained 44 test items and 20 practice items. The correlation between the shorter screening test and the longer test battery was .89. However, future studies are necessary to establish the reliability of this screening test within and across screeners, especially those with different training and preparation, and in varied school environments.

**Objective 3.** The primary objective of Phase II was to determine the sensitivity and the specificity of the screener to predict spelling performance at the end of second grade. For our sample of suburban Quebec children in which a large proportion were bilingual, the PHOPHLO proved to

have a sensitivity of 71% and a specificity of 93% as a screen for poor spelling abilities. Clearly, further study is required to replicate this result as will be discussed further.

Objective 4. Questions about the contribution of the four constructs to the utility of the screening test continued into the second phase of the study. PHOPHLO performance in first grade was associated with BELO performance in second grade, especially with respect to speech production, phonological awareness, and morphology production. The subtest targeting speech perception did not differentiate children with respect to mean BELO score. It is possible that this subtest is particularly vulnerable to poor performance due to extraneous variables that do not elevate the child's risk of spelling difficulties; these may include a noisy environment, poor comprehension of instructions, poor attention, or transient hearing problems on the part of the child. On the other hand, examination of the individual child data in Table 6 suggests that, in some cases, poor speech perception performance may combine with poor speech production and phonological awareness skills to indicate a generalized problem with phonological representations or phonological processing. Ramus, Marshall, Rosen, & Van der Lely (2013) have suggested that children with dyslexia fall into two profiles: those who have difficulty with phonological representations (as revealed by speech perception and production tasks), and those who have difficulty with phonological and non-phonological language skills (as revealed by phonological awareness and language production tasks). Therefore, it seems worthwhile to continue research with all four subtests so as to accumulate data from a larger group of true positives.

## Limitations and future directions

A significant limitation of this study is the small sample size for assessing the predictive validity of the PHOPHLO. Clearly replication samples are required to confirm our estimate of the sensitivity and specificity of the PHOPHLO as a screen for spelling impairments in second grade. We feel that the mixed language background of our sample is a strength of the study given the increasingly multilingual and multicultural characteristic of the school population. However, a larger sample of children for validation of the screening tool would provide greater confidence in the sensitivity and specificity results, while permitting an exploration of differences in predictive accuracy within different subsets of the validation sample. Certainly, exploration of differences across ML versus BL groups would require a very large sample. A first priority would be to cross-validate the results with a larger sample of children with similar composition to that described here.

Subsequently, follow-up studies with more varied samples, including children with lower maternal education, for example, would be advisable.

Another subgroup analysis that would be enabled by a larger validation sample would concern the emergence of possible gender differences in literacy skills during the primary grades. Although significant gender differences are observed on the obligatory written language competency exam in Quebec, we did not observe any gender differences in PHOPHLO performance at school entry. Our sample was too small and unbalanced to explore this issue further. Limbrick, Wheldall, and Madelaine (2012) found that boys and girls do not differ in any aspect of literacy performance in the early school grades and suggested that gender differences emerge over time because of an increasing gap between school expectations and boys' behaviour.

A second limitation of the study, also related to its scope, is the restriction of the predictor and outcome variables to a narrow range, specifically oral language predictors and spelling as the outcome variable. With respect to the predictor variables it is known that there are other types of predictors that are useful as predictors of literacy outcomes. For younger children, print concepts in general and letter knowledge especially is an effective predictor (Erdos, Genesee, Savage, & Haigh, 2011; Storch & Whitehurst, 2002). For older children, orthographic knowledge is another important correlate of reading and spelling abilities (Binamé & Poncelet, 2016; Bourgoin, 2014; Commissaire, Pasquarella, Chen, & Deacon, 2014; Cunningham, Perry, & Stanovich, 2001). Stanké, Flessas, and Ska (2008) describe tests of orthographic processing that are available for testing French-speaking children. A necessary future step would be to determine if the PHOPHLO provides any predictive value over and above that offered by screening tests such as the *Outil de dépistage d'élèves à risque de présenter des difficultés d'apprentisage du langage écrit* (ODLÉ; Stanké & Flessas, 2013). The ODLÉ assesses phonological awareness, visual memory, and orthographic memory, and has been normed on large samples of French speaking children from kindergarten and first-grade classes in Quebec. A combination of oral language and orthographic screening might offer improved sensitivity over oral language screening alone. This raises another limitation of our study, and that is the single time point for screening being first-grade entry. However, a more adequate screening protocol would likely involve layered screenings, for example oral language screening in kindergarten followed by orthographic screening in first grade (after the children have received systematic exposure to written language instruction).

An investigation of the effectiveness of PHOPHLO as a screening tool when used at an earlier age and in the context of a more comprehensive screening protocol would be desirable.

Regarding the outcome measure, spelling was selected as an early indicator of writing abilities that are causing concern on the province-wide competency exam. However, oral language abilities are known to predict many aspects of literacy and therefore a more extensive outcome battery including real word and non-word reading accuracy in addition to spelling would be desirable. Linking early screening to actual performance on the obligatory writing competency examination would also be particularly valuable.

A final limitation of the study is the lack of concurrent validation of the PHOPHLO screening test with another measure of oral language abilities such as the *Petite Évac* (*Épreuve Verbale d'Aptitudes Cognitives pour les petits de 3 à 9 ans;* Lussier, Flessas, & Stanké, 2003). An assessment of the performance of the PHOPHLO in relation to the *Petite Évac* with respect to concurrent and predictive validity would be informative, not only as an indicator of the validity of the PHOPHLO but as an examination of relative efficiency. The administration time for the PHOPHLO is one half to one quarter the time required for the *Petite Évac*; furthermore, the digital implementation of the PHOPHLO permits administration and interpretation by paraprofessionals. The PHOPHLO could be a useful tool for identifying children who require more extensive testing by speech-language pathologists. We note that several children in our sample were suspected to have language impairments but were awaiting speech-language assessments throughout the course of the study.

## Conclusion

We have developed a digital tool that targets children's oral language abilities in four areas of language function, specifically speech perception, speech production, phonological awareness, and morphology production. Our study is unique in the inclusion of an authentic validation sample, including monolingual speakers of French, simultaneous bilingual speakers of French, and children who were first exposed to French upon preschool entry. In a preliminary investigation we have shown that, when administered early in first grade, the screen identified children who were likely to fail a spelling test at the end of second grade with a sensitivity of 71% and specificity of 93%. We have discussed important future directions for this research, given the limitations of our small sample and the need to further investigate the role of oral language

skills at school entry in the emergence of written language competence in French-speaking elementary school children in Canada.

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## Authors' Note

English correspondence concerning this article should be addressed to Susan Rvachew, School of Communication Sciences and Disorders, McGill University, 2001 McGill College Ave., 8th Floor, Montréal, Quebec, Canada, H3A 1G1. Email: susan.rvachew@mcgill.ca.

Les demandes en français au sujet de cet article doivent être adressées à Phaedra Royle, École d'orthophonie et audiologie, Université de Montréal, C.P. 6128, succursale Centre-ville, Montréal, Québec, Canada. Courriel : phaedra.royle@umontreal.ca.