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Enhancing L2 Perceptive Skills of Very Young Learners: The Results of Introducing a Mediation Program to a Bilingual Curriculum in Brazil

Abstract

Phonetic input is considered one of the main factors determining the perception and production of sounds in second language (L2) sound acquisition. The learner's accurate perception and intelligible oral production are claimed to depend on the quality and quantity of the received input. This study presents a mediation program that enriches phonetic input in an early bilingual education context by working with L2 acoustic cues through games. The program was applied to twelve 3- to 4-year-old children in a Brazilian school to observe its effects on the participants' perception of L2 sounds throughout a school year. Perception values were collected with a pre-test at the beginning of the year and a post-test after the program at the end of the year. The collected data showed the participants' difficulty in perceiving the distinction between voiced and unvoiced English plosives and the /ɛ-æ, i-ɪ, u-ʊ/ vowel contrasts. The results also indicated that the program positively impacted children's L2 perception. Moreover, the participants' engagement with the mediation program demonstrated how L2 sound perception through acoustic cues can be developed in bilingual schools from a very young age.

Keywords: phonetic input, mediation program, perception, acoustic cues, bilingual education

With the advances in empirical research, new evidence has emerged in the area of L2 acquisition, such as the importance of phonetic input for L2 sound acquisition (Flege, 1995; Flege & Bohn, 2021; Moyer, 2008), the focus on intelligibility (Alves, 2015; Munro & Derwing, 2015), and the light shed

on children's perception of sounds (Kuhl et al., 2008, 2011). A good number of studies (Flege, 2012, 2017; Flege & Mackay, 2011; Moyer, 2009) point to input as the main factor in L2 sound acquisition and suggest that the accuracy of the learner's oral production depends on the quality and quantity of the phonetic input received.

From the educational point of view, the successful acquisition of L2 sounds by children in a bilingual school context is a challenging endeavour. From the research point of view, articles on phonetic input and L2 sound acquisition that address a theoretical-practical integration in early childhood are scarce. This prompted motivation to verify whether enriching phonetic input through games can enhance L2 sound perception for Brazilian children, living in Brazil, who study in a bilingual school (Brazilian Portuguese, BP—L1/English—L2).

To foster successful L2 sound acquisition it is necessary to consider how L2 sounds are acquired. This entails exploring the links between production and perception, the assimilation process, and the role of acoustic cues. The theoretical framework in which this research is grounded is the Speech Learning Model by Flege (1995), revised by Flege and Bohn (2021). Fundamental to the conceptualization of this study are the studies on intelligibility and comprehensibility by Munro and Derwing (2015), and the research on sound perception and sensitive periods by Kuhl (2011).

Based on robust phonetics and language acquisition theory, a mediation program was created and applied to 12 participants from three to four years old in a Brazilian bilingual school, who spent a daily mean time of four hours immersed in English. One perceptual test was created and applied twice, that is, the pre-test at the beginning of the school year and the post-test at the end of the year. In between, the first semester focused on games which were adjusted to the students' age and interests and which were believed to tune into their overall sound awareness. The second semester concentrated on games to foster their perception of acoustic cues used to differentiate sounds in L2. The games were played every day in different formats, as further described in the method.

Our research questions were: "Do the majority of the participants have some of the L2 sounds assimilated to their L1 counterparts?" and "What are the effects of the mediation program on very young learners' perception of selected L2 sounds? Does the mediation program enhance their perception of the practiced sounds?" We hypothesized that most of the participants would have some L2 sounds assimilated to L1 counterparts, thus, the perception of minimal pairs would be challenging. Also, we hypothesized that the program would foster their perception, resulting in a higher percentage of correct answers in a perception test. The results obtained by the applied mediation program are presented in this paper and show a significant development in the participants' perceptions of L2 sounds.

As this research was conducted by an early childhood educator who works at the school where the test was applied and was the reference teacher of the group for a school year, issues related to school and children's bonds were not intervening. Nevertheless, due to ethical concerns, no control group was allowed. It is acknowledged that each type of research—conducted in a laboratory or the classroom will hold its pros and cons. Despite not having such a controlled environment as a lab-based data collection, classroom research is equally important to the field (Levis, 2016) as it may identify specific needs and give rise to future questions.

Review of Literature

The Speech Learning Model and the Speech Learning Model-Revised

For decades, the difficulty of L2 sound acquisition was claimed to be due to the maturation and lack of brain plasticity. With time, new theories have emerged, and research pointed to the influence of the L1 on the L2 as the main cause of unsuccessful acquisition. With the advance in technology and the possibility of more precise data collection, there was a significant increase in empirical studies, ergo, models to account for how languages are acquired emerged.

The Speech Learning Model (SLM) proposed by Flege (1995) and the revised Speech Learning Model (SLM-r) by Flege and Bohn (2021) contribute to the body of L2 sound acquisition studies as it enlightens the field by bringing concrete results to support Flege's conviction about the importance of input. Despite mentioning important internal factors for L2 sound acquisition, such as age, and the influence of L1 in L2; Flege claims that the external factor of input is the most important for a successful L2 sound acquisition.

To better understand the scope of the mediation program proposed in this work, it is paramount to look at some of the postulates and hypotheses presented in the SLM. Among the postulates, Flege (1995) suggests that "the mechanisms and processes used in learning the L1 sound system, including category formation, remain intact over the life span, and can be applied to L2 learning" (Flege, 1995, p. 239). This indicates that not only can children acquire L2 sounds without necessarily being exposed to the language since birth, but also that teachers may improve their sound perception and production to provide phonetic input of good quality.

One of the postulates of the SLM claims that L1 and L2 phonetic categories coexist in a common phonetic space. This perspective opened deeper

discussions on the inter-influence of L1 and L2, and the impact of the assimilation process. Assimilation, according to Flege (1995), is a process that blocks the formation of new phonetic categories since the new sound in the L2 tends to be produced a sound similar to the category in the L1. The assimilation process and its possible effects are relevant in this study as it explores Brazilian very young learners acquiring English as an L2. Due to the differences between English and BP phonetic inventories, Brazilian speakers are likely to have some L2 sounds assimilated into their L1 counterparts.

Another hypothesis raised by Flege (1995) proposes that the farthest an L2 sound is from an L1 sound, the easiest it is to be discerned; whereas close L2 and L1 sounds are the hardest to be distinguished. As proposed by the SLM, a bilingual can establish a new phonetic category for a similar L2 sound if some differences between both sounds are discerned. According to Flege (1991, 1995) and Flege and Bohn (2021), the assimilation process could be reverted or prevented, and new phonetic categories thus created as long as the speaker receives quality and quantity of phonetic input.

Flege and Bohn (2021) emphasize that one of the determining factors for the formation of phonetic categories is the degree of disparity between one category and another. That is, the better the child can perceive the dissimilarity between a phonetic category of L2 and its closest counterpart in L1, the easier it will be for the formation of the L2 category, and consequently, the acquisition of that sound. Working with the progression of the categories from the most distant to the closest one was an intentional and careful decision based on scientific criteria.

It has also been argued that when acquiring an L2 sound, children, based on the phonetic categories of the L2 input they received, form equivalence categories (Flege & Bohn, 2021). Through acoustic cues, sounds are perceived as belonging to the same phonetic category. Each category is mediated by a series of the best examples of sounds, the so-called prototypes, which best represent the set of properties of these sounds. Prototypes define how a given phonetic category is perceived and produced. Thus, the quality of the phonetic input is crucial for the phonetic categories to be acquired accurately.

The issue concerning our perspective of what phonetic input quality entails will be thoroughly explored further in this work. Although input is the main factor explored in this work, it is not the only variable of L2 sound acquisition. A conglomerate of other factors, such as age, psychological and motivational issues, and L1 influence also play essential roles in the acquisition of the L2 sound inventory.

The BP and English Vowel and Plosive Phonetic Inventories and the Difficulty in Perceiving L2 Sounds

To understand the mediation program presented in this study and its results, some constructs need to be explained. Essential to this work is the assumption that, as stated above, L1 influences L2 acquisition. Research shows that after a very sensitive period, children seem to gradually lose the ability to perceive L2 sounds (Flege, 1995; Kuhl, 2011). Theories have emerged to lend support to such a hypothesis over the past years (Pallier, 2003; Polivanov, 1978, Trubetzkoy, 1969). Even though they may differ slightly from each other, the core remains the same: L1 sounds exert influence on L2 sounds. Such influence may impede the formation of new L2 phonetic categories due to the assimilation process (Flege, 1995; Flege & Bohn, 2021), impacting pronunciation. For this reason, teachers must be mindful of both L1 and L2 phonetic inventories to understand students' needs and challenges, and better scaffold learning.

In this study, the participants are BP speakers who have contact with English mostly during school hours. Due to the BP inventory, some challenges in L2 perception arise, leading to specific assimilation processes. The BP and English vowel inventories differ in their number of vowels. In stressed syllable position, the BP vowel system comprises 7 oral vowels (/i, e, ɛ, a, o, ɔ, u/) (Barbosa & Madureira, 2015) as opposed to the 15 vowel sounds in the English system (Ladefoged & Disner, 2012). As the English oral vowel inventory is larger, there is a tendency for Brazilian learners of English to assimilate two distinctive vowel sounds in English to one in BP, blocking the formation of new vowel categories.

Due to the L1 inventory, Brazilian speakers commonly assimilate the English vowels /ɛ–æ/ into the BP counterpart /ɛ/, the vowel /ɪ/ into the BP counterpart /i/, and the vowel /ʊ/ into the BP counterpart /u/. Thus, minimal pairs such as pen–pan, sheep–ship, and suit–soot are often not discerned by Brazilians. According to Sacchi's (2018) research with BP speakers, the most challenging vowel pair to be distinguished by Brazilians was the /ɛ–æ/, followed by /i–ɪ/ and /u–ʊ/.

Concerning the plosives, in English the mean positive values of VOT in plosive consonants are reported as /p/ 42ms, /t/ 65ms, /k/ 62 ms, /b/ 15ms, /d/ 21ms, and /g/ 27 ms (Hewlett & Beck, 2013); while in BP positive VOT mean values are /p/ 11ms, /t/ 19ms, /k/ 32ms, and negative VOT values /b/ 90ms, /d/ 77ms, and /g/ 66ms (Madureira, Ficker, & Mendes, 2002). Pre-voicing and burst intensity are important features in distinguishing voiced and unvoiced plosive consonants in BP (Alves & Zimmer, 2015). This often leads Brazilian speakers to produce English unvoiced plosives /t–p–k/ similar to the voiced ones /d–b–g/. Both processes may impair the speaker's intelligibility and cause communication problems.

To avoid or reverse these processes, it seems that there needs to be meaningful and rich phonetic input that will guide students' attention to acoustic cues used to distinguish specific L1 and L2 sounds. The work with acoustic cues could not only improve children's perception of L2 sounds but likely improve their production.

Acoustic Cues and the Relation between the Production and Perception of Speech Sounds

In the literature on sound acquisition, there is a widespread idea that the production of sounds is directly linked to the speaker's perception of these sounds (Barry, 1989; Flege et al., 1997; Bradlow et al., 1997, 1999; Flege, 1988; Llisterri, 1995; Rochet, 1995; Whalen, 1995), that is, a faulty perception interferes in the L2 output. This connection has been examined in various studies and is still a matter of interest to numerous researchers (Grosjean & Byer-Heinlein, 2018; Flege & Bohn, 2021; Osborne, 2021).

There seems to be a common agreement that an accurate perception leads to an accurate production (Flege et al., 1997; Bradlow et al., 1999; Flege, 1988; Llisterri, 1995; Osborne, 2021; Rochet, 1995). To foster perception it matters to receive a good quality of phonetic input (Flege, 1991) and have opportunities to explore L2 sounds through intentional work designed by the mediators, formal learning settings (Llisterri, 2003; Henriques et al., 2020).

In the process of sound perception, acoustic cues are paramount to guide attention to the specificities and characteristics of each sound. Acoustic cues are physical products derived from the articulatory mechanisms used to discriminate the different sounds in the same language. It is through precise acoustic cues that a speaker will perceive, and then acquire an L2 sound (Flege, 1995). Thus, intentional work with sounds should focus on providing accurate acoustic cues to help the speaker perceive the differences between particular sounds in L2 and L1.

It is worth mentioning that despite the validation of the positive results that phonetic training has shown (Bradlow et al., 1997, 1999; Jamieson, 1995; Lee et al., 2015; Lively et al., 1994), there are many matters related to the explicit pronunciation practice that need to be taken into account. First of all, many researchers do not understand the dynamics in the classroom with the students, therefore, the published results are not necessarily useful and easy to apply taking into account the curriculum and the school routine. Secondly, several outcomes suggest some pronunciation training techniques that are not necessarily possible to be integrated into the curriculum. Thirdly, the proposed phonetic training offered to students in the classrooms often does not match their age group due to the researchers' lack of pedagogical knowledge.

Even though we share the opinion of the importance of working with L2 sounds and acoustic cues aiming at a more precise perception, we believe that this work should not be done separately from the pedagogical context, nor be a training. It should rather be a mediation carefully thought to respect the students' age and consider their personal factors to improve their perception of L2 sounds (Flege, 1988; Krashen, 1995; Saville-Troike, 2012). To us, the perception of sounds through accurate acoustic cues to guide the students' attention can be worked on by offering them a rich and planned phonetic environment, as will be shown in the further sections of the paper.

The Quality of Input and the Acquisition of L2 Sounds: A New Perspective

Since the 1980s, the discussions on input have encompassed both L1 and L2 acquisition (Chomsky, 1981; Flege, 1988, 2017; Grosjean & Byer-Heinlein, 2018; Krashen, 1995; Long, 1990; Moyer, 2009). Nowadays, researchers continue dedicating their studies to the importance of a robust linguistic environment, supporting the idea that rich input is beneficial and obligatory for infants in order to acquire an L2 (Dehaene, 2021; Marcelino, 2018, 2019).

In the course of research on input, Flege (1991, 2009, 2012, 2017) relates the success of speech sound acquisition and L2 proficiency to both the quantity and quality of input received. Concerning the latter, many researchers correlate the good quality of input with the input provided by L2 native speakers (Bohn & Bundgaard-Nielsen, 2008; Flege & Liu, 2001; Flege, 2009; Moyer, 2009; Steinlen, 2009). According to this perspective, the non-native speaker is generally not seen as capable of offering good-quality phonetic input to learners.

The present work focuses on Brazilian children who study in bilingual schools in Brazil, and whose teachers are, in general, non-native speakers of L2. Although the quality of input is generally related to native speakers of the target language, in this work we strongly believe that non-native speakers can also present quality input and accurate acoustic cues. This might be enhanced as mediators acquire linguistic knowledge of the differences between L1 and L2 phonetic inventories. In light of the SLM, we believe that the quality of the input depends on the accuracy of the acoustic cues that the L2 learner will receive. For this, the reference adults with whom the learners have contact must be able to offer a vast phonetic repertoire that contemplates the L2 sounds produced accurately, generating relevant acoustic cues. This is why, it is fundamental to have teachers with phonetic bases who can identify the learner's difficulties and scaffold learning.

Llisterri (2003) claims that some teachers tend to insist on L2 phonetic training methods in which the learner listens and repeats words aiming at

improving their production of L2 sounds. However, the author states that this practice ignores the fact that the learner commonly does not perceive the sounds accurately due to the L1 influence. That is, the speaker is repeating what they hear but normally do not hear the sounds accurately, not discerning the acoustic characteristics of sounds. We agree with Llisterri (2003) that teachers need to focus firstly on learner's perception and improve it by offering them rich phonetic input and meaningful learning experiences. From our perspective, offering a rich phonetic input encompasses reflecting upon aspects related to the link between the perception and production of sounds, the acoustic cues, and the intelligibility principle (Munro & Derwing, 2015).

We intend to take advantage of the sensitive periods of the children to L2 sounds and thoroughly think of ways to enrich the phonetic input, aiming at providing children with more opportunities to tune their perception through acoustic cues playfully and pleasantly, based on phonetics theory. The way we propose to link this theory with pedagogical practice will be explored in the following sections. We agree with the need for research that focuses both on theory and practice in the area of L2 sound acquisition. It is necessary for the benefit of science and education that more research is carried out within the classroom and that those studies focus on applicable issues to link the theory to pedagogical practices (Levis, 2015, 2017; Munro & Derwing, 2015; O'Brien et al., 2018). That is the reason why based on the results of the aforementioned research and aiming at enlightening the connection between theory and practice, we present an original mediation program, based on the SLM, in playful activities that are suitable and adaptable to fit in a daily pedagogical practice of bilingual schools.

Method

Research Questions

In the study described in this paper, we posed the following research questions:

1. Do the majority of the participants have some of the L2 sounds assimilated to their L1 counterparts?

2. What are the effects of the mediation program on very young learners' perception of selected L2 sounds? Does it enhance their perception of the practiced sounds?

Participants

This research analyzed the perception of the English plosives and the /ɛ–æ, i–ɪ, u–ʊ/ vowel contrasts by twelve Brazilian children from three to four years old who were studying in a bilingual school in Brazil (BP/English). The participants spent around four hours at school daily and had contact with BP for 50 minutes every day. Throughout the year, all the participants attended the same group composed of 14 children. However, two of the participants were eliminated from the research—one child left the group in the middle of the year; the other revealed attention deficits that impeded the accomplishment of the pre-test. All the participants were advised to go through an audiometry exam as it is a school recommendation at this age. Moreover, there were no reports from the parents of any hearing problems.

Instruments and Data Collection Procedures

To observe the effects of the mediation program on the children's perception of the selected L2 sounds, the participants took part in a perceptual test. To collect information about the participants' linguistic background and control various variables, an online form was sent to parents. This form contained questions about the language(s) spoken at home, the language(s) exposed to the participant, how this exposure was (family members, songs, videos, etc.), and the age of first contact with English. Overall, the major contact the participants had with the English language was at school. Eleven of the participants were exposed also to English through videos and songs. One participant was exposed to English since birth and would only speak English to the mother. We decided to keep this participant to observe how the mediation program would impact simultaneous BP-English bilingual children.

To analyze the effects of these games within the mediation program on children's perception, the pre-test and the post-test were applied. The perceptual test was composed of minimal pairs with the elected sounds divided into four tasks which were age-appropriate and engaging. All participants demonstrated interest in the perceptual tests tasks and the data was collected throughout a week at school in a silent room. The stimuli for the perceptual test were recorded by a female North American English speaker and edited in Praat (Boersma & Weenink, 2016). The corpus of the test was composed of the following minimal pairs: tie–die, toe–doe, pea–bee, pear–bear, coat–goat, cold–gold, pen–pan, keys–kiss, sheep–ship, Luke–look, suit–soot. The test consisted of four tasks, specified below. After the mediation program, all the participants answered them with no difficulty.

1. “I spy”—in which the child would listen to a stimulus such as “I spy the doe” and had to choose the doe image among other options—such as toe, dot, and toy, containing the /t–d/ contrast not necessarily in minimal pairs;

2. “Choose the image”—in which the child heard an isolated word such as “pen” and needed to choose between two images with the minimal pair;

3. “What do you hear?””—in which the child heard a four-word chain with a minimal pair, for instance, “sheep–sheep–ship–-sheep,” and needed to choose the images corresponding to the words heard;

4. “Sequencing cards,”—in which the child heard a sequence of three words and needed to organize the flashcards in the order heard.

A trial of the perceptual test, namely the pilot test, was created and applied with a familiar lexicon to the same participants to observe whether the format and duration of the pre-test would be feasible with these young participants. One initial task had to be modified for its complexity, and another task was added as the participants showed engagement and openness to a more extended test.

The pre-test and post-test were the same and consisted of slides on a tablet with the images and auditory stimuli, a sound box, printed flashcards for some of the tasks, and a table to keep track of the answers. The pre-test was conducted at the beginning of the school year, and the post-test at the end of the school year. Both tests were applied at school in a silent room. No feedback was given during the tests and each participant completed the test once. The scores were checked on a printed table by the researcher, who was their teacher for the school year.

After the pre-test, the mediation program began to be implemented. By the end of the school year, after all the steps of the program, the post-test data was collected, and the results were analyzed.

Teaching Procedures—Introduction to the Mediation Program

As previous works discussed, having more research conducted in the classroom that sheds light not only on teachers’ practices but also on how sounds can be worked and integrated into the pedagogical curriculum is paramount (Derwing & Munro, 2005; Munro & Derwing, 2015; Levis, 2015, 2016, 2017; O’Brien et al., 2018). At the same time, the challenges of such works are well-known. Along with the trusting relationship with the school directors, and the bond with the children, there is also the need to adhere to ethics requirements.

In this work, the data collection caused no disruption in the pedagogical curriculum nor interruption in the routine. To participate in the perceptual tests, each child was called individually while they were playing. During the months when the mediation program was applied, the games proposed were

either in collective moments, with the whole or small groups, or individually. During the school routine, there is an amount of time of approximately one hour in which children are encouraged to work with Montessori materials and explore books independently or investigate with one of the classroom teachers. In these moments, the mediation program games happened with one of the teachers. All the participants' engagement with the games proposed was evident throughout the school year.

There was a control table to guarantee that all children had the opportunity to play with all the games in all the steps. After some weeks, the participants were already used to being invited to the games, and to play some of them collectively by the end of the day.

Sound Awareness

This program is divided into two parts, namely, Sound Awareness and Phonetic Awareness. Both parts consist of games that prioritize attention to sounds and L2 acoustic cues. The proposals for games that focus on sound awareness aim to improve the ability to listen attentively and selectively to the various sounds that surround the child. Sound awareness work, which precedes the phonetic awareness activities, is crucial, as it allows the young child to pay attention to sounds in isolation, sharpening auditory perception and facilitating the perception of acoustic cues later.

The activities proposed in this present work were planned to be carried out in fun moments in which the children are involved and engaged. Some activities presented were based on Adams et al. (1998), and others were based on teaching practices throughout the years of experience. Table 1 shows the suggested games to prepare children's attention to sounds and guide their perception of acoustic cues later. The Sound Awareness games were part of daily moments throughout the first semester (beginning of April up to the end of June). Children were on vacation in July and returned in August when we began to implement the second part of the program, Phonetic Awareness.

Table 1

Sound Awareness Games Proposed to Foster Children's Attention to Environmental Sounds

Category	Objective	Suggested Games	Description
Sound and Movement	Connect body exploration and attention to sound and silence	Freeze	Children are invited to dance to the music and freeze when it stops.
		Exploring rhythms	Different songs are played to allow children to dance accordingly, noticing different rhythms.

Table 1 continued

Category	Objective	Suggested Games	Description
Sound Identification	Encourage children to listen carefully and make connections between the sounds heard and their sound repertoire	What can you hear?	Children are invited to pay attention to the diverse sounds heard in various spaces around the school through a "sound walk."
		What sound is this?	Different sounds are played, one at a time, for children to hear and try to guess what makes that sound (animals, traffic, nature, objects). The corresponding image or video is shown later for children to make the connection.
		Guess the instrument	The sound of three different musical instruments is presented, and with them hidden, one of them is played for each child to guess the instrument that is making the sound.
		Who said that?	A child is blindfolded and invited to ask a question. Another child is chosen to answer it. The blindfolded child is encouraged to guess who answered by voice recognition.
		Mystery box	Children are invited to guess which object is inside the box by its sound.
Sound Sequence	Sharpen the child's listening skills involving memory, encouraging children to memorize a succession of sounds	Musical instrument sequence	Three different musical instruments with very different sounds are present. Children are encouraged to keep their eyes closed while the adult plays the instruments in a random sequence. Each child is invited to play the same sequence heard.
		Body sound sequence	Body sounds are explored and a sound sequence is presented for children to follow. Children are encouraged to keep their eyes closed and focus on the sound. They are invited to reproduce the sequence heard.
Spatial	Detect where a sound comes from and move spatially towards that sound. Stimulate the ability to detect sounds at a greater distance and to perceive that a sound becomes more evident the closer the child is to it.	Finding the alarm clock (Adams et al., 1998)	Children are invited to find an alarm clock hidden in the classroom by the sound of its ring.
		Where are you? (Adams et al., 1998)	A blindfolded child is invited to find a friend who is playing a musical instrument amongst other peers by moving toward the sound. An extension to this game would be adding a different instrument to challenge the perception.

Table 1 continued

Category	Objective	Suggested Games	Description
Sounds of Nature	Stimulate the perception and reproduction of the sounds of nature is a work that involves sound symbolism. Sharpening this sensitivity to sound symbolism can have positive consequences for the child's language acquisition (Imai & Kita, 2014).	Reproducing sounds of Nature	Children are invited to guess which nature sound is being played, and later, encouraged to reproduce that same sound.
		Reproducing sounds of animals	Children are invited to guess which animal sound is being played, and later, encouraged to reproduce that same sound.

Phonetic Awareness

As previously discussed, this program aims to enrich phonetic input in bilingual schools through games, aiming at more accurate L2 sound perception. Sound awareness proposes a specific order to play with the chosen sounds based on sound perception studies (Flege, 1988; Llisterri, 1995; Grosjean & Byer-Heinlein, 2018; Rochet, 1995) and the SLM third hypothesis (Flege, 1995).

These orders consider that children are acquiring an L2 in bilingual schools and live in a country where the L1 is spoken. Thus, to better scaffold L2 sound perception and foster attention to acoustic cues, we argue that it is necessary to implement a progression: first, introduce more easily distinguishable pairs, and gradually introduce exercises containing pairs of sounds that cause more difficulty in discrimination, as they are not contrastive in the speakers' L1. Not considering this progression is expecting the child to produce a sound that they do not even perceive.

The games used in the classroom as part of phonetic awareness development (see Table 2) were ordered in the following way: (1) consonants of different phonetic categories; (2) consonants of similar phonetic categories; (3) vowels of different phonetic categories; (4) vowels of similar phonetic categories; and (5) minimal pairs. It is worth mentioning that this work with sounds is interconnected with storytelling, songs, and nursery rhymes, which are part of very young learners' routine. Thus, these elements pervaded the mediation program and enriched children's experiences with diverse aspects of oral language.

Table 2

Phonetic Awareness Games Proposed to Foster Children's Attention to L2 Acoustic Cues

Suggested Games	Description
Three-Period Lesson (Montessori, 1965)	This game consists of three steps: naming, recognizing, and recalling. Although the original lesson was planned to account for vocabulary, this activity is here proposed to tune acoustic cues. Working with 2 to 4 flashcards, the first step is naming each one by saying "this is the…"; the second step is asking the child to show the flashcard: "show me the … please"; and the third step is inviting the child to name them by asking: "what is this?".
I Spy	With some flashcards spread on the table, the child is invited to get the corresponding image according to the stimulus heard. Sentences such as "I spy with my little eye a goat" will be said by the teacher. The child will, then, reach for the flashcard with a goat. Using magnifying glasses or binoculars makes the game even more engaging and attractive.
Up and Down	The game Up and Down is a variation of a well-known Brazilian game called "Vivo ou Morto (Dead or Alive)," and was modified to privilege the work with sounds. In this game, two words are chosen, one for the movement of standing up (tiger, for instance), and another for getting down (doe, for instance). By telling which word represents what, children should follow the stimulus with their actions. When the word "tiger" is heard, children should stand up. When the word "doe" is heard, they should get down. The game gets more fun with the unexpected sequencing of words.
Sequencing Cards	This game consists of a four-word chain said by the teacher that should be reproduced with the flashcards with the corresponding images. For that, some flashcards are placed on the table and the sequence is produced by the teacher (Toe–toe–die–die, for instance). Children should hear the sequence, get two flashcards with the toe image, and two with the die image, and organize them in the same order heard.
Odd one out	In this game, the children must detect and odd the different words out of the heard sequence. This can be done by a gesture agreed upon by the group, such as touching their head, or clapping hands. A chain of words (Pan–pan–pan–boat–pan–pan–boat–pan...) is produced by the teacher and children clap their hands once whenever the odd word is heard.
Scavenger Hunt	For this game, some flashcards must be hidden and the teacher must tell the children which ones to find, one by one. During the last step of the Phonetic Awareness order, both flashcards of the minimal pair are to be found together ("Find the sheep and the ship, please").

Table 2 continued

Suggested Game	Description
Where is it?	This game is played with many flashcards facing down the table in an organized way. Each child, one at a time, will be asked to find one image by flipping only one card on the table ("Where is the dot?", for instance). If the child finds it, the flashcard remains facing up. If not, the following child is asked the same question and has the chance to find the image. The game continues until all flashcards are facing up.
What's Missing?	In this game, some flashcards are presented to the children and placed on the table. A child is asked to close her eyes while one of the cards is hidden by the teacher or another peer. When the child opens the eye, she is encouraged to say which flashcard is missing, which means, which flashcard the teacher/peer is holding.
Creative Storytelling	For this game, the child is encouraged to create a non-sense story by using the available flashcards or small objects. It can be played by having the child choose the cards to add to the story, or by facing the flashcards down and flipping them one by one randomly to be added to the story.

Table 3

Phonetic Awareness L2 Sound Category Order

Sound Category	Description	Suggested corpus
Consonants of distinct phonetic categories	/p – t – k – l – m/ /b – d – g – r – n/	Pea, chin, nose, ladder, fan, bee, mouth, rabbit, van, goat...
Consonants of similar phonetic categories	/p – b/ /t – d/ /k – g/	Parrot, paint, pot, ball, boat, boy... Tiger, turtle, tie, toe, doll, dear, dot, daisy... Cat, camera, cold, game, goat, girl...
Vowels of distinct phonetic categories	/ɛ – i – u/ /æ – ɪ – ʊ/	Elephant, egg, pen, sheep, keys, eagle, suit, boot... Ant, pan, anchor, ship, insect, kiss, soot, foot...
Vowel of similar phonetic categories	/ɛ – æ/ /i – ɪ/ /u – ʊ/	Elbow, anchor, pen, bat... Eel, iguana, kiss, ship... Luke, moon, soot, book...
Minimal pairs	/p – b/ /t – d/ /k – g/ /ɛ – æ/ /i – ɪ/ /u – ʊ/	Pee – bee Tie – die Coat – goat Pen – pan Sheep – ship Suit – soot

Results

In this section, we present the tables with the results comparing the pre-test and the post-test outcomes. The tables with the data suggest that the mediation program had a positive effect on the participants' perception of L2 sounds. The one simultaneous bilingual child had high scores in the pre-test compared to the other participants. The post-test results show that the mediation program enhanced his perceptive skills and was able to discriminate nearly all the stimuli. Table 4 shows the overall values and compares all the participants' (P) results displayed for each task separately. As observed, after the implementation of the playful mediation program, all participants' values were significantly higher in L2 consonant and vowel perception and discrimination.

Table 4

Percentage of Correct Answers Comparing the Pre- and Post-Tests with Vowels and Consonants

P	Task 1		Task 2		Task 3		Task 4	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
1	69%	94%	50%	83%	50%	100%	13%	75%
2	25%	81%	33%	83%	10%	80%	0%	63%
3	63%	100%	83%	100%	20%	90%	63%	75%
4	81%	100%	50%	100%	70%	100%	88%	88%
5	63%	88%	67%	100%	40%	90%	25%	88%
6	44%	94%	50%	100%	0%	100%	25%	88%
7	44%	75%	50%	83%	10%	80%	0%	63%
8	25%	75%	0%	83%	0%	70%	13%	75%
9	56%	94%	67%	100%	50%	90%	13%	75%
10	31%	63%	17%	100%	30%	90%	13%	50%
11	38%	81%	50%	83%	10%	100%	25%	75%
12	63%	94%	50%	100%	20%	70%	63%	100%

The following tables are divided into consonants and vowels. Table 5 shows the consonant results from tasks 1 and 2, in which the tokens were either presented in isolated words or in four-word chains where one of the words differs from the others. Table 6 evidences the results of tasks 3 and 4, in which the

tokens were part of a word chain. For the consonants, we expected that the voicing would be challenging, and the voiced plosives would be perceived as voiceless.

Table 5

Pre-Test and Post-Test Consonant Values—Tasks 1 and 2

		/t/ – /d/			/p/ – /b/			/k/ – /g/	
		pre-test	post-test		pre-test	post-test		pre-test	post-test
Task 1 – I spy	Doe	54%	92%						
				Bee	92%	92%	Goat	46%	83%
	Die	69%	100%						
Task 2 – Choose the image	Doe	54%	92%	Bear	77%	100%	Goat	77%	100%

Table 6

Pre-Test and Post-Test Consonant Values—Tasks 3 and 4

		/t/ – /d/			/p/ – /b/			/k/ – /g/	
		pre-test	post-test		pre-test	post-test		pre-test	post-test
Task 3 – What do you hear?	Toe–toe–toe–doe	8%	75%	Bee–pea–bee–bee	25%	75%	Gold–gold–cold–gold	17%	75%
Task 4 – Sequencing cards	Doe–toe–doe	31%	92%	Pea–bee–bee	15%	58%	Cold–gold–cold	23%	83%

Tables 5 and 6 indicate that there was a visible improvement comparing the pre-test with the post-test. The sounds /p–b/ had an overall result of 52% of perception in the pre-test, and 81% in the post-test. The results for the sounds /k–g/ were 41% in the pre-test, compared to 85% accuracy in the post-test. And for the sounds /t–d/, 43% of correct answers in the pre-test and 90% in the post-test. With regard to the word "bee" in Table 5, we observe that the results were the same both in the pre-test and the post-test when the word was isolated, which was not expected. We interpret this data as being due to the

familiarity children had with this word, which is present in many stories and everyday songs.

Tables 7 and 8 present the vowel results. The tables show the percentage of correct answers in each task. Table 7 shows how the vowel contrasts were perceived in tasks 1 and 2 in both the pre- and post-test. Table 8 shows the participants' discrimination of the vowel contrasts in tasks 3 and 4, both with word chain stimuli. For the vowels, we expected that the pair /æ–ɛ/ would be the most challenging, followed by the pairs /i–ɪ/ and /u–ʊ/.

Table 7

Pre-Test and Post-Test Vowel Values—Tasks 1 and 2

	/ɛ/ – /æ/			/i/ – /ɪ/			/u/ – /ʊ/		
		pre-test	post-test		pre-test	post-test		pre-test	post-test
Task 1 – I spy	Pan	23%	50%	Ship	39%	92%	Soot	62%	92%
	Pen	31%	67%	Sheep	69%	100%	Suit	23%	50%
Task 2 – Choose the image	Pan	31%	92%	Kiss	46%	100%	Suit	0%	75%

Table 8

Pre-Test and Post-Test Vowel Values—Tasks 3 and 4

	/ɛ/ – /æ/			/i/ – /ɪ/			/u/ – /ʊ/		
		pre-test	post-test		pre-test	post-test		pre-test	post-test
Task 3 – What do you hear?	Pan–pan–pen–pan	25%	83%	Sheep–sheep–sheep–ship	25%	100%	Look–Luke–look–look	17%	100%
Task 4 – Sequencing cards	Pan–pen–pen	0%	17%	Sheep–sheep–ship	31%	92%	Suit–suit–soot	8%	67%

Tables 7 and 8 also indicate improvement with the vowel sounds. Overall, the sounds /ɛ–æ/ went from 22% of perception in the pre-test to 62% in the post-test. The sounds /i–ɪ/ had 44% of correct answers on the pre-test, and 97% on the post-test. The perception of the sounds /u–ʊ/ improved from 22% on the pre-test to 77% on the post-test.

The tables presented in this section evidence that there was difficulty regarding the voicing in the consonants, and in differentiating the vowel contrasts in the pre-test. As observed in the post-test numbers, the participants' perception was more accurate, suggesting that there was increased attention to the phonetic details that differentiate the sounds. In the section that follows, we further discuss the results.

Discussion

To show how the sounds were confused, we present the results of a confusion matrix of pre and post-tests for consonants and vowels.

Table 9

Pre-Test Confusion Matrix—Consonants

	Perception						
Stimulus	p	b	t	d	k	g	Total
p	25	11					36
b	13	23					36
t			27	9			36
d			15	21			36
k					25	11	36
g					20	16	36

Table 10

Post-Test Confusion Matrix—Consonants

Stimulus	Perception						
	p	b	t	d	k	g	Total
p	32	4					36
b	4	32					36
t			34	2			36
d			2	34			36
k					34	2	36
g					2	34	36

Table 11

Pre-Test Confusion Matrix—Vowels

Stimulus	Perception						
	i	I	ɛ	æ	u	ʊ	Total
i	32	4					36
I	24	12					36
ɛ			14	22			36
æ			15	21			36
u					12	24	36
ʊ					11	25	36

Table 12

Post-Test Confusion Matrix—Vowels

Stimulus	Perception						
	i	ɪ	ɛ	æ	u	ʊ	Total
p	35	1					36
b	2	34					36
t			25	11			36
d			8	28			36
k					27	9	36
g					4	32	36

The confusion matrix results of the pre-test as compared to the ones of the post-test show that children got better at discriminating between the voiced and voiceless consonants and the vowel contrasts. The results show that the pair /ɛ–æ/ was the most difficult to distinguish, which is in tandem with Sacchi's (2018) results on Brazilian speakers. Following, in order of difficulty for Brazilian speakers to distinguish were the pairs /u–ʊ/ and /i–ɪ/. These results confirmed the hypothesis that L2 sounds were assimilated to L1 sounds (Flege, 1995).

There was no difficulty concerning the place of articulation of the stop consonants. Voicing discrimination in the pre-test was troublesome, though. According to the results of Madureira, Barzaghi, and Mendes (2002), Brazilian Portuguese positive VOT averages for stop consonants were 11 ms for /p/, 19 ms for /t/, and 32 ms for /k/, and voiced plosives were preceded by a voicing bar (negative VOT values). Average means for negative VOT values were /b/ 90, for /d/ 77, and for /g/ 66. Not one of the voiced plosives in the English test stimuli was preceded by a pre-voicing bar. Positive VOT intervals were found in the productions of /d/ and /g/ (3ms) in the test stimuli. These contrasting features between BP and English may explain the difficulties facing discrimination

between English-voiced and voiceless stops by Brazilian children. In stop consonant perception, aspiration is an important cue for English and pre-voicing for BP. The improved results obtained in the post-test may reflect attention to the aspiration cue discriminating between voiceless and voiced consonants in English.

Vowel discrimination is complex, especially between two high vowels and a mid-low and low vowel. The fact that there are two high front and two high back vowel phonemes in English and that there is only one high front vowel and one high back vowel in the BP phoneme inventory favours assimilation of two sounds into one. In the pre-test the high front vowels were assimilated to /i/ and the high back vowels to /ʊ/. This difference in terms of assimilation to the member of the pair may be interpreted in terms of palatal versus velar articulatory features. It is expected that the tongue dorsum movement in the velar region is accompanied by lip protrusion and its lowering movement does not affect the position of the tongue on the horizontal axis as fronting does.

Pedagogical Implications

The mediation program presented in this paper can be integrated into the school's curriculum in different ways. All the games were thoroughly thought out, considering the learner's age and the available time the teacher could have to play them daily. As discussed in section Teaching Procedures—Introduction to the Mediation Program, the program was applied at a school in which teachers could work individually or in small groups on a daily basis. We understand that this might not be the case for all bilingual schools, and it may be a challenge to complete the program. In these cases, we recommend choosing the games that are feasible and still engaging, adjusted to the whole group setting. Another challenge might be playing the proposed games every day, due to logistics and unexpected situations that are likely to happen when working with very young children. During these moments, choosing a game that is fast to be played or leaving the planning for the following day is not likely to disrupt the effect of the long-term mediation program.

Two other aspects are worth highlighting, as they play important roles in the teachers' scaffolding process: game repetition and the learner's oral production. Firstly, repetition is fundamental for very young learners to learn (Montessori, 1967). Through repetition, children feel comfortable with the proposal presented and master more aspects worked on at each cycle. Thus, repeating the proposed

games sometimes is far from being repetitive for children, on the contrary, it brings benefits to their development (Montessori, 1967). Secondly, although this work focuses on perception, the moments proposed for the game activities are opportunities to encourage the child's production as well, targeting both the motor and articulatory skills necessary to produce L2 sounds. The child's oral production is also part of the phonetic input used to develop L2 (Flege, 2009). This is because there is a direct link between production and perception, causing feedback from articulation to hearing (Whalen, 1995). Considering this when mediating is likely to enhance the learner's L2 development.

Conclusion

This paper showed that working with attention to the acoustic cues may optimize very young learners' sound perception. To account for that, a mediation program was created and presented in this paper. The program aims to enhance perception by offering acoustic cues that help draw attention to them through game-like activities. To validate the program's effectiveness, the perceptive abilities of 12 very young Brazilian learners of English were measured before and after taking part in the mediation program. Even though the work presents some limitations, such as a small sample and the impossibility of having a control group, the data collected corroborates the studies of L2 sound acquisition and bilingual education as it proposes a connection between linguistic theory and pedagogical practice.

The article presented empirical results that show the benefits of the mediation program in the case of children's perception of selected L2 sounds. The pre-test results revealed that most children had some L2 sounds assimilated by their L1 counterparts, thus, they did not perceive the difference between the sounds in minimal pairs (/p–b/, /k–g/, /t–d/, /ɛ–æ/, /i–ɪ/, /u–ʊ/). After consistent and playful work with L2 sounds through games, the participants' perception of these sounds enhanced significantly, as observed by the higher values in the post-tests. This result leads to a hypothesis that at a very young age the assimilation process might be reverted, as suggested by Flege (1995) and Flege and Bohn (2021).

The games suggested and applied are age-appropriate and can be integrated into the pedagogical curriculum as they require few materials and are adaptable to suit the schedule. The results derive from a natural and comfortable environment, and present teaching techniques to work with sounds that are replicable and suitable to bilingual schools. Children engaged in the games proposed since the beginning of the year, and their play with sounds intensified

throughout the months. Furthermore, one semester after the completion of the program, in the following school year, there was positive feedback from some of the children's teachers concerning the interest of some students in sounds as well as their intelligible pronunciation.

The combined teaching and research experience gained from conducting this study opens further discussions in the area, as the effects of such perception work in the children's literacy process, and the role of the teacher in scaffolding the work with L2 sounds. We claim for more research carried out in classroom settings so further data is collected to support children's L2 sound acquisition in schools, and theory that supports teacher's needs.

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