

ABSTRACT

The aim of this study was to develop and content validate specific speech and language intervention picture cards: The Letter-Sound (L&S) cards. The present study was also focused on assessing the influence of these cards on letter-sound correspondences and speech sound production. An expert panel of six speech and language therapists analysed and discussed the L&S cards based on several criteria previously established. A Speech and Language Therapist carried out a six-week therapeutic intervention with a group of seven Portuguese phonologically delayed pre-schoolers aged 5;3 to 6;5. The modified Bland-Altman method revealed good agreement among evaluators, i.e., the majority of the values was between the agreement limits. Additional outcome measures were collected before and after the therapeutic intervention process. Results indicate that the L&S cards facilitate the acquisition of letter-sound correspondences. Regarding speech sound production, some improvements were also observed at word level. The L&S cards are therefore likely to give phonetic cues which are crucial for the correct production of therapeutic targets. These visual cues seemed to have helped children with phonological delay develop the above-mentioned skills.

Keywords

Children · content validity · pre-literacy · phonological delay · visual stimuli

LEARNING OBJECTIVES

The reader will be able to (1) describe the development and content validation of the L&S cards and (2) determine the influence of the L&S cards on letter-sound correspondences development and speech sound production.

INTRODUCTION

In recent years, considerable attention has been directed towards children's acquisition of emergent literacy skills^{1,2}. Emergent literacy skills are useful for developing conventional forms of reading and writing³. Early literacy experiences of children during preschool years have a positive effect on their understanding of print and metalinguistic skills⁴. The relationship between oral expression and print is important to reinforce the ongoing development of literacy skills⁵. As a result, speech and language therapists (SLTs) need to be aware of the relationship between oral and written language^{4,6}. Early prevention, identification, assessment and intervention of future literacy skills are critical steps for planning interventions, specifically in at-risk pre-schoolers^{5,7}.

It is also known that language impairment has an impact on children's future reading abilities⁴. Oral language, phonological processing abilities, print knowledge and children's alphabetic knowledge are different components of emergent literacy skills and they tend to be recognised as strong predictors of future literacy success^{8,9}. Letter-sound correspondences are related to the development of phonological awareness skills which facilitate the acquisition of letters, sounds and their relations^{10,11}. Current research indicates that children receiving both letter name and sound instruction are likely to acquire the sounds of letters whose names include cues to their sounds. Piasta and Wagner¹² have previously shown that letter name and/or sound instruction play an important role in facilitating letter sound acquisition. For example, the letter properties (whether the letter is a consonant or vowel, the letter position within the alphabet, its manner of articulation or whether it is associated to one or more sounds) could influence how easily children acquire the letter name. Additionally, children are more likely to know the sound associated to a given letter if the first sound of the letter name is related to its sound (CV

sequences) compared to names that start with a vowel (VC sequences) or letters with names and sounds that are not associated (NA letters such as <W>)¹².

Children with low levels of phonological awareness¹⁰ tend to have difficulties acquiring letter-sound correspondences¹³. A breakdown in the processing of phonological and letters-sound relationships is the primary cause of reading disabilities¹⁴. Some risk factors such as language disorders, speech sound disorders (e.g., phonological delay and phonological disorder), low socioeconomic level, few pre-literacy experiences in natural context (e.g., lack of shared book reading) will have a negative impact on children's literacy development^{5,15,16}. After six years of age, children diagnosed as phonologically delayed have inadequate phonological representations and persistent sound production errors¹⁷. They have six times more probability to experience pre-literacy skills acquisition and phonological awareness difficulties compared to typically developing children¹⁸⁻²⁰. Research indicates that the phonological awareness skills of children with speech sound disorders is significantly lower than their normally developing peers¹⁵.

Visual stimuli based treatment approaches facilitate early literacy skills acquisition and increase engagement during early literacy activities. These intervention approaches may stimulate children's abstract representations and help them discover the connection between letters and sounds from an early age. Children become more aware of sounds in words as they form connections between letters, sounds and words. Some specific visual representations such as picture cards that provide visual cues to the production of sounds that correspond to the alphabetic letters have been shown to result in great gains in pre-literacy skills development²¹⁻²³. Evidence-based early intervention programs show the influence of structured approaches based on the above-mentioned visual representations (e.g., Phonic Faces²⁴ or the Lindamood

approach^{23,25}. These programs benefit the acquisition of letter-sound correspondences and speech sound production^{21–24,26}.

Lindamood and Lindamood²³ developed a multisensorial program (visual, kinaesthetic and tactile) that consists of different activities to teach specific sounds, the alphabetic principle and phonemic awareness. The Lindamood approach²³ was effective with students at risk for reading failure between kindergarten and Grade 1. They made significant gains in phonological awareness and letter-sound correspondence in classrooms where this approach was used²⁷.

Phonic Faces²⁴ is a program that consists of a set of cards that provide not only speech production visual cues but also the associated sounds of the letters. This program consists of different instructional procedures to foster the ability to identify and sequence sounds. For instance, letters are categorised into groups and these are associated to child-friendly names (e.g., sounds such as [p] are identified as “lip poppers”). The instructional activities are focused on the use of various oral motor structures (tongue, lips and mouth) in producing an array of sounds, which stimulate phonemic awareness and correct speech production²⁸. Regarding speech sound production, the Phonic cards provide visual information that help children understand the speech cues provided by the letter which benefit the acquisition of the letter-sound correspondences that children do not know. Additionally, the therapist can explain the speech production cues of the Phonic Faces and have children make the same sound (e.g., the <M> tells us to put our lips together and make the sound [m])²⁴. Various studies using control groups have shown consistent positive outcomes with Phonic Faces²⁹. Doyle et al.²⁹ reported that children made greater gains in articulation (speech) and emergent literacy skills using specific materials such as Phonic Faces books than children receiving traditional articulation therapy.

In Portugal, to the best of our knowledge, there are no scientific studies addressing the development of such intervention materials based on specific visual stimuli. Therefore, the

present study was carried out in order to accomplish the following goals: Developing additional visual stimuli materials and assessing their impact on letter-sound correspondences and speech production skills acquisition in Portuguese pre-schoolers with phonological delay. In Portugal, the pre-school age range is generally from 3;6 to 6;6 years old³⁰.

AIMS OF THE STUDY

The primary aim of this study was to explore the influence of the L&S cards in letter-sound correspondences development and in speech production improvement. The current study is focused on the following research questions:

1. Do the L&S cards have content validity?
2. Do the L&S cards benefit the letter-sound correspondence acquisition in phonologically delayed Portuguese pre-school children?
3. Do the L&S cards contribute to decrease the number of phonological processes in phonologically delayed Portuguese pre-school children?

METHOD

The content validity of the therapeutic intervention materials was studied using the method proposed by Davis³¹. According to Davis³¹, the identification of the items and domains of any instrument is the first step in the content validity process: The *developmental stage*. This stage involves domain identification, item generation and then the appropriate items are assembled into a usable instrument. During the following stage (*judgment stage*), a number of experts, evaluate the relevance of each item based on detailed criteria and indicate if the entire instrument has content validity^{31–33}. The sections below describe the *developmental and judgment stages* of the L&S cards.

Phase1: Development of the L&S Cards

As previously mentioned, the L&S cards are meant to stimulate letter-sound correspondences and speech sound production: The L&S cards promote the letter name-to-sound facilitation effect^{12,34}. Each letter was included into different categories based on consonant-vowel (CV) and vowel-consonant (VC) patterns. Regarding the sound associated to a specific letter, each illustration links letter-sound correspondence to familiar contexts (e.g., the letter-sound <f>/[f] is related to a familiar situation, for instance, a furious cat making a [f] sound). As a result, children are more likely to easily recall these associations. The Portuguese alphabetic system does not have letters associated to the category NA and therefore it was not considered in the present study.

The L&S cards illustrations were developed by a Graphic Designer specialised in children's illustration. Fifty L&S cards were created: 38 L&S cards with direct letter-sound correspondences (<p>/[p], /[b], <t>/[t], <d>/[d], <n>/[n], <l>/[l], <f>/[f], <v>/[v], <m>/[m], <s>/[s], <z>/[z], <ch>/<x>/[ʃ], <j>/[ʒ], <c>/[k], <g>/[g], <r>/[r], <nh>/[ɲ], <lh>/[ʎ]); 12 L&S cards with indirect letter-sound correspondences (<r>/[r], <c>/[s], <g>/[ʒ], <s>/[z], <s>/[ʃ]). The development of each illustration took into account the number and colour of the letters. The colour of the letters is different from the rest of the colours presented in each card.

Each L&S card is double-sided. The front of the L&S card (see figure 1) has a letter on the left and an illustration on the right (e.g., the L&S card <M> has a red uppercase letter which is placed on the left; on the right side there is an illustration of the sound associated to the letter <M>, i.e., the girl sniffing a flower).

Insert figure 1 about here

The back of the L&S cards consists of speech sound production photos and also an articulatory description and stimulation procedures that could be used by SLTs during therapeutic intervention (see figure 2).

Insert figure 2 about here

The development of each photo (see figure 2) was based on the data provided by an European Portuguese (EP) magnetic resonance study³⁵. The articulation of the consonants presented in each photo was guided by the magnetic resonance images of the above-mentioned study. The articulatory principles outlined by Cruz-Ferreira³⁶, Jesus et al.³⁷, Mateus & d'Andrade³⁸ and Vigário et al.³⁹ had also been considered.

Phase 2: Expert Panel

The expert panel of this study consisted of six Portuguese SLTs. The following inclusion criteria were established⁴⁰: Qualifications in the research fields of the present study (including phonological awareness and alphabetic principle); clinical experience in the research fields of the present study (minimum of two years); geographic proximity to the University of Aveiro, where the expert panel met. None of these SLTs had participated in phase 1 of the study.

Questionnaires

Each expert panel member had received two questionnaires. The purpose of the first questionnaire was to gather data regarding each individual profile. The second one was based on a set of specific questions that were meant to obtain the overall evaluation of the L&S cards (see Appendix I). Both questionnaires used visual analogic scales (VAS) and consisted of a 100 mm horizontal line, divided at equal length by three tick marks: 0 mm – Strongly disagree; 50 mm –

Neither agree nor disagree; 100 mm – Strongly agree. The experts marked each response on the line. Finally, a ruler was placed over each line in order to get an accurate measure. A set of six values (from six independent experts) was obtained for each item and their mean and standard deviation were calculated afterwards. Apart from the questionnaires, the authors of the current study developed an oral presentation which included detailed information regarding each L&S card. The expert panel had the opportunity to carefully analyse each L&S card before answering the associated specific questions. Moreover, the authors of the present study encouraged the members of the expert panel to share their viewpoints about each L&S card and they made valuable suggestions which helped improve them.

Phase 3: Therapeutic Intervention

A six week therapeutic intervention with phonologically delayed pre-schoolers was carried out to determine the practical pertinence of the L&S cards. Similar intervention periods have been previously reported in various research studies^{25,41–43}. A quasi-experimental design was used for the current study, i.e., participants could not be randomly selected or assigned to groups. The structure of this study followed a rationale based on pre-test / post-test group comparison. It was not possible to control all the potential confounding variables³².

The sample of the study followed the principles outlined by the method designated as “single-group design”, as all the participants were selected according to specific criteria (e.g., age and severity level)^{44,45}. The participants were phonologically delayed pre-schoolers because they demonstrate difficulties in phonological representation (e.g., pre-schoolers diagnosed with phonological delay have difficulty acquiring letter-sound correspondences). They also usually perform poorly on literacy skills¹⁷. Phase 3 took place at Tondela-Viseu Hospital’s Speech and

Language Therapy Service in Viseu, with ethical approval from the relevant research ethics committees.

Sample

The sample of this study consisted of seven phonologically delayed Portuguese children (five boys and two girls) aged between 63 and 77 months, with a mean age of 70.9 months (standard deviation (SD) = 5.1 months). The participants of the present study were diagnosed with a phonological delay, i.e., they produced a set of phonological error patterns that are typical of children chronologically younger than them. The following inclusion criteria was considered: Children whose mother tongue was European Portuguese; children aged between 60 and 77 months; children whose receptive and expressive language scores on the Teste de Avaliação de Linguagem na Criança (TALC)⁴⁶, i.e., a standardised receptive and expressive language test⁴⁶, were within the average range based on each age group (-1 and +1 SD). TALC⁴⁶ is a standardised instrument which assesses language development in three different linguistic areas: Semantics (vocabulary, semantic relationships and nonsense sentences), morpho-syntax (complex sentences and other morphemes) and pragmatics (social language). The receptive language test has 69 items and the expressive language test has 54 items. The average application time is 30-45 minutes. Table I shows the average mean and SDs according to each age group. According to the information presented in Table I, all children obtained receptive and expressive language scores within the normal range.

Insert table I about here

Audition of 20 dB or lower in frequencies 500, 1000 and 2000 Hz was also considered as an inclusion criteria of the present study. This data was collected by a certified audiologist in the

Otolaryngology Department of Tondela-Viseu Hospital. The speech errors were not due to oral-motor difficulties or structural problems as indicated by the results obtained from an oral examination assessment instrument, named Protocolo de Avaliação Oro-facial (PAOF)⁴⁷. All speech sounds were stimulable in isolation when tested.

Equally important was the cognitive skills assessment. Therefore, all participants in the present study were assessed with the Wechsler Intelligence Scale for Children (WISC-III) and the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-R)⁴⁸ in order to measure children's cognitive ability. Three children had non-verbal abilities (NVIQ) within the normal range (above 85). None of them had a NVIQ below 77.

The method proposed by Shriberg and Kwiatkowski⁴⁹ was followed in order to collect and analyse each participant's spontaneous speech sample using three different pictures^{26,50}. Omissions, substitutions and distortions were considered as errors to calculate the percentage of consonants correct (PCC) values. All children were diagnosed with a moderate phonological delay because their PCC was between 65-85%, as previously proposed by Shriberg⁵¹. Table I summarises specific characteristics of the study sample.

Pre-Intervention Assessment

All study participants had been assessed during the first two weeks, i.e., weeks 1 and 2 (see Table II) with the following standardised European Portuguese assessment instrument^a: Teste Fonético-Fonológico-ALPE (TFF-ALPE)^{52,53}; Prova de Avaliação de Competências de Pré-Literacia (PACPL)⁵⁴.

Insert table II about here

^a This assessment instrument has been previously used in Portuguese children with speech sound disorders by Lousada, Jesus, Capelas, Margaça, Simões, Valente, Hall & Joffe²⁶ and Lousada, Jesus, Hall & Joffe⁵⁰.

The TFF-ALPE^{52,53} is a standardised assessment instrument which gathers data regarding children's verbal articulation skills, percentage of phonological processes usage, types of phonological processes and also inconsistent productions. This test analyses all sounds in different word positions, including the following phonological processes for analysis: Final consonant deletion, weak syllable deletion, cluster reduction, gliding of liquids, stopping, fronting, depalatalization, backing, palatalization, and devoicing. All the responses from each child were recorded using an AKG Perception 120 USB microphone connected to a laptop computer, using the Praat 5.3.43, with 16 bits and a sampling frequency of 48 kHz.

The PACPL⁵⁴ is an instrument that assesses the knowledge related to the name and the sound of each letter in children aged between 5;0 and 8;0. It consists of four subtests: The letter name identification (LNI); the letter name production (LNP); the letter sound production (LSP); the letter sound identification (LSI). A study⁵⁵ has been carried out in order to assess the construct validity and reliability of the above-mentioned instrument. Results showed that the instrument is valid and reliable. Cronbach's α , used to measure PACPL's internal consistency, was 0.982. The inter-rater agreement was 96.2%, whereas the intra-rater agreement was 95.6%. The values of Cohen's k for inter-rater and intra-rater were 0.92 and 0.91, respectively. The PACPL was also analysed based on the developmental progression of raw scores with age. Not only a significant improvement was observed in mean values with age but also significant differences between all age groups for all sections (all t-tests $p<0.001$) have been shown⁵⁶. These results suggest that the PACPL⁵⁴ is a valid and reliable standardised instrument to assess pre-literacy skills in Portuguese pre-schoolers.

Intervention Procedures

The therapeutic intervention lasted six weeks, i.e., weeks 3 to 8 (see Table II), which is a reasonable period of time for short duration programs as shown in previous studies^{25,41-43}. The therapeutic intervention used a combined letter name and sound condition¹². This period was carefully monitored to ensure the same number of sessions, a similar sequence of intervention activities and the same number of activities. Each weekly session was carried out over 45 minutes¹². During each session personalised materials and the targets were presented during 5 to 10 minutes to each child (see Appendix II and Appendix III). The same experienced SLT carried out the whole intervention with all children. The children did not receive other forms of intervention or special education during the intervention period.

Table II summarises the above-mentioned information related to pre-intervention, intervention process and post-intervention. Table II also provides a detailed explanation associated with the sequence of the therapeutic sessions and specifies the gradual introduction of therapeutic targets. The therapeutic target and letter-sound correspondence that have been introduced in the first session appear in black, the stimuli recapped in each session appear in green and the new target presented in each session appears in orange.

In the first session, two stimuli were simultaneously presented to each child (the therapeutic target and a new letter-sound correspondence). The subsequent therapeutic sessions provided after the first one included the therapeutic target, the letter sound correspondence already introduced in the previous session and another new letter-sound correspondence. The beginning of each subsequent session systematically consisted of a review of all the concepts already introduced (see Table II).

The therapeutic targets (letter and target sound) were selected based on the following criteria:

- Phonological process usage (a percentage of usage higher than 40% was considered a priority intervention target)⁵⁷;
- Normal phonological development sequence which is based on sound acquisition and in the decrease of phonological processes usage⁵⁸;
- Stimulability (stimulable sounds were a priority for therapy), which is important for increasing children's motivation⁵⁹.

The authors developed a set of lists which were comprised of treatment European Portuguese words and these had been used throughout the intervention. Test words from TFF-ALPE⁶⁰ were avoided as treatment words. The process of list development was based on the following criteria: linguistic complexity; articulatory factors; global phonological similarity^{61,62}.

Post-Intervention Assessment

After six therapy sessions, the participants were assessed by the SLT involved in the pre-treatment phase and the same instruments, i.e., TFF-ALPE⁶⁰ and PACPL⁵⁴. Data collected pre and post intervention was compared.

Outcome Measures

The following outcome measures were used: PCC⁴⁹; phonological process usage²⁶; phonetic repertoire²⁶; pre-literacy skills (identification/production letter name/sound)¹².

Phonetic transcription reliability

The first author (a SLT) carried out the phonetic transcriptions of all speech samples. The production of all isolated words of two randomly selected children were annotated and transcribed by another SLT not involved in the study and blind to its aims. Point-to point reliability was 96.8% (pre-intervention) and 97.5% (post-intervention), which are comparable with those reported in other studies in disordered child phonology^{63,64} and were considered

adequate according to the aims of this study.

RESULTS

Expert Panel

The analysis presented in figures 3 and 4 is based on a modified Bland-Altman method^{65(pp4-5)} for more than two measurements. The graphs plot the mean of the measurements against their standard deviation (SD) to provide a visual representation of the extent of agreement. The calculation of the differences between the scores was replaced by the calculation of their standard deviation (SD). The mean was then calculated and the results were represented in graphs which are similar to the ones originally suggested by Bland and Altman⁶⁶. Like in the original Bland-Altman⁶⁶ method, the limits of agreement are obtained through a 95% confidence interval, which in this case is based on a chi-squared distribution, related to the distribution of the sample variance. However, whereas in the Bland and Altman⁶⁶ graph for differences disagreement may occur in both directions, when considering the SD, disagreement always means an increase of its value (total agreement produces a zero SD)⁶⁵. Therefore, in the modified Bland Altman graph⁶⁵ the confidence interval is one-sided and only the upper limit is of interest.

Figure 3 shows the extent of inter-evaluator agreement related to the photos/illustrations presented on each L&S card.

Insert figure 3 about here

All the evaluators focused their attention on the influence of the illustrations in eliciting the associated letter sound (e.g., L&S card <M>, the girl sniffs a flower (illustration) and at the same time a pleasant sound is produced which is similar to [m] (letter sound)) and provided several valuable opinions afterwards. All the values are between the limits of agreement. Overall, the graph shows a good pattern of inter-evaluator agreement. The light grey circle highlights the group of items considered in the questionnaire with the highest inter-evaluator

agreement. The main trend observed indicates that the agreement increased whenever the evaluators scored high the individual items (scores between 85 and 95). The black circle shows the group of items that were revised because of the disagreement among the expert panel members. The main trend observed indicates that the disagreement increased whenever the evaluators scored low the individual items (scores between 40 and 75).

Figure 4 shows the extent of inter-evaluator agreement regarding L&S cards items (e.g., voicing cues, nasality cues and practical pertinence) that were not considered in the figure 3.

Insert figure 4 about here

The light grey circle shows the group of items with the highest inter-evaluator agreement: Items 7, 8 and 9 (voicing cues presented on L&S cards, nasality cues presented on L&S cards and practical pertinence in SLTs intervention). The black circle shows the group of items that were revised because of their low score, namely items 3.2 and 4.2 (quality of the picture presented on L&S card and its association to letter sound [b]).

Pre and Post Intervention Assessment

The results shown in table III suggest that all children improved specific skills targeted during the therapeutic intervention (e.g., pre-literacy and phonological skills).

Insert table III about here

Regarding pre-literacy skills, all children showed low knowledge in LNP skills pre-intervention when compared to standardised data provided by Jesus et al.⁵⁴ (see table III) and to post intervention assessment (see table III). None of them produced the associated sound to a specific letter at the pre-treatment assessment which means that they had not mastered the letter-sound correspondences, even though they demonstrated stimulability for those sounds in

isolation. Post intervention results suggest that all children were able to produce the associated sound presented throughout the intervention period (see table III). The latter assumption means that all phonologically delayed children were able to verbally match the name of each letter with its associated sound. Due to the small sample size, a non-parametric statistical test, i.e., the Wilcoxon signed ranks test, was used to compare the change (increase) in scores for LNP, LNI, LSP, LSI from pre to post intervention with the expected increase due to spontaneous improvements (changes that occur without intervention) over a six-week period.

The natural maturation over six weeks was estimated based on the data⁵⁵ from 216 Portuguese children aged 5;0-7;11. These children were homogeneously divided into six age subgroups ([5;0-5;5], [5;6-5;11], [6;0-6;5], [6;6-6;11], [7;0-7;5], [7;6-7;11]). Since the pre-test scores are very low for the present intervention group, the spontaneous improvement was estimated only from the lowest performing individuals of the PACPL study⁵⁵. For that purpose we considered the lower 25th percentile values of the six age subgroups. We first determined the average one-year improvement for the first three age subgroups. We did not consider the oldest age subgroup (improvement from [6;6-6;11] to [7;6-7;11]) since this proved to be very small as children at this age have acquired most of the assessed skills. We then divided the average one-year improvement by 52 and multiplied by 6 in order to obtain the six week improvement estimate. The obtained values were: 0.8 for LNI, 1.1 for LSI and LNP and 1.2 for LSP.

The results suggest that there are significant positive differences between the obtained scores and the spontaneous improvements at a significance level of 5% (LNP: p=0.016; LNI: p=0.016; LSP: p=0.008; LSI: p=0.008). These results suggest that the spontaneous improvements are relatively small in comparison with the obtained increase in scores.

As far as the phonological skills are concerned, table IV provides detailed information about the following outcome measures: PCC; phonological process usage; phonetic repertoire.

The information regarding phonological process usage and phonetic repertoire were obtained using TFF-ALPE⁶⁰. The results suggest improvements in PCC, specifically at isolated word level (IW) and also in phonological process usage, especially those that were targeted during intervention (targeted phonological processes are marked with an asterisk in table IV).

Insert table IV about here

Regarding PCC, the results revealed significant differences between pre and post intervention at a significance level of 5% ($p=0.008$). As far as the phonological process usage is concerned, the results also show significant differences between pre and post intervention, considering the phonological processes targeted during the intervention, at a significance level of 5% ($p=0.008$). All children, except MC, added a new sound (intervention target), which means an expansion of the phonetic inventory.

DISCUSSION

This study reports on the systematic content validation method used to validate the influence of the L&S cards in early literacy skills acquisition (e.g., alphabetic mastery and speech sound production). The content validity assessment of the L&S cards was based on specific criteria associated to a well-established methodology, which was similarly reported in various research studies³¹⁻³³. There is wide agreement that the method proposed by Davis³¹ is one of most recognised methodologic approaches to help researchers draw conclusions about an instrument quality. According to Beck and Gable⁶⁷, this method is essential for all instruments and it is generally described as a two-stage process because it combines both the developmental stage (Phase 1: development of L&S cards) and judgment stage (Phase 2: Expert Panel). As a result, the developmental stage of this study ensured that the L&S cards included important visual cues to stimulate letter-sound correspondences and speech sound production. The judgment phase of

the present study followed various crucial steps such as the expert panel assessing the validation of each item, calculating the percentage of items considered to be relevant and then taking an average of the percentages across experts. In the present study, the expert panel consisted of six professionals which is deemed adequate in terms of inter-evaluator results reliability^{31,68}. Furthermore, each expert panel member was chosen based on the numbers of years of experience and background knowledge in the study field. All expert panel members revealed an extensive background knowledge regarding the field of this study. These criteria reveal the expertise of each expert panel member in the target area of study and it is considered to be extremely relevant in various studies^{69,70}.

Each L&S card was assessed in terms of image clarity and practical pertinence. These procedures have also been adopted in a similar research study on the content validity of stimuli for an instrument⁷³. Regarding inter-evaluator agreement, the values between 85% and 95% were considered acceptable and therefore no changes had been made to the L&S cards. The current study addressed all the inter-evaluator agreement results that were either outside of the limits of agreement or had very low scores. For instance, crucial adjustments have been made to the L&S cards according to a set of agreed suggestions and clinical practice expertise of each member of the expert panel. The expert panel meeting was extremely useful because each professional provided valuable feedback regarding each L&S cards based on theoretical and practical knowledge. These steps helped create an agreed finalised version of each L&S card in terms of content relevance as suggested by Beck and Gable⁶⁷.

The sample of the current study consisted of seven children diagnosed with phonological delay. Bird et al.¹⁵ have previously shown that interventions based on teaching letter-sound correspondences benefit children diagnosed with phonological delay or other phonological disorders because their difficulties are phonological in nature and therefore they are likely to

exhibit risk for future reading problems. Froma et al.⁴¹, Laing and Espeland²⁵ and Berntsson and Palle⁴³ have also recruited children diagnosed with phonological delay in order to analyse their improvements on pre-literacy skills (e.g., letter-sound correspondences) during a 6-8 weeks intervention period.

Various studies have used a comparable sample to the current study. For instance, Roth et al.⁴¹ studied eight children (five boys and three girls) whose age was between 4 and 6 years old. The current study includes more boys than girls due to the fact that phonological delays and other phonological disorders are more recurrent in boys when compared to girls⁶⁴. All children had normal language development and therefore the same likelihood to similarly develop pre-literacy skills⁷⁴.

As far as the pre-intervention findings are concerned, some children revealed higher letter-name knowledge compared to sound knowledge. Some studies indicate that it is typical to encounter pre-schoolers who have higher letter name knowledge compared to sound knowledge^{10,12}. AM revealed the best performance in letter name knowledge, when compared to the other participants. Piasta and Wagner¹² have shown that given a letter name, pre-schoolers are not able to intuitively deduce the associated sound. As a result, children benefit from cues in order to be able to know the letter sounds⁷⁵. AM may have learned the associated sound quicker than her peers because it is widely known that letter name knowledge has an impact on how quickly children acquire the associated sounds^{8,76,77}.

The therapeutic intervention, i.e., a combined letter name and sound condition approach, was carried out over six weeks. This intervention period is comparable to some previous studies^{25,41-43}. After the intervention period, the authors observed improvements in the following outcome measures: PCC; phonological processes usage and phonetic repertoire. The <l>/[l], <r>/[r] and <z>/[z] L&S cards positively influenced the above-mentioned outcome measures

because all children added the target sound in their phonetic repertoire, which suggests that they expanded the number of phonological contrasts, and it could have influenced the observed speech production improvements. One of the children, MG, had concomitantly decreased the usage of two phonological processes, PAL and DES. These improvements might be associated with spontaneous generalisation because MG added another sound to his phonetic inventory [s] which has the same place of articulation as the intervention target [z].

Children need to be encouraged to discover the connection between letters and sounds before being able to read²⁴. The results obtained in the present study suggest that there are significant differences between pre and post intervention times regarding LNP, LNI, LSP and LSI. Consequently, the L&S cards are likely to have helped children improve their letter-sound correspondences. The following data from the literature help explain why the L&S cards positively influenced the letter-sound correspondence acquisition in pre-schoolers^{12,25,41}. Hoffman and Norris²¹ pointed out that pre-schoolers with speech sound disorders need to support their mental processing with visual representations in order to easily learn abstract concepts. Therefore children benefit from being exposed to resources that help them discover the connection between letters and sounds^{78,79}. When given cues, children seem to be more likely to learn the letter sounds⁷⁵. Consequently, the L&S cards were considered useful visual stimuli as these facilitate the simultaneous acquisition of the letter name and its associated sound. Each child's attention seemed to have been directly drawn to the phonological structure of letter name and its associated sound¹². The L&S cards were a specific resource that might help trigger the mental processing of abstract concepts and therefore the systematic use of phonological skills, which supported the correct production of the target sounds. Foy and Mann¹⁰ showed that these children need to be taught different letter sounds because it might influence further development of phonological awareness. Ball and Blachman⁸⁰ have previously observed that phonological

awareness skills are enhanced in children who have received explicit instruction in letter-correspondences.

Additionally, the following predictors might have also contributed to the above-mentioned results. The participants in the present study have language skills within the average range which is deemed to be a good predictor in terms of the alphabetic principle acquisition³. Additionally, children have not been exposed to more than four letter-sound correspondences which might have contributed to a better acquisition of the above-mentioned skills. These results were obtained over a short period of intervention and therefore children are likely to process the information related to the phonological concepts already taught. Roth et al.⁴¹ obtained similar results. Moreover, the phonological structures associated to the letter name (CV and VC) have cues that facilitate the associated sound acquisition, as previously mentioned by McBride-Chang⁸¹, Treiman and Kessler⁷⁷, Foy and Mann¹⁰ and Randolph⁸². As mentioned in the present study, the Consonant-Vowel (CV) (<l>, <r>, <f>) and Vowel-Consonant (<z>, <t>, <v>) phonological patterns have been targeted and considered to be easily acquired by children. Children appear to have greater CV and VC letters knowledge compared to NA letters³⁴. Additionally, children who are taught about letter names and sounds have more knowledge about letters with names containing the associated sound, regardless of whether the sound is at the beginning (CV) or end (VC).

Finally, these findings suggest that the improvements observed in this study were related to the intervention process and not the maturation because spontaneous improvements are smaller when compared to the obtained improvements after therapy. Moreover, there were no improvements in non-target skills (e.g., a decrease in non-targeted phonological processes use)⁸³. Additionally, it is unlikely different NVIQ scores influenced the speech production results.

Lousada et al.²⁶ reported that Portuguese children with low NVIQ and children with normal NVIQ did not perform significantly different in terms of their speech production.

CONCLUSIONS

This study highlights the importance of the content validation of therapeutic intervention materials. This process standardises procedures, which facilitates the clinical practice and research development. These cards can be a link between clinical context and natural context, which promotes an active participation of parents and teachers during the therapeutic intervention.

Future research could include the development of “Alphabet Books” as proposed by Norris²⁴. These specific books are a combination between words and other visual representations (illustrations and speech sounds). Additionally, future studies could investigate the effect of the L&S cards in therapeutic intervention in other disorders (e.g., dyslexia).

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Appendix I

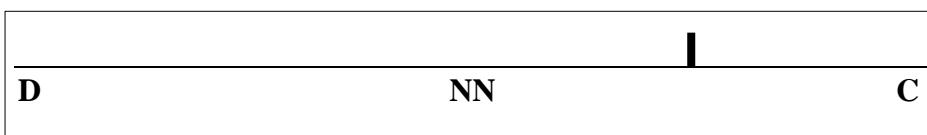
CONTENT VALIDITY OF THE VISUAL STIMULI (L&S cards)

The following questionnaire consists of several questions regarding various specific domains, which are necessary to determine the content validity of the visual stimuli (L&S cards).

Image Clarity: How do the L&S card images look like? Are the images neat and clear?

Practical Pertinence: Are the L&S cards images suitable to illustrate the articulatory configuration which is necessary to achieve correct sound production? Are the L&S cards images suitable to prompt letter-sound correspondences?

The following scale is used to draw a perpendicular line over the 10cm line as exemplified. The anchor points have different meanings: **D** – Strongly disagree; **NN** – Neither disagree nor agree; **C** – Strongly agree). You are requested to make notes of suggestions/observations whenever you select D and NN options.



Is there a relationship between L&S card images and the associated sound?

- 1. From your point of view, is there a clear relationship between the L&S card images and the one-to-one letter/sound correspondence?***

D	NN	C

P

B

T

D

D **NN** **C**

N

D **NN** **C**

L

D **NN** **C**

F

D **NN** **C**

V

D **NN** **C**

M

D **NN** **C**

J

D **NN** **C**

Ch

D **NN** **C**

Nh

D **NN** **C**

Lh

2. *From your point of view, is there a clear relationship between L&S cards images and the other letter/sound correspondences?*

D **NN** **C**

C [kɪ]

D **NN** **C**

C [sɪ]

D **NN** **C**

G [gɪ]

D **NN** **C**

G [ʒɪ]

D **NN** **C**

R [rɪ]

R [rɪ]

D **NN** **C**

D **NN** **C**

S [sɪ]

D **NN** **C**

S [ʃɪ]

D **NN** **C**

S [zɪ]

D **NN** **C**

Z [zɪ]

D **NN** **C**

Z [ʃɪ]

3. From your point of view, are the images clear?

D **NN** **C**

P

D **NN** **C**

B

D **NN** **C**

T

D **NN** **C**

D

D **NN** **C**

N

D **NN** **C**

L

D **NN** **C**

F

D **NN** **C**

V

D **NN** **C**

M

D	NN	C	S
D	NN	C	Z
D	NN	C	J
D	NN	C	C
D	NN	C	G
D	NN	C	Ch
D	NN	C	Lh
D	NN	C	Nh
D	NN	C	R [R̄]
D	NN	C	R [r̄]

4. From your point of view, do the images match the practical pertinence criteria?

D	NN	C	P
D	NN	C	B
D	NN	C	T
D	NN	C	D
D	NN	C	N
D	NN	C	L
			F

D	NN	C	
D	NN	C	V
D	NN	C	M
D	NN	C	S
D	NN	C	Z
D	NN	C	J
D	NN	C	C
D	NN	C	G
D	NN	C	Ch
D	NN	C	Lh
D	NN	C	Nh
D	NN	C	R [R̄]
D	NN	C	R [r̄]

5. From your point of view, does the red colour highlight the target letter on each card?

D	NN	C
---	----	---

6. From your point of view, is it suitable to have three letters on each L&S card image?

D

NN

C

7. From your point of view, is it suitable to have the voicing cue on each card?

D

NN

C

8. From your point of view, is it suitable to have the nasality cue on each card?

D

NN

C

9. From your point of view, are these L&S cards useful in daily clinical practice?

D

NN

C

Suggestions / Observations

Appendix II

Speech-Language Therapy Session Guidelines

“Combined Letter Name and Sound Condition”¹²

The following Speech-Language Therapy Session guidelines explain the stimuli used to develop the activities throughout the session.

1st Part: Introduction to letter-sound correspondence activities using an L&S card^a (letters in black presented in Table II):

- a. The SLT should make sure that the child’s attention is focused on L&S card stimuli while a brief explanation about it is provided.

- i. The SLT should hold a white paper sheet on the left side of the L&S card. Then, the SLT should clearly say the letter name “Let’s take a look at the red letter of this card. Can you see it? This is ____ (The SLT says the letter name).
- ii. Then the SLT should say to the child “Now it’s your turn! Look at this letter! Do you remember the name of the letter that I’ve just said?” (the SLT should wait until the child says the name of the letter);
- iii. After that, the SLT should say to the child “We’re going to move on to this picture as I want you to take a look at it. What do you see on this picture?” The SLT should ask the child to do different tasks (see examples below):
 - i. Describing the picture;

^a The SLT should explain the content of the back of the L&S card according to the described procedures whenever phonetic practice is needed.

- ii. Making 3 circles around the red letters presented on the card;
 - iv. The SLT should ask to the child “Which sound does the furious cat make?”,
 - v. Finally, the SLT should ask children to pretend to be a SLT and therefore they have the opportunity to perform the whole task once again.
- b. The SLT should put two L&S cards (face up) over a white board or any other surface in order to present the following activities^a:
 - i. The SLT should put two pictures over a surface (the beginning sound of the target words should have different places of articulation, e.g., **pan** and **fan**);
 - ii. First of all, the SLT says the name and the sound of the letters. Secondly, the child should identify them and produce the correct sound;
 - iii. Thirdly, the SLT should say to the child “Pick one of the cards! I want you to pay attention as I say the name of these pictures (the SLT should highlight the sound presented in the target words). “Which one of these cards has the sound that you just heard?”
- c. The SLT should make sure that the child’s attention is focused on the words which are written in a set of colour cards;
 - i. The SLT should say “Now we are going to look for the letter ___ which is presented in these words (the child should produce the letter name without support).

^a If the child is not successful in this task, the SLT should follow the recommendations proposed by Norris²⁴:

- Point to the L&S card and produce the sound and the word (e.g., /p/ /p/ /p/ /plate/)
- Hold the L&S card near the mouth and produce the sound and the word (ex: /p/ /p/ /p/ /plate/)
- Produce the words once again;
- Put the card next to the target picture (e.g., /p/ /p/ /p/ /plate/)
- Emphasize the target sound of the L/S card;

- ii. The SLT provides a set of words presented in cards and they need to be correctly matched to the L&S card.
- iii. Considering the fact that each target sound could be in any word position, then the SLT should ask the child to identify the correct position of the sound associated to each letter. The SLT should say to the child “Look at this word. Where is the letter that makes the sound ____?”;
- iv. The SLT, after providing the speech model, asks for the corresponding word production “The word _____ (produced by the SLT) has the letter _____ (produced by the child) that makes the sound _____ (produced by the child). Well done!”;
- v. Finally, the SLT presents a set of cards with pictures on the table. The SLT and the child are supposed to take turns. One of them produces the word related to the picture that is on the card. The other one needs to look for the L&S card.

Feedback: Each child should be given positive reinforcement (“The word _____ (produced by the child) has the sound _____ (produced by the child). Well done!). If the child says anything wrong, then the right model should be given straight away (“The word _____ (produced by the Therapist) has the sound _____ (produced by the Therapist)“).

2nd Part: Recapping the letter-sound correspondences (letters in green presented in the Table II)

Suggestion: The SLT has 1 minute to review all the letter-sound correspondences already introduced in previous sessions, following the steps that were described in the 1st part of this guide²⁴.

- i. The SLT should summarise all the letters already taught in previous sessions (e.g., “We’re going to start off with all the letters you’ve learned. The name of this letter is ___ and the sound of this letter is ___ (produced by the child)”).

3rd Part: Introduction of a new letter-sound correspondence (letters in orange presented in the table II)

1. Activities related to identification / production of the letter-sound correspondences

- vi. The SLT should hold a white paper sheet to the left side of the L&S card. Then, the SLT should clearly say the letter name “Let’s take a look at the red letter of this card. Can you see it? This is ___ (The SLT says the letter name). ”
- vii. Then the SLT should say to the child “Now it’s your turn! Look at this letter! Do you remember the name of the letter that I’ve just said?” (the SLT should wait a few minutes until the child says the name of the letter);
- viii. After that, the SLT should say to the child “We’re going to move on because I want you to take a look at this picture. What do you see on it?” The SLT should ask the child to complete different tasks, such as:
 - i. Describing the picture;
 - ii. Making 3 circles around the red letters presented on the card;
- ix. The SLT should ask to the child “Which sound does the furious cat make?”;
- x. Finally, the SLT should ask children to pretend to be a SLT and therefore they have the opportunity to perform the whole task once again.

2. Examples of other systematic activities related to identification / production of the letter-sound correspondences

- i. The SLT hides the face of the L&S card previously presented in the identification/production of the name/sound of the letter;
- ii. Then the SLT develops a game targeting these skills. For instance, the SLT explains a game that consists of several balls with letters on them. Each player should pick one of the balls and look at it. They need to check if the ball matches the L&S card;
- iii. Concomitantly, the SLT says to the child “This is the letter ___ (produced by the child)). Well done!”.

Appendix III



Activity related to the 1st part of the therapeutic session. The SLT briefly explains the content of the L&S <z> / [z].



Activity related to the 1st part of the therapeutic session. The SLT produces the sound associated with a given letter. The child draws a circle and produces the target sound.



Activity related to the 1st part of the therapeutic session. The child matches the words with the L&S card.



Activity related to the 2nd and 3rd parts of the therapeutic session. This activity exemplifies an activity associated with the recapping of letters already introduced in previous sessions. It could be also used to introduce new letters.

Figure 1 <M>/[m] L&S card front. The girl is sniffing a flower and concomitantly producing a sound similar to [m] which is associated to the <M> letter.

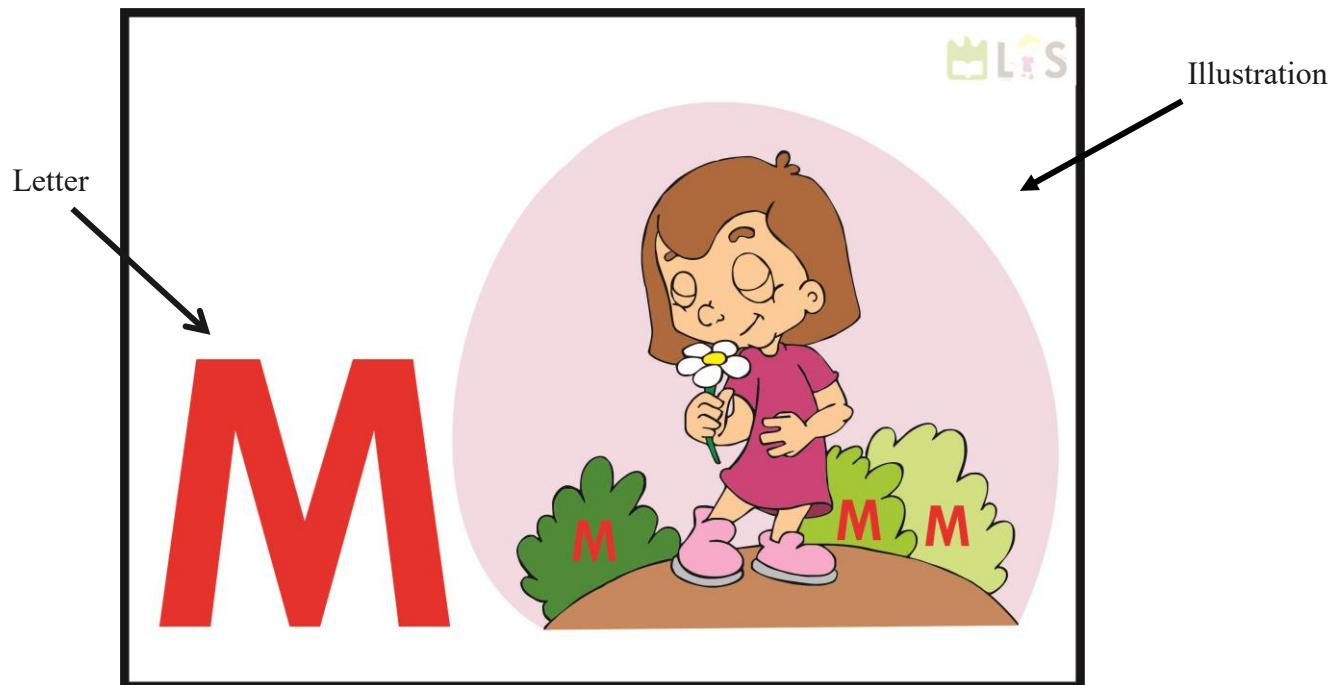


Figure 2 <M>/[m] L&S card front, with nasal cue (left) and speech sound production (right) photos for [m]. The following speech sound stimulation procedures are also included: Speech production photo: The lips are closed and the mandible raised; there is nasal airflow; there is voicing. Eliciting techniques: Use a tongue depressor to touch the upper and lower lips; the child is asked to breathe through the nose and to produce the [m] sound (the adult repeats the same task and asks the child to try again); an Altman mirror could also be used to show the airflow through the nasal cavity; the child is encouraged to feel that there are structures in the nose and the larynx that vibrate when the air flows through them; when the pulmonic egressive mechanism is mastered, the child is asked to produce [a] during the expiratory phase and with closed lips.



Figure 3 Inter-evaluator agreement related to the photo/illustration presented on each L&S card according to the modified Bland & Altman method^{65(pp4-5)}. The items 1.1, 1.2, 1.6, 1.14 and 1.16 presented on the questionnaire are related to the following L&S cards: 1.1 – <p>/[p]; 1.2 – /[b]; 1.6 – <l>/[l]; 1.14 – <c>/[k]; 1.16 – <g>/[g].

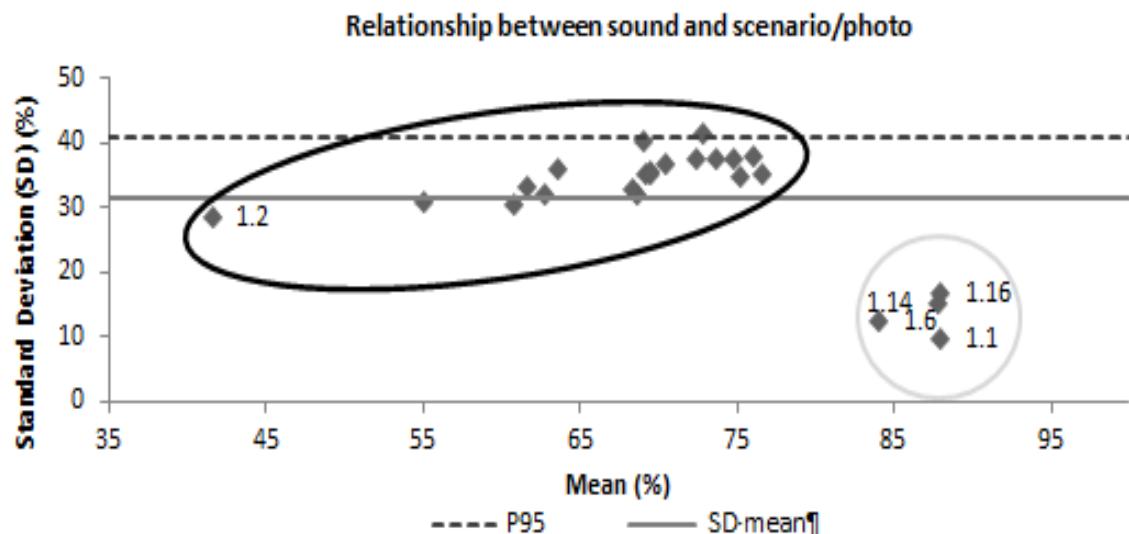


Figure 4 Inter-evaluator agreement regarding other additional L&S cards items (e.g., voicing cues, nasality cues, practical pertinence) according to the modified Bland & Altman method^{65(pp4-5)}. The items 3.2, 4.2, 7, 8 and 9 are related with specific L&S cards items presented on the questionnaire (quality of the picture presented on L&S card and its association to letter sound [b]; voicing cues presented on L&S cards, nasality cues presented on L&S cards and practical pertinence in SLTs intervention, respectively).

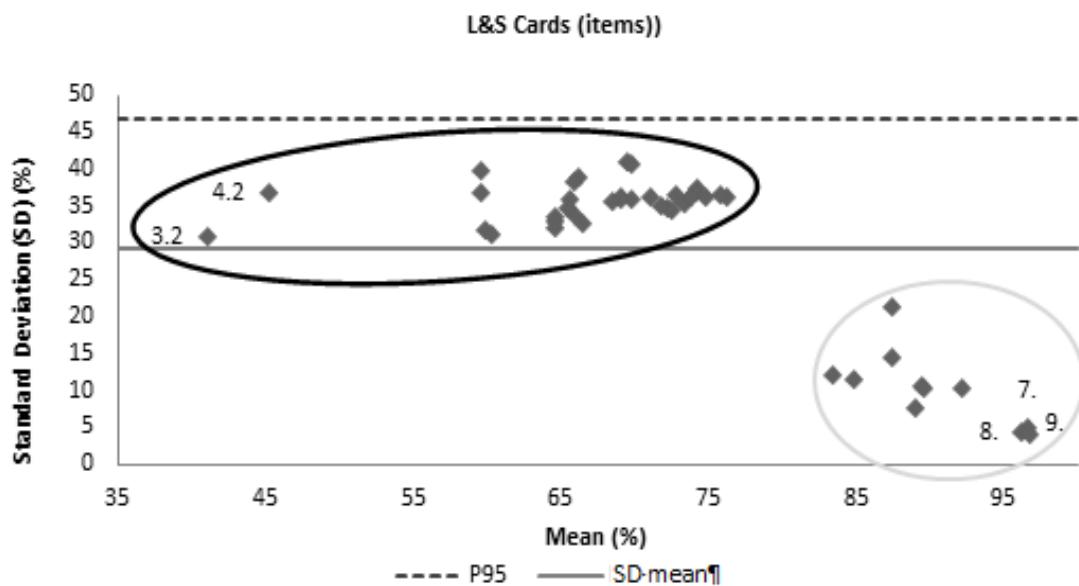


Table I Characteristics of the sample

<i>Child</i>	<i>Gender</i>	<i>Age (months)</i>	<i>PCC</i>	<i>NVIQ (mean=100; SD=15)</i>	<i>Receptive Language Score (mean±SD)</i>	<i>Expressive Language Score (mean±SD)</i>
LA	Male	74	81%	77	63 (64.93±3.32)	WNL
JD	Male	69	84%	77	67 (64.93±3.32)	WNL
AF	Male	77	79%	81	65 (64.93±3.32)	WNL
FC	Male	63	78%	109	63 (64.93±3.32)	WNL
MG	Male	75	76%	78	63 (64.93±3.32)	WNL
MC	Female	66	71%	90	66 (64.93±3.32)	WNL
AM	Female	72	81%	111	64 (64.93±3.32)	WNL

PCC – Percentage of consonants correct; NVIQ – Non-verbal intelligence quotient; SD – Standard deviation; WNL –Within normal limits. The information related to Mean±SD is presented in the Teste de Avaliação de Linguagem na Criança (TALC), a standardised receptive and expressive language test⁴⁶

Table II Pre-Intervention assessment (weeks 1 and 2), intervention process (weeks 3-8) and post-intervention assessment (week 9), goals and detailed explanation.

Week	Goal	Detailed explanation
1 and 2	Pre-intervention assessment	Each child is assessed during weeks 1 and 2 (pre-intervention assessment phase)
3	A+B	Each child is concomitantly exposed to two stimuli (A (therapeutic target) +B (new letter-sound correspondence))
4	A+ B + C	Each child has the opportunity to review the stimuli already introduced (A+B) and also learn a new letter-sound correspondence (in this case, C)
5	A + B + C + D	Each child has the opportunity to review the stimuli already introduced (A+B+C) and also learn a new letter-sound correspondence (in this case, D)
6	A + B + C + D	Each child is focused on reviewing the stimuli he/she had already learned (A+B+C+D)
7	A + B + C + D	Each child is focused on reviewing the stimuli he/she had already learned (A+B+C+D)
8	A + B + C + D	Each child is focused on reviewing the stimuli he/she had already learned (A+B+C+D)
9	Post-intervention assessment	Each child is assessed during week 9 (post-intervention assessment phase)

Table III - Overview of the participant's PACPL scores related to the following skills: LNP; LNI; LSP; LSI.

Child	LNP		LNI		LSP		LSI	
	Pre Score/total	Post Score/total (mean±SD)	Pre Score/total	Post Score/total (mean±SD)	Pre Score/total	Post Score/total (mean±SD)	Pre Score/total	Post Score/total (mean±SD)
LA	0/19	5/19 (8.78±5.05)	5/19	8/19 (14.94±4.49)	0/20	4/20 (3.86±5.31)	6/20	8/20 (12.47±4.2)
JD	1/19	5/19 (7.17±5.06)	5/19	8/19 (13.83±4.71)	0/20	4/20 (2.22±3.25)	4/20	8/20 (10.17±5.48)
AF	1/19	5/19 (8.78±5.05)	4/19	8/19 (14.94±4.49)	0/20	4/20 (3.86±5.31)	4/20	8/20 (12.47±4.2)
FC	0/19	3/19 (3.22±3.44)	0/19	4/19 (4.44±2.0)	0/20	4/20 (0.44±1.21)	0/20	4/20 (6.92±3.33)
MG	1/19	4/19 (8.78±5.05)	3/19	8/19 (14.94±4.49)	0/20	4/20 (3.86±5.31)	2/20	6/20 (12.47±4.2)
MC	0/19	3/19 (7.17±5.06)	0/19	4/19 (13.83±4.71)	0/20	4/20 (2.22±3.25)	0/20	4/20 (10.17±5.48)
AM	19/19	19/19 (8.78±5.05)	19/19	19/19 (14.94±4.49)	0/20	4/20 (3.86±5.31)	11/20	15/20 (12.47±4.2)

LNP – letter name production; LNI – letter name identification; LSP – letter sound production; LSI – letter sound identification; Pre – Pre-intervention; Post – Post-intervention; SD – Standard Deviation. The information related to Mean±SD has been reported by Jesus et al.⁵⁴

Table IV Individual results according to different outcome measures: PCC, phonological process usage and phonetic repertoire.

Child	PCC (%)		Phonological Process usage (%)		Phonetic Repertoire	
	Pre	Post	Pre	Post	Pre	Post
LA	IW – 75% IW – 79%		*GL – 68%	*GL – 26%	All except [l], [z] and [k]	All except [l] _{coda} and [k]
			DEV – 50%	DEV – 33%		
			FCD – 32%	FCD – 25%		
			CR – 31%	CR – 26%		
			WSD – 4%	WSD – 4%		
			PAL – 1%	PAL – 1%		
JD	IW – 71% IW – 76%		*CR – 73%	*CR – 53%	All except [l] _{coda} , [z], [r] and [k]	All except [l] _{coda} , [f] _{coda} and [k]
			FCD – 46%	FCD – 32%		
			PAL – 40%	PAL – 40%		
			GL – 21%	GL – 21%		
			DEV – 17%	DEV – 17%		
			WSD – 14%	WSD – 9%		
AF	IW – 64% IW – 71%		*CR – 74%	*CR – 58%	All except [l], [z], [r], [k] and [n]	All except [l] _{coda} , [f] _{coda} , [z] and [k]
			FCD – 43%	FCD – 43%		
			DEV – 33%	DEV – 33%		
			GL – 32%	GL – 21%		
			PAL – 20%	PAL – 20%		
			WSD – 18%	WSD – 18%		
FC	IW – 77% IW – 79%		*CR – 79%	*CR – 53%	All except [z] _{onset} , [r] and [k]	All except [f] _{coda} and [k]
			DEV – 33%	DEV – 0%		
			FCD – 36%	FCD – 36%		
			GL – 11%	GL – 0%		
			FR – 3%	FR – 0%		
				SUB – 11%		
MG	IW – 66% IW – 67%		*DEV – 83%	*DEV – 66%	All except [l], [z], [r], [k] and [z]	All except [l] _{coda} , [z], [f] and [k]
			CR – 74%	CR – 74%		
			PAL – 70%	PAL – 30%		
			GL – 47%	GL – 47%		
			FCD – 36%	FCD – 36%		
			WSD – 14%	WSD – 14%		
MC	IW – 69% IW – 72%		*DEV – 100%	*DEV – 83%	All except [z], [r], [k], [s] and [z]	All except [z], [r] and [z]
			CR – 89%	CR – 89%		
			FCD – 43%	FCD – 43%		
			PAL – 40%	PAL – 40%		
			GL – 16%	GL – 11%		
AM	IW – 86% IW – 89%		*DEV – 100%	*DEV – 50%	All except [z], [k] and [z]	All except [z] and [k]
			CR – 21%	CR – 11%		
			GL – 16%	GL – 16%		
			FCD – 11%	FCD – 3%		
			WSD – 5%	WSD – 0%		

IW – Isolated word; GL – Gliding; DEV – Devoicing; FCD – Final consonant deletion; CR – Cluster reduction; WSD – Weak syllable deletion; PAL – Palatalization; FR – Fronting; SUB – /l/ and /r/ substitutions; Pre – Pre-intervention; Post – Post-intervention (added to the inventory); * Phonological processes which had been targeted during intervention.