Visual stimuli in intervention approaches for pre-schoolers diagnosed with phonological delay

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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 6-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, that is 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.

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 writing (3). Early literacy experiences of children during preschool years have a positive effect on their understanding of print and metalinguistic skills (4). The relationship between oral expression and print is important to reinforce the ongoing development of literacy skills (5). 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 in 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 abilities (4). 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 Wagner (12) 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 awareness (10) tend to have difficulties acquiring letter-sound correspondences (13). A breakdown in the processing of phonological and letters-sound relationships is the primary cause of reading disabilities (14). 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 6 years of age, children diagnosed as phonologically delayed have inadequate
phonological representations and persistent sound production errors (17). They have six times more probability to experience pre-literacy skills acquisition and phonological awareness difficulties compared to typically developing children (18–20). Research indicates that the phonological awareness skills of children with speech sound disorders are significantly lower than their normally developing peers (15).

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 development (21–23). Evidence-based early intervention programs show the influence of structured approaches based on the above-mentioned visual representations [e.g. Phonic Faces (24) or the Lindamood approach (23)] (25). These programs benefit the acquisition of letter-sound correspondences and speech sound production (21–24,26).

Lindamood and Lindamood (23) developed a multisensory program (visual, kinaesthetic and tactile) that consists of different activities to teach specific sounds, the alphabetic principle and phonemic awareness. The Lindamood approach (23) 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 used (27).

Phonic Faces (24) 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 production (28). Regarding speech sound production, the Phonic cards provide visual information that helps 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 \( \text{< M> tell s us to put our lips together and make the sound [m]} \) (24). Various studies using control groups have shown consistent positive outcomes with Phonic Faces (29). 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 old (30).

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 Davis (31). According to Davis (31), 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 \( < \text{f}>/\text{[f]} \) 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>/[b], \<t>/[t], \<d>/[d], \<n>/[n], \<l>/[l], \<f>/[f], \<v>/[v], \<m>/[m], \<s>/[s], \<z>/[z], \<ch>/[ch], \<j>/[j], \<z>/[z], \<nh>/[nh], \<lh>/[lh]); 12 L&S cards with indirect letter-sound correspondences (\<r>/[r], \<c>/[s], \<g>/[g], \<s>/[z], \<s>/[f], \<z>/[f]). 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).

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).

The development of each photo (see Figure 2) was based on the data provided by an European Portuguese (EP) magnetic resonance study (35). 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-Ferreira (36), Jesus et al. (37), Mateus and Andrade (38) and Vigário et al. (39) were considered.

**Phase 2: Expert panel**

The expert panel of this study consisted of six Portuguese SLTs. The following inclusion criteria were used (40,41): 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 received two questionnaires. The purpose of the first questionnaire was to gather data regarding their profile. The second one was based on a set of specific questions to gather 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 (SD) were calculated afterwards. The authors of the current study also 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 6-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. A quasi-experimental design was used for the current study, that is, 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 variables.

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). 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 skills. 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 (SD = 5.1 months). The participants of the present study were diagnosed with a phonological delay, that is they produced a set of phonological error patterns that are typical of children chronologically younger than them. The following inclusion criteria were considered: Children whose mother tongue was EP; children aged between 60 and 77 months; children whose receptive and expressive language scores on the Teste de Avaliação de Linguagem na Criança (TALC), a standardised receptive and expressive language test, were within the average range based on each age group (−1 and +1 SD). The TALC 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 min. Table 1 shows the average mean and SD according to each age group. According to the information presented in Table 1, all children obtained receptive and expressive language scores within the normal range.

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). 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...
Table 1. Characteristics of the sample.

| Child | Gender | Age (months) | PCC (%) | NVIQ (mean = 100; SD = 15) | Receptive language score (mean ± SD) | Expressive language score (mean ± SD) |
|-------|--------|--------------|---------|---------------------------|-------------------------------------|-------------------------------------|
| LA    | Male   | 74           | 81%     | 77                        | 63 (64.93 ± 3.32) WNL               | 46 (48.89 ± 3.04) WNL               |
| JD    | Male   | 69           | 84%     | 77                        | 67 (64.93 ± 3.32) WNL               | 47 (48.89 ± 3.04) WNL               |
| AF    | Male   | 77           | 79%     | 81                        | 65 (64.93 ± 3.32) WNL               | 48 (48.89 ± 3.04) WNL               |
| FC    | Male   | 63           | 78%     | 109                       | 63 (64.93 ± 3.32) WNL               | 45 (48.89 ± 3.04) WNL               |
| MG    | Male   | 75           | 76%     | 78                        | 63 (64.93 ± 3.32) WNL               | 46 (48.89 ± 3.04) WNL               |
| MC    | Female | 66           | 71%     | 90                        | 66 (64.93 ± 3.32) WNL               | 45 (48.89 ± 3.04) WNL               |
| AM    | Female | 72           | 81%     | 111                       | 64 (64.93 ± 3.32) WNL               | 46 (48.89 ± 3.04) WNL               |

PCC: percentage of consonants correct; NVIQ: non-verbal intelligence quotient; SD: standard deviation; WNL: within normal limits. The raw score (mean ± SD) of the Teste de Avaliação de Línguagem na Criança (TALC), a standardised receptive and expressive language test (47).

with the Wechsler Intelligence Scale for Children (WISC-III) and the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-R) (49) 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 Kwiatkowski (50) was followed in order to collect and analyse each participant’s spontaneous speech sample using three different pictures (26,51). 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% and 85%, as previously proposed by Shriberg et al. (52). Table 1 summarises specific characteristics of the study sample.

Pre-intervention assessment

All study participants had been assessed during the first 2 weeks, that is weeks 1 and 2 (see Table 2) with the following standardised EP assessment instrument1: Teste Fonético-Fonológico-ALPE (TFF-ALPE) (53,54); Prova de Avaliação de Competências de Pré-Literacia (PACPL) (55).

The TFF-ALPE (53,54) 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 PACPL (55) 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 sub-tests: The letter name identification (LNI); the letter name production (LNP); the letter sound production (LSP); the letter sound identification (LSI). A study (56) 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 .982. The inter-rater agreement was 96.2%, whereas and the intra-rater agreement was 95.6%. The values of Cohen’s κ for inter-rater and intra-rater were .92 and .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 < .001) have been shown (55). These results suggest that the PACPL (55) is a valid and reliable standardised instrument to assess pre-literacy skills in Portuguese pre-schoolers.

Intervention procedures

The therapeutic intervention lasted 6 weeks, that is weeks 3–8 (see Table 2), which is a reasonable period of time for short duration programs as shown in previous studies (25,42–44). The therapeutic intervention used a combined letter name and sound condition (12). 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 min...

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1This assessment instrument has been previously used in Portuguese children with speech sound disorders by Lousada, Jesus, Capelas, Maragaça, Simões, Valente, Hall & Joffe (26) and Lousada, Jesus, Hall & Joffe (51).
During each session personalised materials and the targets were presented during 5–10 min to each child (see Appendix II and Appendix III). The same experienced Speech and Language Therapist (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 2 summarises the above-mentioned information related to pre-intervention, intervention process and post-intervention. Table 2 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 2).

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 usage (58).
- **Stimulability** (stimulable sounds were a priority for therapy), which is important for increasing children’s motivation (59).

The authors developed a set of lists which were comprised of treatment EP words and these were used throughout the intervention. Test words from TFF-ALPE (60) 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, that is TFF-ALPE (60) and PACPL (55). Data collected pre- and post-intervention were compared.

**Outcome measures**

The following outcome measures were used: PCC (50); phonological process usage (26); phonetic repertoire (26); 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 (37, pp. 4–5) for more than two measurements. The graphs plot the mean of the measurements against their 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 SD. The mean was then calculated and the results were represented in graphs which are similar to the ones originally suggested by Bland and Altman (65). Like in the original Bland–Altman (65) 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 Altman (65) 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) (37). Therefore, in the modified Bland Altman graph (37) 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. 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 were between the limits of agreement. Overall, the graph shows a good pattern of inter-evaluator agreement. The dashed-line ellipsis 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 solid-line ellipsis 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 individual items’ scores were low (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 are not considered in Figure 3. The dashed-line ellipsis 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 solid-line ellipsis 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 3 suggest that all children improved specific skills targeted during the therapeutic intervention (e.g. pre-literacy and phonological skills).

Regarding pre-literacy skills, all children showed low knowledge in LNP skills pre-intervention when compared to standardised data provided by Jesus et al. (55) (see Table 3) and to post-intervention assessment (see Table 3). 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 3). 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, that is 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 6-week period.

The natural maturation over 6 weeks was estimated based on the data (56) 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 study (56). 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: \( p = .016 \); LNI: \( p = .016 \); LSP: \( p = .008 \); LSI: \( p = .008 \)). 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 4 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-ALPE (60). 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 4).

Regarding PCC, the results revealed significant differences between pre- and post-intervention at a significance level of 5% (\( p = .008 \)). 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% (\( p = .008 \)). All children, except MC, added a new sound (intervention target), which means an expansion of the phonetic inventory.

### Discussion

This paper reports the systematic content validation 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 studies (31–33). There is wide agreement that the method proposed by Davis (31) is one of most recognised methodological approaches to help researchers draw conclusions about an instrument quality. According to Beck and Gable (66), 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 (31,67). 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 which has been considered to be extremely relevant in various previous studies (68,69).

Each L&S card was assessed in terms of image clarity and practical pertinence. Regarding inter-evaluator agreement,
the values between 85% and 95% were considered acceptable and therefore no changes had to be 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 Gable (66).

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. Roth et al. (42), Laing and Espelund (25) and Berntsson and Palle (44) 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. (42) 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 girls (64). All children had normal language development and therefore the same likelihood to similarly develop pre-literacy skills (70).
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). Participant AM revealed the best performance in letter name knowledge, when compared to the other participants. Piasta and Wagner (12) 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 sounds (71). Participant 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 (8,72,73).

The therapeutic intervention, that is a combined letter name and sound condition approach, was carried out over 6 weeks. This intervention period is comparable to some previous studies (25,42–44). 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 read (24). 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 (12,25,42). Hoffman and Norris (21) 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 (74,75). When given cues, children seem to be more likely to learn the letter sounds (71). 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 sound (12). 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 Mann (10) showed that these children need to be taught different letter sounds because it might influence further development of phonological awareness. Ball and Blachman (76) 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 acquisition (3). 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. (42) 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-Chang (77), Treiman and Kessler (73), Foy and Mann (10) and Randolph (78). As mentioned in the present study, the CV (<l>, <r>, <s>) and VC (<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 letters (34). 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) (79). 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 the clinical and natural contexts, 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 Norris (24). 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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