Phonological Awareness Training on Recoding of At-Risk German Kindergarten Children With and Without Behavioral Difficulties

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Abstract

The number of students who are deficient in literacy is increasing worldwide, possibly exacerbated by concurrent behavioral difficulties. This international challenge leads to the question of how and when to support children. Support should start in kindergarten and be focused on the acquisition of phonological awareness. Based on this premise, we evaluated a German phonological awareness intervention with motivational reinforcers to help ensure an easier transition to school for at-risk kindergarteners with and without behavioral difficulties through improved recoding. A single-case study ($N = 7$) took place over a period of 10 weeks with three weekly intervention sessions. Results showed that all children improved in recoding with significant moderate to large effects and slope effects. Based on these findings, limitations and implications are discussed.

Keywords: Literacy, phonological awareness intervention, German kindergarten children, behavioral difficulties

Introduction

Literacy Development and the Role of Phonological Awareness

Statistics are increasingly showing a wide gap in reading development among students in elementary school, not only in Germany (Stanat et al., 2017) but also worldwide (Dyslexia Action, 2017). This growing difference between stronger readers and their less proficient peers (Bundesministerium für Bildung und Forschung, 2017) makes it difficult for teachers to provide adequate literacy support to individual students. As a result, the ability to spell correctly also decreases and students find it increasingly difficult to learn reading and spelling (Stanat et al., 2017). However, these difficulties can be detected early on; namely, by looking at students' phonological awareness (PA) (Wagner & Torgesen, 1987). Indeed, PA is a major influential factor regarding literacy (Landerl et al., 2013) because to be successful in literacy, the brain needs to make a connection between the visual appearance of a letter and its sound.

Most languages fall into two groups, those that have a transparent orthography and those that have a more opaque orthography. The German language, the language of the students in the current study, falls into the former category, meaning there is a consistent mapping from a grapheme to a phoneme (Milankov et al., 2021), which is acquired easier, giving these students an advantage compared to learners of opaque languages (e.g., English). Nevertheless, Milankov et al. (2021) found that students with reading difficulties scored lower in PA than their typically developing peers even in transparent languages. Further, Allor et al. (2006) noted that children who have difficulties with PA do benefit to the same degree from reading instruction as their peers with higher proficiency. Thus, the importance of PA in literacy acquisition is undisputed (Pérez-Pereira, 2020).

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According to Gillon (2018), PA represents the ability to break words into smaller units at three different levels: syllables, onset-rhyme level, and phonemic awareness, the latter being the focus in the present study. To solve task formats at this level, readers must understand that words are composed of phonemes (Gillon, 2018). Indeed, two subcomponents of phonological awareness – phonemic awareness (the recognition that words are composed of individual sounds) and letter-sound knowledge (phonics) – are the strongest predictors of children's literacy performance during the first two years of school (Carson et al., 2019). Thus, phonemic awareness and letter-sound knowledge provide children with the foundational skills to be able to apply an alphabetic decoding strategy when interpreting written words. Together, these abilities then act as a gateway to developing reading fluency and, ultimately, enable children to utilize their spoken language skills to comprehend written texts (Melby-Lervåg et al., 2012; Ukrainetz et al., 2011).

Carson et al. (2019) emphasized the importance of fostering both components during the early years. Moreover, they noted that much of the existing research has focused only on broader levels of phonological awareness, such as syllable awareness, and, therefore, call for increased attention to more narrowly defined phonological awareness (e.g., concentration on sounds) already in preschool settings. For example, these skills can be incorporated in models of reading and writing such as the dual-route cascaded model (DRM; Coltheart et al., 2001). According to the DRC model of reading, there are two primary pathways for word recognition: the lexical route and the non-lexical route.

The lexical route allows for direct recognition of familiar words by accessing stored representations in the mental lexicon. This pathway is typically used when encountering words that the reader already knows and can recognize as whole units, without needing to sound them out. The non-lexical (or sublexical) route, by contrast, involves decoding unfamiliar words by converting graphemes into corresponding phonemes. This process requires phonological recoding and relies heavily on phoneme analysis skills, which are a key aspect of phonological awareness. Inferentially, the non-lexical access draws on phoneme analysis skills.

The spelling model by Simon and Simon (1973) briefly outlines a process in which spoken words are internally analyzed into phonemes that are then converted into written form via phoneme-to-grapheme correspondences, generated by a central "spelling generator" (Simon & Simon, 1973, p. 118). If one recognizes the letter sequence for the word, this leads to a successful "match." In short, PA is part of phonological recoding, which is relevant for the reading and writing process.

Behavioral Difficulties and Literacy Acquisition

Many children with emotional and social challenges perform poorly in reading and writing (Hurry et al., 2018; Murray et al., 2020). For example, Hurry et al. (2018) found that problem behavior exacerbates reading and writing difficulties, concluding that these students need more individual attention and support in order to thrive. Since an increase in all behavioral domains is mostly observed in children with reading and writing difficulties after entry into school, a comorbidity between reading and writing performance and behavioral difficulties may be an explanatory factor (Horbach et al., 2020). Also, a relationship has been found between problem behavior and language hurdles (Chow & Wehby, 2018) in that poorer language abilities are seen as a risk factor for developing problem behavior (Petersen & LeBeau, 2021).

How to Foster Phonological Awareness

Early development of the components of literacy is critical as the early years are said to constitute a significant foundation for literacy development (Greenwood et al., 2011). Indeed, according to Kuespert and Schneider (2018), PA should be promoted even before children start school. Further, Bradley and Bryant (1983) found that promotion of PA is most successful when PA is trained together with alphabetic letters before the first school lesson. For example, Carson et al. (2019) conducted a PA training program, focusing on sound segmentation, with preschool children aged 4 years old. The experimental group outperformed the control group across all PA measures. Additionally, they showed superior ability in applying their skills to non-word tasks. These findings further underscore the importance of implementing targeted PA training on a lower level (concentration on sounds) in preschool settings. Similarly, a meta-analysis by Rice et al. (2022) highlighted the effectiveness of early PA instruction for preschool children.

With particular relevance to the current study, Pfost et al. (2019) found that German preschool children directly benefitted from interventions in

PA and letter knowledge with strong short-term effects. Brandenburg et al. (2017) also recommended implementation of interventions with a focus on phonological processing. Milankov et al. (2021) found that a major problem in transparent languages, such as German, was sound omissions when the focus was on reading accuracy, in turn leading to fluency problems. They also concluded that students with enhanced phonological skills score better in reading fluency and reading comprehension.

The German program Listen & Learn (German: Hören, Lauschen, Lernen; HLL; Kuespert & Schneider, 2018) is aimed at developing PA in preschool children to treat reading and spelling difficulties preventively. Hoese et al. (2016) evaluated the program with a training and a control group consisting of low-performing preschool children at risk for developing dyslexia. The training group was supported for 11 weeks on 3 days a week with Listen & Learn, similar to the present study; findings showed that the children benefitted from the program with a medium effect size. Another study by Moraske et al. (2018) evaluated the Listen & Learn program, which targets children at risk for reading and spelling difficulties by enhancing their phonological awareness and letter-sound knowledge prior to school entry. The findings indicated that children who participated in the program showed significant improvements in reading and spelling skills throughout first and second grade, compared to at-risk peers who did not receive the intervention. Moreover, the program contributed to a reduction in the number of children diagnosed with LRS up to second grade, with indications of sustained benefits extending into third grade.

How to Boost Motivation

Difficulties in learning can lead to a loss of motivation, which therefore needs to be considered when planning interventions. Among available motivational concepts, self-graphing (e.g., Stotz et al., 2008) has proven successful. That is, students monitor their learning progress in a diagram and visually compare and track their current vs. past learning status (Morrison et al., 2020). Stotz et al. (2008) demonstrated that self-graphing led to an increase in learning and positive behaviors. Similarly, Gunter et al. (2003) showed that self-graphing can have a beneficial effect on learners' motivation and academic performance. Finally, Briesch and Chafouleas (2009) noted that self-graphing is particularly effective when combined with other motivational techniques such as positive reinforcement (e.g., getting rewards). In short, a reinforcer system can positively influence social behavior and learning gains (Rohrbeck et al., 2003).

Purpose of the Present Study

Given the increasing number of students experiencing significant difficulties in literacy, the growing heterogeneity among learners, existing evidence on effective literacy promotion, and the importance of phonological awareness in a narrow sense (e.g., sound segmentation), we combined a shortened German phonological awareness training program called "HLL" with motivational boosters focusing on segmentation of sounds and whole words. The study targeted German kindergarten children who were at risk for literacy difficulties.

The research questions were as follows:

1. To what extent does phonological awareness training influence the segmentation of individual sounds in German kindergarten children?
2. To what extent does phonological awareness training affect the segmentation of whole words in German kindergarten children?
3. How do German kindergarten children perceive the intervention (phonological awareness training) with regard to its social validity?

Materials and Methods

Participants and Setting

The study was conducted in a German kindergarten in a suburban area. Prior to the study, consent forms were sent to the children's parents or legal guardians and their names were changed for data protection reasons. Nine preschool children aged 5-6 years old formed the sample based on the results of phonological awareness screenings. Two children were not included in the data due to missing data, resulting in seven participants (see Table 1).

Pretesting

To participate in the study, the children had to take a German phonological awareness assessment called Basic Competencies for Reading and Spelling Performance (BAKO 1-4; Stock et al., 2017) and a researcher-developed Grapheme-Phoneme

Correspondence Test (GPC-T). Further, an adapted version of the Integrated Teacher Report Form German (A-ITRF-G; Volpe et al., 2018) was implemented to measure problem behavior. The participants' results did not exceed five raw score points on the BAKO 1-4.

Basic Competencies for Reading and Spelling Performance (BAKO 1-4)

To assess PA, the BAKO 1-4 was administered, consisting of seven subtests: Pseudoword Segmentation, Vowel Substitution, Residual Word Determination, Phoneme Interchange, Sound Categorization, Vowel Length Determination, and Word Reversal (Stock et al., 2017). The raw scores are assigned percentile ranks (PR), with the normal range starting at a percentile rank of 29, which corresponds to 19 raw scores. Reliability is described by the reliability coefficients Cronbach's alpha and Spearman-Browns bisection coefficient, reaching .94 and .92 with respect to the first class. Validation is described in terms of criterion-related validity, among others, which demonstrates correlations between scores on the BAKO 1-4 and scores on the reading and spelling tests, averaging $r = .44$ to $r = .60$ (Stock et al., 2017). The children were assessed individually.

Grapheme-Phoneme Correspondence Test (GPC-T)

To determine whether the children had already acquired an understanding of grapheme-phoneme correspondence, the alphabet was shown to the children, and they were asked to name the corresponding sounds (with no time limit). For this purpose, a PowerPoint Presentation was designed showing all letters of the German alphabet. One letter was written on each slide and the letters were not shown in the usual ABC order, but randomly. There were a total of 26 letters and corresponding sounds. The children were assessed individually.

Adapted Integrated Teacher Report Form German (A-ITRF-G)

In addition, the ITRF-G short form (Volpe et al., 2018) was used, but adapted to the kindergarten setting. That is, the items related to typical school aspects such as homework or lessons were rewritten to include tasks such as painting, handicrafts, or group activities. The division into eight items for learning-related and eight items for disruptive behavior was retained. The items on learning-related behavior had to be adapted to kindergarten setting. Nevertheless, the core areas of independence, participation, and task accomplishment were taken into account.

Design

A multiple-baseline design across participants was employed in order to investigate how changes in an independent variable affect a dependent variable (Vannest & Ninci, 2014). The baseline and intervention sessions were distributed over 10 weeks with 3 days per week lasting 20 minutes each. The children were randomly and equally assigned to one of three groups with different baseline and intervention lengths (Kratochwill et al., 2013). Group 1 had five baseline sessions and 25 intervention sessions. Group 2 received six baseline sessions and 24 intervention sessions. Group 3 had seven baseline sessions and 23 intervention sessions. Even though students dropped out of data, which resulted in only one participant for Group 3, two tiers are sufficient

Table 1
Participant Characteristics

Participants	Gender	Age	First Language	ITRF (OD)	ITRF (APD)	GPK	BAKO (RS/PR)
Lara	female	5;7	German	2	10	0(26)	0(<1)
Marline	female	5;11	German	3	12	3(26)	1(<1)
Felix	male	6;2	German	3	3	0(26)	0(<1)
Hajani	female	5;11	Dari	0	4	1(26)	0(<1)
Lukas	male	6;2	German	24	3	21(26)	2(<1)
Emma	female	5;10	German	0	1	3(26)	0(<1)
Tim	male	5;11	German	2	10	1(26)	1(<1)

Note. BAKO = screening for phonological awareness; ITRF = Integrated Teacher Report Form: cutoff OD (disruptive behavior) = 5, APD (academically engaged behavior) = 10; GPC-T = Grapheme Phoneme Correspondence Test: 26 sounds to name in total; RS = raw score; PR = percentile.

Table 2
Example Monosyllabic, Bisyllabic, and Trisyllabic Words

Reis *(rice)*	Pilz *(mushroom)*	*Obst (fruits)*	*Wann (when)*	Gans *(goose)*
Dose *(can)*	Insel *(island)*	Juni *(June)*	Ufer *(shore)*	planen *(to plan)*
Bikini *(bikini)*	Donnerstag *(Thursday)*	Fantasie *(fantasy)*	Januar *(January)*	Gemüse *(vegetables)*

to estimate effects (Lanovaz & Turgeon, 2020). A master's level student in special needs education served as test leader and interventionist. She was trained intensively beforehand in administering assessment and implementing the intervention.

Dependent Variables and Data Collection

Referring to Gillon (2018), PA can be measured, amongst others, through phoneme segmentation (Gillon, 2018; e.g., for German: "H-e-l-d," or for English: "h-e-r-o"), where the word must be segmented into all phonemes. The assessment was specially developed to collect phonetic analysis in two ways: Dependent Variable 1 represented the segmentation of a given word into its individual sounds ("sounds"), which was scored per correctly uttered sound. Dependent Variable 2 represented the segmentation of whole words into all sounds ("words"), which was scored per correctly word sounded out. According to Klicpera et al. (2017), phoneme segmentation or sound isolation can be used to measure PA in a narrower sense, which represents the concept of sound analysis in this study.

In both task formats, a word was given for which the sounds had to be named. Data were collected individually from each participant after each baseline session and after each intervention session. To avoid bias, two raters rated the dependent variables, resulting in 100% interrater agreement. The word lists per measurement were taken from a pool of 300 words, with one third each consisting of mono-, bi-, or trisyllabic words (see Table 2). The words were chosen from a German basic vocabulary list (https://www.gut1.de/grundwortschatz/grundwortschatz-500/). From this pool of words, 10 mono-, bi-, and trisyllabic words were randomly assessed. Distributed over 30 assessments, the words did not appear more than once. Further, we ensured that the letters of the German alphabet were equally present in the words. The words were individually shown on a PowerPoint slide. In addition, the time frame per child was set at approximately 10 minutes, which was not to be exceeded.

Procedures

Baseline

In the baseline phase, the children were supervised for the same length of time as in the intervention sessions, and the two dependent variables were measured. Mainly handicrafts and coloring were done as activity prior assessment to counteract a possible Hawthorne Effect (Chiesa & Hobbs, 2008). It was important that the children were not already trained in PA during baseline to catch the current state of the two dependent variables directly after a baseline session.

Intervention Material

For the intervention, the material was taken from the program Listen & Learn (Kuespert & Schneider, 2018). An integral part of the intervention was picture cards, which included everyday representations of shorter and longer words. Also, real everyday objects were used (e.g., taking things out of a box and segmenting them into syllables). In addition, sometimes the use of a ball is indicated, mainly intended to coordinate whose turn it is to solve the task. (It must be noted that the study represented an abbreviated intervention of Listen & Learn.) Which blocks were considered to what extent with which exercises is shown in Table 2. For the most part, the material was verbal, so that words were listed, and explanations were given about which operation the children were to perform. Additionally, a self-graphing sheet was designed.

The children were given a self-graphing sheet for self-graphing showing the sessions on the x axis and the points to be reached on the y axis. On the left-hand side was a race car and on the right-hand side a flag. In between there were >50 boxes (for segmenting the sounds) or 10 boxes (for segmenting whole words). Each new row represented a new session and measurement of the dependent variable (see Figure 1 for an example).

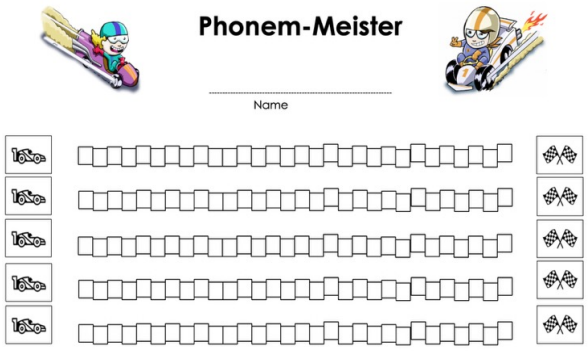

Figure 1
Example of a Self-Graphing Sheet

Note. May be easily adapted to any goal.

Intervention

After the baseline phase, the actual intervention began. Which group was to start was decided randomly. Based on our knowledge about the importance of PA in a narrower sense, we put a heavier emphasis on initial sounds and phonemes and less emphasis on rhymes, for example (see Table 3; Carson et al., 2019). The intervention began with one of the three prepared games from the Listen & Learn program.

As part of the audio games, the interventionist whispered a phrase into the ear of the first child, who then passed it to the next student, and so on, until it was finally recited aloud by the last child in line. For the units with rhymes, the interventionist gave a sentence beginning, to which the child had to add a rhyming word. Both rhyming words were repeated by all the children. For the units on sentences and words, the interventionist introduced a sentence and assigned a word to each child, who had to stand up while naming the word. For the syllable units, the interventionist threw a ball to a child. The selected child broke their first name into syllables and chose another child to throw the ball to. For the units on sounds, the interventionist started with a sound (e.g., [s]) and told the children to guess what word she was thinking of. If the children named a word with the correct initial sound, but it was not the word to be guessed, the interventionist praised the child and encouraged them to continue guessing. After successful guessing, the interventionist deliberately pronounced the initial sound in a stretched-out manner. For the phoneme units, the interventionist placed 10 pictures with representations of short words in front of the children. One child might choose a picture and said it out loud (e.g., [O] [m] [a]). The rest of the group was asked to guess the word (e.g., grandma – German: Oma = Engl.: Grandma). Motivational components were additionally implemented.

In each assessment situation, children received feedback on the number of segmented sounds and whole words they had answered correctly. In addition, progress was visually represented in a graph for each child ("self-graphing"). Along with receiving verbal feedback, each child was individually shown their progress. After each assessment, the children recorded the number of correctly segmented sounds and words on their self-graphing sheet (Figure 1) to enhance motivation. As positive reinforcement, the children received a sticker for each correctly segmented word, which could be exchanged for rewards at the end.

Treatment Fidelity

The goal of treatment fidelity is to show that conclusions are valid based on the effects of the intervention (Sanetti et al., 2021). Behind the term treatment fidelity is a multidimensional concept composed of four dimensions: Adherence, Dosage, Exposure, and Quality. *Adherence* refers to the extent to which intervention steps are implemented as planned (e.g., Were the specific instructions and

Table 3
Overview of Shortened Program Plan From Listen & Learn (Kuespert & Schneider, 2018)

Session	Original Program (18 weeks)	% Distribution	Study Intervention (9 weeks)
Audio games	1 week	1/18 = 5.6%	0.5 week
Rhymes	1 week	1/18 = 5.6 %	0.5 week
Sentences/words	2 weeks	2/18 = 11.1%	1 week
Syllables	2 weeks	2/18 = 11.1%	1 week
Initial sounds	3 weeks	3/18 = 16.7%	1.5 weeks
Phonemes	9 weeks	9/18 = 50%	4.5 weeks

materials used exactly as prescribed?). Meanwhile, *dosage* refers to the intervention frequency (e.g., How many training sessions were actually completed?) and duration whereas *exposure* is defined as the frequency and duration that the subjects actually receive (e.g., How much time did the child actively spend on phonological awareness tasks during each session?). Finally, *quality* addresses how well the intervention steps are implemented (e.g., How clearly and effectively were the instructions delivered by the trainer?). According to the treatment above fidelity sheets, all three groups were carried out exactly as planned. Inter-observer agreement was calculated according to Wolery et al. (2011), showing 100% agreement.

Social Validity

Social validity is important in intervention research as a means of assessing the usefulness and acceptance of an intervention (Briesch et al., 2013). To assess social validity, we designed a questionnaire to be completed by the participants at the end of the study. To elicit children's attitudes toward participation, responses to items such as "I liked coming to the intervention." were elicited using a five-point rating scale ranging from *not at all true* to *fully true*. The children were assessed with the educators' help without the presence of the interventionist to avoid bias; the questionnaire items were read out loud to the children to avoid any bias related to reading ability.

Data Analysis

To analyze the data, the statistics program "R" was used. First, visual inspection was conducted followed by descriptive statistics and overlap indices. As overlap indices, the Non-Overlap of All Pairs (NAP; Parker, Vannest, & Davis, 2011), Percentage of All Non-Overlapping Data (PAND; Parker et al., 2007), and Tau-U with possible baseline trend correction were used (A vs. B + $Trend_B$ – $Trend_A$; Parker, Vannest et al., 2011).

A regression analysis was also implemented according to Tate et al.'s (2016) recommendation that inferential statistics be considered when testing for effects in single-case research. All baseline data points of one individual form a regression line to estimate participants' progress during intervention. Hierarchical piecewise regression modeling has become the most common way for investigating the null hypothesis (see Manolov et al., 2010). Changes in level and/or slope across phases can then be tested for statistical significance. Analysis on Level 2 (across all participants) was used to examine causal elements behind treatment effectiveness.

Results

Single Sounds

Starting with the first dependent variable, single sounds, a steady increase from Phase A (baseline) to Phase B (intervention) was found for all participants (see Figure 2). Tim clearly already knew some sounds in Phase A. Felix and Hajani needed more time before an increase became visible. Overall, there were no obvious baseline trends. With regard to descriptive statistics (see Table 4), all but Emma reached the maximum possible value at the end of the intervention (52.00). However, she was close to the maximum. As reflected in the graphs, all participants reached mastery at the last intervention session and a functional relationship was found between the dependent and the number of correct single sounds.

Table 4
Descriptive Statistics for Single Sounds

Participants	N(A)	N(B)	*M*(A) *SD*	*M*(B) *SD*	Max A	Max B
Lara	5	25	4.40(1.67)	24.77(17.08)	7.00	52.00
Marline	5	25	3.60(1.14)	24.67(14.36)	5.00	52.00
Felix	5	25	4.40(2.41)	25.83(15.18)	7.00	52.00
Hajani	6	24	6.20(1.64)	25.87(14.94)	8.00	52.00
Lukas	6	24	15.00(2.12)	29.69(11.85)	17.00	52.00
Emma	6	24	6.00(2.28)	23.14(13.64)	8.00	50.00
Tim	7	23	22.29(6.58)	34.14(9.54)	27.00	52.00

Note. N = measurement; A = baseline; B = intervention; *SD* = standard deviation; *M* = mean; Max = maximum.

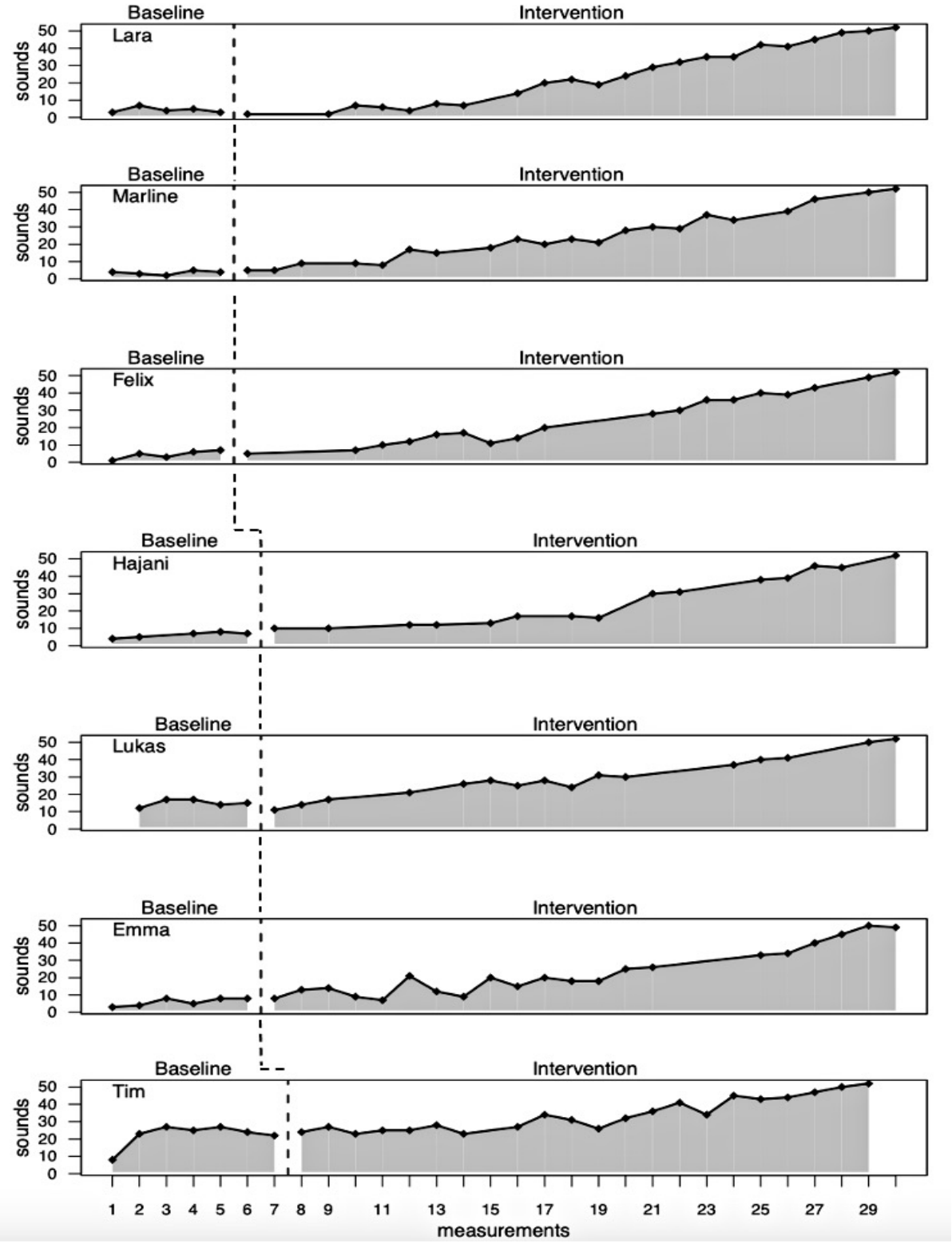

Figure 2
Number of Correct Sounds

Regarding the NAP, medium effects were found for Tim (85.00, p<.01), Lara (87.00, p<.01), and Lukas (88.00, p<.01). Strong effects were found for Emma (97.00, p<.001), Felix (97.00, p<.001), Marline (99.00, p<.001), and Hajana (100.00, p<.001). PAND values revealed medium achievements for Tim (78.57), Lukas (80.95), Lara (81.48), and Emma (85.19). A highly effective treatment was found for Felix (91.30), Marline (94.23), and Hajani (100.00). Finally, regarding Tau-U, moderate changes were found for Hajani (0.37, p<.01), Lukas (0.38, p<.01), and Felix (0.53, p<.001). Large changes were found for Emma (0.61, p<.001), Tim (0.66, p<.001), Marline (0.67, p<.001), and Lara (0.68, p<.001).

Considering the results of the regression analysis across all groups, a significant negative level effect (p<.001) and significant slope effect (p<.01) were found. All participants improved in sounds with an average increase of 1.070 per intervention session.

Whole Words

For the second dependent variable, whole words, as illustrated in Figure 3, all baselines were quite flat with the exception of Lukas' and Tim's where some fluctuation could be observed. All participants got better beginning from Session 12, whereafter an immense increase was seen in all children up to the maximum value in the last session. Even though some children missed sessions, they still reached the maximum value. Regarding the descriptive statistics (see Table 5), five participants had a mean of zero in Phase A, followed by 0.40 (Lukas) and 0.86 (Tim). Tim showed the highest mean score in Phase B (4.42) and Emma the least (2.33). Nevertheless, all children reached the maximum (10) at the end of the intervention.

The NAP showed overall significant medium effects (79.00-88.00; p<.05-p<.001). PAND values also revealed medium effects (71.43-78.85). Finally, Tau-U results showed moderate changes in Lukas (0.29, p<.05), Hajani (0.30, p<.01), Felix (0.41, p<.01), Emma (0.47, p<.01), and Marline (0.54, p<.01). Large improvements were found for Lara (0.61, p<.001) and Tim (0.65, p<.001). Regression analysis on Level 2 revealed a negative level effect (p<.001) and a positive slope effect (p<.05) with an average increase of recoded whole words of 0.237 per intervention session.

Social Validity

The social validity questionnaire showed that all children fully agreed that the intervention helped them recode words and was fun. Interesting, however, not all children expressed an interest in participating again. This may be due to the fact that the students in their class who did not participate in the intervention were playing outside at the same time, as reflected in the selection of the item "I rather liked to play instead of learning sounds." Moreover, the children had different opinions about the difficulty of the intervention and sometimes reported that they were under pressure while working on the various tasks.

Discussion

Main Findings

The purpose of this study was to teach at-risk kindergarten children to recode individual sounds and whole words to determine if this preventive intervention would lay important milestones for acquisition of reading and writing. More precisely, the intervention focused on segmenting words into sounds, a skill that is significant in first grade and of immense overall importance for literacy mastery (Brandenburg et al., 2017; Milankov et al., 2021).

Table 5
Descriptive Statistics for Whole Words

Participants	N(A)	N(B)	*M*(A) *SD*	*M*(B) *SD*	Max A	Max B
Lara	5	25	0.00(0.00)	3.27(3.69)	0.00	10.00
Marline	5	25	0.00(0.00)	2.67(2.32)	0.00	10.00
Felix	5	25	0.00(0.00)	3.39(3.62)	0.00	10.00
Hajani	6	24	0.00(0.00)	3.27(3.75)	0.00	10.00
Lukas	6	24	0.40(0.55)	3.31(3.34)	1.00	10.00
Emma	6	24	0.00(0.00)	2.33(3.14)	0.00	10.00
Tim	7	23	0.86(0.90)	4.42(3.33)	2.00	10.00

Note. N = measurement; A = baseline; B = intervention; *SD* = standard deviation; *M* = mean; Max = maximum.

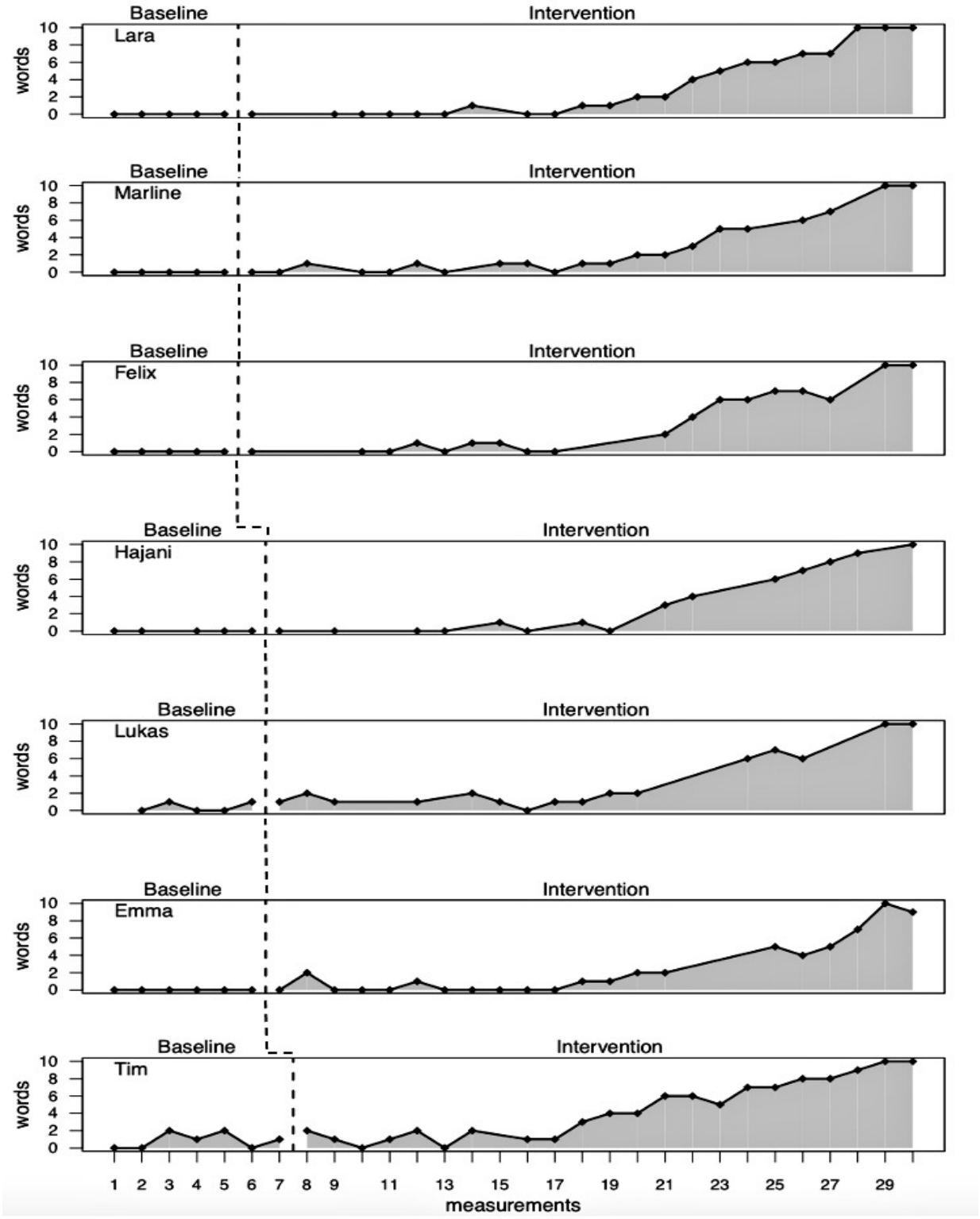

Figure 3
Number of Whole Words

Single Sounds

With regard to the first dependent variable, single sounds, all children benefitted from the intervention, even if it took a few sessions for increases to occur. A level effect could not be determined across the board, but a gradual increase after the first sessions was seen in all children. All participants also achieved a very high score of 50-52 for correctly recoded sounds at the end of the intervention. The greatest increase was seen in Marline. Moderate to large effects were observed across all children, including Tau-U values, which considered possible Phase A trends. All results can be viewed as significant. Lukas and Tim demonstrated a steady slope from A to B whereas Hajani and Lara seemed to need more time for effects to become apparent compared to the others. Hajani had learned German as a second language and came from a different alphabetic orthography (Dari), which may explain her rather slower increase (e.g., Jeuk, 2018). As for Lara, she was the youngest child in the group and was rated as having some issues with learning-related behavior, which also might have had an effect (e.g., Garwood et al., 2017). Lukas performed the best on the pretest, and continued to perform on a higher-level during the intervention. However, Tim, on the other hand, had very low scores in pretesting, which made his good performance in baseline and intervention somewhat surprising. Also, Lukas rated high on problem behavior and Tim on learning-related behavior, but this did not seem to have had any impact on the effectiveness of the intervention, including Marline, who performed really well but also showed difficulties in learning-related behavior.

Looking at the social validity questionnaire, Marline rated the intervention as overall very positive. However, all the children would rather have played outside than learning sounds – a response that was both to be expected and understandable. However, even if the children would have preferred to play, the intervention still had its effect, which is a very positive sign. Interesting, it was precisely Tim and Lukas who did not like learning together with a group. Likewise, Lukas found the words too difficult. Hajani and Lara found it very difficult to concentrate, which could be an explanation for why they needed more time to internalize the sounds. Also, Lukas' improvement could be explained to a certain extent by his prior knowledge. The regression analysis, which found no overall baseline trends (p = .65), revealed a negative significant level effect, meaning that with beginning of the intervention the performance in all children went down. However, a significant slope effect could be reported.

Whole Words

Regarding the second dependent variable, whole words, all children required a couple of sessions to start recoding whole words correctly. From about Session 17 on, all children started recoding whole words correctly. They needed some time to internalize all the phonemes before being able to sound out whole words correctly, which was to be expected. At the end, all children could recode all shown 10 words correctly. That is, overall, there was not a real difference between the children regarding their word performance. All benefitted equally. In conclusion, the medium effects can be explained by the number of sessions all children needed to show some improvement. Nevertheless, and most important, all children were able to recode single sounds and all shown whole words at the end of the intervention phase. From the phoneme building block onward, which took place after some weeks of intervention (see Table 3) effects can be observed across all children. In the sixth module, phonetic analysis operations were trained, so it is not surprising that the effects increased with the addition of this module.

General Findings

The children with behavioral difficulties, despite not being the primary target of the intervention, appeared to have benefitted comparably from the training. That is, problem behavior did not seem to have played a leading role in the children's response to intervention even though problem behavior can have a negative effect on academic achievement (Roberts et al., 2020). This is a noteworthy finding, particularly in light of the growing prevalence and educational impact of behavioral difficulties in early childhood education, often leading to risk of academic underachievement (e.g., Murray et al., 2020) along with rising challenges to teachers to provide adequate support (Carter et al., 2010).

These findings are in line with Bradley and Bryant (1983), who concluded that a phonological awareness training with a focus on letters is most effective. Our results are also supported by Pfost et al. (2019), who found that phonological awareness training with letter knowledge was effective for German kindergarten children, reporting strong short-term effects. Further, Hoese et al. (2016), who evaluated the Listen & Learn program over 11 weeks, reported medium effect sizes, and Moraske et al. (2018) indicated that children who participated in the program showed significant improvements in reading and spelling skills throughout first and second grade.

Through single-case research, it is possible to make claims about causal relationships. However, a causal relationship between the independent and dependent variable can only be considered generalizable if the findings are confirmed by a larger sample design (Morrison, 2021). Nevertheless based on the results of the present study, it can be stated that for all children variation in the independent variable improved outcomes in the dependent variable. Thus, causal inferences to be made in terms of individual experimental research can be assumed for this group. However, no clear level changes were detectable by the onset of the intervention for all children, so the development must be regarded as rather continuous and reinforced by the building block of phonemes.

Social Validity

Social validity revealed an overall positive attitude towards the intervention. All participants thought that the intervention helped them to recode single sounds and that they have learned a lot. Only Hajani did not think he had learned much. She was also the one who struggled the most, which could be partly explained by her language background and her limited experience with the German language. The children, moreover, stated that it was difficult to stay concentrated, which is consistent with their rating that they would prefer playing outdoors instead of learning sounds. (The participants were taken out of their kindergarten groups and sometimes their friends were playing outside while they were sitting inside learning German sounds.)

Limitations

Despite the encouraging positive effects of the intervention, some limitations of the study warrant mentioning. First, it is not clear whether the effects of the intervention have an impact on the acquisition of overall literacy, as stated by Pfost et al. (2019). However, it can be assumed that the children will find it easier to start acquiring literacy in first grade (Saksida et al., 2016). Since the focus was on at-risk children, it appears that the support reduced the gap between the differences in the children's starting performance.

Finally, to some degree, the effects could theoretically also be attributed to threats to internal validity (e.g., Ledfort & Gast, 2018), but this possibility can be ruled out as shown in the following. Due to the time-delayed start of the intervention phases, the influence of intervening events/history such as maturation and insufficient separation between baseline and intervention can be excluded. In addition, the assessment instrument did not change over time, so the threat of changes in operationalization did not come into play. The selection of 300 words each of monosyllabic, bisyllabic, and trisyllabic words also rules out the possibility of practice effects due to repeated measurement. In addition, the survey items were created independently of the intervention and randomly assigned to the respective assessments. The external validity was preserved by the fact that the intervention had a demonstrable effect on all children and closed the gap between the baseline differences. Unfortunately, it was not possible to determine transfer effects on reading and writing in elementary school in this study. The focus on children with behavioral issues may be subject to criticism as we did not run an analysis to differentiate the effect of the intervention between children with and without behavioral difficulties. While we agree that future research should include subgroup analyses to statistically validate these observations, we believe the current findings can be seen clearly via visual inspection and that the data offer an important practical implication: Literacy interventions can also support children who present with behavioral challenges, even when these interventions are not specifically designed for that purpose. This perspective highlights the potential for inclusive, low-threshold approaches to serve a broader range of children, including those who are often underserved by traditional support systems.

Recommendations for Future Research

For students for whom German is a second language, a PA training might need to be more intense, consisting of more sessions and/or more weeks, especially when children come from different linguistic backgrounds. This might also help solve the issue raised in the social validity survey where participants stated that the intervention was partly too difficult and that they felt under pressure. According to Oslund et al. (2012), PA interventions are effective for children from different language backgrounds. However, more intervention research needs to be done in second language while paying attention to the participants' first languages if there is a difference in response to intervention dependent on first languages.

Further, it might be helpful to determine which blocks of the intervention are really necessary to achieve effects in phoneme segmentation. For example, Burns et al. (2018) found that rhyme intervention did not have the same high effects on early literacy skills as segmenting interventions. Thus,

one could try leaving out the rhyme block. Regarding transfer effects, it would be interesting to determine if PA training has direct influences on reading and spelling, with reference to studies by Pfost et al. (2019) and Wolf et al. (2016), who did not find transfer effects on reading but small effects on spelling.

Conclusion

To grant everybody access to literacy, it is important to counteract the growing gap between less proficient and proficient students with regard to literacy. According to Bacon (1998), it is essential that all students receive appropriate literacy support in order to develop into literate adults, as literacy is considered a fundamental human right. The present study provides insight into how to effectively support young children at risk for literacy difficulties in PA before they enter school, including children with behavioral difficulties, who benefitted the same way as their peers without behavioral issues.

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