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Phonological awareness development in children with and without spoken language difficulties: A 12-month longitudinal study of German-speaking preschool children

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Abstract

Purpose: There is strong empirical evidence that English-speaking children with spoken language difficulties (SLD) often have phonological awareness (PA) deficits. The aim of this study was to explore longitudinally if this is also true of preschool children speaking German, a language that makes extensive use of derivational morphemes which may impact on the acquisition of different PA levels.

Method: Thirty four-year-old children with SLD were assessed on eleven PA subtests at three points over a 12-month period and compared to 97 four-year-old typically developing (TD) children.

Result: The TD-group had a mean percentage correct of over 50% for the majority of tasks (including phoneme tasks) and their PA skills developed significantly over time. In contrast, the SLD-group improved their PA performance over time on syllable and rhyme but not on phoneme level tasks. Group comparisons revealed that children with SLD had weaker PA skills, in particular on phoneme level tasks.

Conclusion: The study contributes a longitudinal perspective on PA development before school entry. In line with their English-speaking peers, German-speaking children with SLD showed poorer PA skills than TD peers, indicating that the relationship between SLD and PA is similar across these two related but different languages.

Introduction

It has been widely accepted that phonological awareness (PA), i.e. the ability to reflect on the structure of an utterance independent of its meaning (Stackhouse & Wells, 1997), is a strong predictor for later literacy acquisition and an important link between spoken and written language. Previous research has shown that in addition to PA skills, speech and language skills are needed to build a solid basis for literacy acquisition and to access the school curriculum (Law, Todd, Clark, Mroz, & Carr, 2013). A large number of studies have shown that children with speech and language difficulties (SLD) are at high risk for literacy difficulties (e.g. Peterson, Pennington, Shriberg, & Boada, 2009). Therefore, it is important to understand how spoken language deficits may impact on PA skills and how PA develops.

The impact of spoken language difficulties on PA performance

It is argued that difficulties in processing speech are likely to lead to less accurate phonological representations (for an overview see Elbro, 1996). Due to these inaccuracies, similar word forms cannot be properly differentiated and divided into sublexical units, which in turn negatively affects PA development (Carroll & Snowling, 2004; Chiappe, Chiappe, & Siegel, 2001; Sutherland & Gillon, 2007). There is evidence for English-speaking children that a considerable number of children with SLD also have poor PA skills (e.g. Bird, Bishop, & Freeman, 1995; Farquharson, Centanni, Franzluebbers, & Hogan, 2014; Leitao, Hogben, & Fletcher, 1997; Mann & Foy, 2007; Mortimer & Rvachew, 2008; Preston, Hull, & Edwards, 2013; Thatcher, 2010; Webster & Plante, 1995). Gernand and Moran (2007), for example, assessed 12 primary school children (age range 5;11-7;02 years) with mild to moderate speech difficulties. Their performance on standardised PA tasks (Newcomer & Barenbaum, 2003) and non-standardised PA tasks (rhyme detection, phoneme blending, phoneme

counting) was compared to twelve age-matched controls. The typically developing children significantly outperformed the children with speech difficulties on all PA tasks. In addition, Rvachew, Ohberg, Grawburg, and Heyding (2003) who compared 13 children with SLD and 13 typically developing children (mean age 4;08) on rhyme matching, onset matching and onset segmentation found that the typically developing children showed better performance on all three tasks.

Leitao and colleagues (1997) assessed 74 six-year-olds, including typically developing children, children with speech difficulties, children with language difficulties, and children with a mixed speech and language deficit. All were tested on a segmenting/blending task and a deletion task. Both tests showed significant differences between the typically developing children and the children with isolated or mixed speech/language problems.

Differentiating a range of PA subskills is important since typically and atypically developing children show high variability in PA performance and may not differ across all PA tasks (Bird, Bishop, & Freeman, 1995; Leitao et al., 1997; Rvachew, Chiang, & Evans, 2007). For example, Hesketh, Adams, and Nightingale (2000) compared a group of children with speech difficulties (n=61, age range 3;06 to 5;00 years) with a group of typically developing peers (n=59). They administered five different PA tests. Overall test scores showed a significant group difference in favour of the typically developing children (t (118) = 2.509, $p \leq 0.013$). Nevertheless, looking at each subtest individually, significant group differences were only found for onset matching and word initial segmentation/matching (but not for rhyming, blending phonemes or consonant deletion). These findings highlight the importance of using a number of different PA tasks in order to profile and compare the developmental trajectories of children with and without SLD at different points in time.

Development of PA in English-speaking children

There is a wealth of literature documenting PA development in typically developing English-speaking children (e.g. Cassady, Lawrence, & Putman, 2008; Lonigan et al., 2009). However, as Cassady et al.'s (2008) critique suggests, many of the tests administered do not systematically consider (i) the size of the linguistic unit that is processed (i.e. syllable, onset-rhyme, phoneme segment) and (ii) the task demand, i.e. the cognitive resources required to carry out a task. Commonly, tests are used which combine two or more linguistic units in one subtest and performance is influenced by task instructions. This makes it difficult to describe developmental patterns according to each level (i.e. linguistic unit and task demand) and to compare results across studies. Nevertheless, there is empirical evidence that PA improves over time and that implicit tasks are easier to complete than explicit tasks (see Anthony & Francis, 2005, for an overview). For example, a cross-sectional study by Burt, Holm and Dodd (1999) assessed 57 British-English-speaking children divided into two age groups (3;06-4;03 and 4;04-4;10 years). Group differences were found for all subtests. The older group completed the syllable segmentation task most successfully, followed by phoneme isolation, alliteration, rhyme identification, and phoneme segmentation. Task complexity impacted on PA performance (e.g. children completed the phoneme isolation task more successfully than the phoneme segmentation task). In a longitudinal study, Cassady and colleagues (2008) assessed kindergarten children in the US who significantly improved in all 14 subtests, over three testing points. Effect sizes were strong for most of the tasks. More implicit tasks, such as the identification of beginning sounds, were more successfully performed than the phoneme deletion task. In the same vein, Carroll, Snowling, Hulme and Stevenson (2003) conducted a one-year longitudinal study with 67 British-English-speaking children (aged 3;02- 4;05 at the beginning of the study), testing syllable, rhyme and phoneme awareness at three different time points. A main effect of age was found for all tasks. The

percentage of children who performed above chance on the PA tasks at T1 suggests that syllable and rhyme tasks are already achievable at an early age. At T3 (average age 4;09 years) more than 50% of children performed above chance on all tasks except phoneme deletion. There was no statistically significant difference between the syllable and rhyme tasks, but there was a significant difference between rhyme and phoneme subtests. In sum, studies provide evidence that PA in typically developing English-speaking children improves over time, that syllable and rhyme awareness are acquired before phoneme awareness, and that task demand impacts on PA performance.

PA has been the subject of much research, but despite a great interest in its development and its relation to other cognitive and linguistic skills including literacy (e.g. Hulme et al., 2002; Muter, Hulme, Snowling, & Stevenson, 2004) there are relatively few studies exploring PA development from a longitudinal perspective. By assessing PA skills over time, error variance associated with individual differences is reduced. It allows monitoring of developmental trajectories within the same group of children and sheds light on how quickly certain skills develop between two time points. Further, a longitudinal analysis of different developmental patterns in children with SLD may identify critical stages in PA acquisition and which PA subskills show troublesome or even arrested development. This has clear clinical relevance, as such findings can help identify when children with SLD may start falling behind and need intervention. However, there are few longitudinal studies of PA skills in nursery children (aged four to five) with and without SLD, particularly in languages other than English.

Thus, the present investigation of PA in German-speaking children with and without SLD extends the literature and is of specific interest for three reasons. Firstly, German is the most widely spoken of the Germanic languages apart from English. It is estimated that

approximately 90 to 98 million people are native speakers of German and that approximately 80 million people speak German as a second language (Marten & Sauer, 2005). With such a large language population, a corpus of valid data on children's PA is clearly vital to understanding speech, language and literacy development in German. Secondly, German-speaking children start school around the age of six, and although nurseries and parents/carers might introduce activities such as rhyme games, syllable clapping and letters before this time, this exposure is unstructured in the majority of cases, since there are no obligatory governmental guidelines for preschool education across all German federal states (www.bildungsserver.de). Hence, looking at 4-year-old German children with and without SLD is a possible way to examine PA longitudinally without extensive effects of formalised schooling. Thirdly, comparisons with data on English PA development is of specific linguistic interest. Although English and German have similarities in syllable structure, phonetic inventories and proportion of rhyme neighbours (De Cara & Goswami, 2003), there are important differences. German makes extensive use of derivational morphemes, resulting in compound words, and word length distributions show that German words are, on average, longer than English words (Nemeth & Zainko, 2011; Smith, 2012). For German-speaking children, the syllable may therefore be of greater importance in early PA development (in particular syllable awareness), whereas English-speaking children exposed to shorter words may attend more to intra-syllabic units to differentiate minimal pairs (i.e. onset-rhyme and phoneme awareness). If English-speaking children are, in general, exposed to shorter words than German-speaking children, they may develop fine-grained phonological representations earlier than German-speaking children. Hence, phoneme awareness may be observable in German-speaking children later than in English-speaking children.

Phonological awareness development in German-speaking children

There is limited empirical information about PA development in German-speaking preschool children with and without SLD. Rather, the focus of previous studies has been on predictors of literacy skills, and the development of literacy skills in relation to orthography (e.g. Landerl & Wimmer, 2008; Schneider & Näslund, 1997; Wimmer & Goswami, 1994) or early literacy intervention programs (Schneider, Ennemoser, Roth, & Kuspert, 1999; Schneider, Küspert, Roth, Vise, & Marx, 1997). Schneider et al. (1997) conducted a PA training study with German-speaking nursery children (mean age 5;07 at the beginning of the study). Phonological processing skills, nonverbal intelligence and early literacy were assessed, but no additional speech or language assessments were conducted. PA tests included one rhyme task and four phoneme tasks (identification, blending, segmentation, deletion). Findings focused on training effects but raw scores for both groups showed that there was developmental progression from pre- to post-test. At the beginning of the study, all children were most successful in the phoneme blending task (mean percentage correct: 69.5%), followed by the rhyme task (30.1%), and the expressive sound identification task (26.4%). A receptive sound identification task was more difficult to complete (18.5%). Phoneme segmentation (15.2%) and phoneme deletion (3.6%) were the most difficult tasks. Stenzel (1999) provided cross-sectional pilot data on a range of PA skills and age groups. She assessed 37 children aged 3;00-6;11 (subdivided into four age groups) on six PA tasks (syllable segmentation, rhyme identification, sound identification, word completion, phoneme isolation, and phoneme segmentation). Performance on all tasks showed age differences and generally confirmed the developmental progression from syllable to onset-rhyme and phoneme awareness.

In summary, the lack of longitudinal data means that very little is known about the developmental trajectories of PA skills in German-speaking children, and particularly those

with SLD. Comparing the PA development of German-speaking children with SLD and their TD peers over time would not only contribute to how PA develops in a language other than English but also reveal what PA skills German-speaking children with SLD find difficult to acquire. This in turn could be helpful when addressing what support is required in order to support their literacy as has been the case in English and other cross-linguistic studies of PA.

To frame such an exploration, the current study adopted a 12-month longitudinal design to compare PA skills between German-speaking children with and without SLD across different time points. The following research questions were addressed:

1. Are there developmental differences in the acquisition of phonological awareness between typically developing German-speaking children and children with SLD?
2. How do German-speaking children with SLD perform on syllable, rhyme, and phoneme level PA tasks compared to their typically developing peers across different time points?

Method

The PA development of a group of typically developing children (TD) and a group of children with speech and language difficulties (SLD) was compared in a 12-month longitudinal group study to explore development over time. There were three test points: one at the beginning of the study and then two at six month intervals, henceforth referred to as T1 (beginning), T2 (at 6 months), and T3 (at 12 months).

Participants

A total of 127 children participated in the study. Of these, 97 were designated as typically developing and 30 were assigned to the SLD group, according to the following protocol.

A parental questionnaire was used at T1 to gather information about each child's developmental history. To take part in the study, children needed to fulfil the following selection criteria: (a) aged 4;00 to 4;11 at the onset of the study (T1), (b) monolingual German-speaking children, (c) no significant hearing loss, (d) no learning difficulties (information gathered from parental questionnaires/nursery staff), no cognitive delay (measured by a nonverbal reasoning test, see below) and no noticeable medical or neurological problems, and (e) no atypical dysfluencies.

All children were tested on the *Coloured Progressive Matrices* (CPM, Raven, Bulheller, & Häcker, 2002) for nonverbal reasoning. They all scored above the 25th percentile and hence showed unimpaired nonverbal reasoning skills. In addition, the German version of the *Test for Reception of Grammar* (TROG-D, Fox, 2006), two receptive vocabulary subtests of the *Patholinguistic Diagnosis* (Kauschke & Siegmüller, 2002) and a speech screening assessment (Fox, 2005) were administered. Spontaneous speech samples were used to confirm speech error patterns. To be included in the TD-group, children had to show typical speech development and standard scores within normal limits on the vocabulary and grammar comprehension tests. Children were included in the SLD-group if they had one or more of the following spoken language difficulties: (a) phonological delay or disorder according to the classification by Dodd (2005) and Fox (2011), (b) receptive vocabulary below one standard deviation in both subtests of the Patholinguistic Diagnosis (Kauschke & Siegmueller, 2002), and/or (c) a T-score of 40 or below on the *TROG-D* (Fox, 2006). For a summary of all participants see Table I.

Table I about here

Of the 30 children selected for the SLD group, 24 showed speech difficulties, two showed language difficulties and four showed a combined speech and language deficit. This

sample was opportunistic and therefore the study did not seek to differentiate, at this stage, between sub-groups of children, i.e. children with isolated speech difficulties, isolated language difficulties or children with combined speech and language difficulties. They all attended the same nurseries as the typically developing children. Although this study did not aim to measure intervention effects, some of the children started speech and language therapy during this period (see Table II). For ethical reasons, the possible impact of treatment on the results could not be controlled.

Table II about here

To explore potential confounding variables, including gender, age and nonverbal reasoning skills, group comparisons were computed. For gender, nonparametric independent group comparisons between boys and girls were carried out for both groups of children (Mann-Whitney-U tests, based on raw scores). Gender differences across all tasks and testing points (including PA, language skills, CPM) were small and statistically not significant (all ps >.05) for both the TD and SLD group. Therefore, gender was not added in to any further analysis.

For nonverbal reasoning, a test of normality (Kolmogorov-Smirnov) showed that scores for the CPM (raw scores) were normally distributed; therefore, a t-test was run. It showed that the groups differed at T1 but not at T3 (T1: $t(125) = -2.413$, $p = 0.017$; T3: $t(119) = -1.608$, $p = 0.118$). Hence, nonverbal reasoning was entered as a covariate when comparing both groups regarding their PA performance over time.

For age, a test of normality showed that scores for age were not normally distributed, therefore a non-parametric group comparison was run (Mann-Whitney-U). A significant effect for age was found (U=989.000, z = -2.661, p = 0.008). Hence, age was entered as covariate when comparing both groups regarding their PA performance.

Materials

A PA-test battery comprising eleven subtests from the *Test of Phonological Awareness* (TPB, Fricke & Schäfer, 2011) was administered to all children (see Table III for a detailed description of the subtests).

Table III about here

At T1, only the syllable, rhyme, and onset-rhyme tasks were presented, since earlier studies have shown that phoneme-level tasks are too difficult for 4-year old children (Schaefer et al., 2009). At T2 and T3, the complete test battery was administered.

Procedure

Children were recruited via their nurseries. Written consent was obtained from all nurseries and participants. All children were tested individually at their nursery. All tests were carried out over one to three sessions of 20-45 minutes each. Prior to the PA subtests, the children were asked to name all pictures to ensure familiarity with the stimuli.

Result

Firstly, to address research question 1, the data were examined for any developmental differences in the acquisition of PA between TD children and children with SLD. Descriptive statistics for raw scores showed that PA skills varied considerably within the two groups at each point in time (see Table IV).

Table IV about here

To compare PA task performances across the two groups, repeated measures ANOVA with *time of testing* as a within subject variable were computed. For the TD-group the effect of time for all PA subtasks was significant (syllable tasks and onset-rhyme tasks: F (10, 82) = 30.964, $p < 0.001$); phoneme tasks: F (6, 87) = 17.882, $p < 0.001$), i.e. the children improved on PA during the year. In contrast, the SLD-group's improvement was only significant for the following subtasks: Syllable-segmentation-output (F (2, 46) = 10.066, $p < 0.001$); Rhyme-identification-input (F (2, 46) = 21.420, $p < 0.001$), Rhyme-production-output (F (2, 46) = 21.412, $p < 0.001$), Onset-rhyme-blending-output (F (1.50, 34.59) = 4.536, $p = 0.026$). Since Mauchly's test indicated that the assumption of sphericity had been violated for Onset-rhyme-blending-output, Greenhouse-Geisser estimates are reported.

In summary, both the TD group and the SLD group showed improved performance on all syllable and rhyme tasks over time apart from Onset-rhyme-blending-input. However, while the TD group also showed growth in the phoneme tasks, the SLD group did not.

Effect sizes were calculated to explore whether some PA skills developed earlier than others. Table V summarises the effect sizes on all PA tasks for both groups across T1 to T2 and T2 to T3.

Table V about here

Overall, for T1 to T2, growth patterns for both groups were comparable on the syllable and rhyme tasks. For T2 to T3, the TD-group showed more growth in the phoneme tasks, and differences emerged between the two groups in particular on the output tasks. In contrast, while the SLD-group continued to improve substantially on the rhyme tasks, this was not the case on the phoneme tasks.

To address the second research question about possible group differences on PA task level (phoneme, rhyme and syllable) at the different test points, mean correct percentages were computed (see Table VI), a measure commonly used to describe PA task performance (see e.g. Burt et al., 1999). Both groups were able to successfully complete the syllable and onset-rhyme awareness tasks (i.e. scoring 50% or above) at all testing points, with only two exceptions: Onset-rhyme-blending-output; Rhyme-identification-input at T1 for the SLD-group. In addition, for the TD-group at T3, the score was above 50% on the majority of phoneme tasks, but for the SLD-group this was only observable for the Sound-blending-input task. The Sound-deletion-output task seemed to be particularly difficult for both groups.

Table VI about here

To assess whether children with or without SLD differed significantly in their PA skills, direct group comparisons were computed between the TD- and SLD-groups by conducting multiple analyses of variance, including age and non-verbal reasoning as covariates. The TD-group outperformed the SLD-group on the majority of subtests (see Table VII).

Table VII about here

One aspect which may have impacted on these findings is that the SLD group was not homogeneous; it was comprised of children who had difficulties with speech only, or language only, or both speech and language. Further, these three subgroups were not equally represented. Since the children with isolated speech difficulties formed the largest component of the SLD-subgroup (n=24), additional statistical analyses were computed (Mann-Whitney-U-Tests) to explore whether they (as a subgroup) performed differently in comparison to the children with isolated language or combined language and speech difficulties. Children with isolated speech difficulties showed better performance on the following tasks (even after

applying Bonferroni corrections): (a) Rhyme-identification-input at T1 and T3 (T1: U = 25.500, z = -2.44, p = 0.015, r = .45; T3: U = 13.500, z = -3.00, p = 0.009, r = .60); (b) Rhyme-production-output at T3 (U = 10.500, z = -2.69, p = 0.007, r = .53)

To explore whether the differences in these two subtests would impact on the TD- versus SLD-group comparison presented above, multivariate analysis of variance was computed once more, this time only including children with isolated speech difficulties in the analysis. Outcomes for the rhyme-production-output at T3 and the rhyme-identification-input task at T1 were comparable to the results when all SLD-children were included. However, for the rhyme-identification-input task at T2 and T3, the children with isolated speech difficulties performed on a similar level as their typically developing peers. This contradicted findings for the complete SLD-group.

In summary, the SLD-group and the speech only subgroup performed consistently more poorly than the TD group on the majority of PA tasks (in particular phoneme awareness tasks), but differences at syllable and rhyme level were less pronounced for the SLD- and speech only subgroups. Moreover, the differences between the children with SLD the TD-group generally increased over time.

Discussion

This study investigated PA skills in German-speaking preschool children with and without SLD and whether their PA performance differed at the level of syllable, rhyme and phoneme awareness at three different points of testing.

The first research question was concerned with developmental differences in the acquisition of phonological awareness between typically developing German-speaking children and children with SLD. Descriptive statistics revealed high variability in test performance across both groups at all three testing points. This is in line with findings from English-speaking children (e.g. Hesketh et al., 2000) and highlights the need to consider individual differences when interpreting the data. It also emphasises the need to identify meaningful differences (in the form of effect sizes) before drawing conclusions.

While all PA skills developed significantly in the TD-group, a finding which corroborates findings from studies with English-speaking children of a comparable age range (e.g. Cassady et al., 2008; Lonigan et al., 2009; Carroll et al., 2003; Thatcher, 2010), children with SLD only showed significant progression in the syllable and rhyme tasks. Effect sizes for syllable and rhyme tasks from T1 to T2 were similar for children with or without SLD. Hence, for this time period, PA development was similar for both groups. However, differences emerged between T2 and T3. In this period the PA development for the rhyme and syllable tasks (i.e. Rhyme-identification-input, Rhyme-production-output and Syllable-segmentation-output) seems to be prolonged for the SLD-group since these tasks were still the ones which showed the strongest effect sizes. The phoneme tasks showed the smallest effect size, indicating slower development of phoneme awareness. In contrast, during this T2-T3 period, the TD-group improved their performance more rapidly on Onset-rhyme-blending-output and phoneme awareness tasks, and Sound-identification in particular. These diverging patterns suggest that the speech processing deficits apparent in the SLD-group impact on their metalinguistic skills specifically when developing phoneme awareness. This corroborates the findings of Carroll et al. (2003), in whose study the articulation skills of English speaking children predicted phoneme awareness longitudinally in typically developing English-speaking children. However, it is important to note that Carroll and

colleagues also found that syllable and rhyme awareness predicted performance on phoneme awareness tasks substantially. Hence, there is a strong link between the two task types.

The question that remains is why the SLD-group in the current study made little improvement with phoneme awareness even though syllable and rhyme awareness were developing as fast as for the TD-group. One reason could be that the SLD-group started at a lower level of PA skills, and this level of skills was not sufficient to develop precise phonological representations quickly enough to improve phoneme awareness within the time of testing. Another could be that the reduced exposure to shorter words in German in comparison to English-speaking children may contribute to a later development of phoneme awareness and a reduced ability to build accurate and fine-grained phonological representations in children who have speech processing deficits. However, overall, the results show the importance of differentiating between different PA tasks, in particular between syllable and rhyme versus phoneme awareness tasks, in order to pick up the PA deficits in children with SLD.

The second research question focussed on direct group comparisons between children with and without SLD, looking longitudinally at syllable, rhyme, and phoneme task performance. The majority of typically developing children could successfully complete PA tasks on syllable, rhyme and even phoneme level (with the exception of phoneme deletion, a task English-speaking children also struggle with; see e.g. Hesketh et al., 2000). This indicates that there is no substantial support for the assumption that TD German-speaking children would have less developed PA skills (particularly phoneme awareness) than their English-speaking peers because they have less exposure to short words in their language or because their formal literacy instruction starts comparatively late.

In contrast to the TD-group, the SLD-group succeeded only on the syllable, onset-rhyme and the Sound-blending-input tasks, and struggled with phoneme awareness. This may

indicate that the children's speech output errors could have negatively affected their developing speech rehearsal and reflection abilities, skills important for the fine-tuning of phonological representations and PA development generally (Stackhouse, 2006), and that they may be more vulnerable when processing the longer words typical of the German language.

The SLD-group exhibited poorer rhyme-identification skills than the TD children at all testing points, in line with outcomes from a range of studies with English-speaking children (for example Gernand & Moran, 2007; Mann & Foy, 2007). However, the subgroup of children with isolated speech difficulties showed comparable results to the TD-group, supporting findings from Hesketh et al. (2000) who did not find group differences on their rhyming task either. This distinction between children with isolated speech difficulties, isolated language difficulties, or a combined deficit, may be explained by the greater challenges posed for children with vocabulary problems. These children may struggle to differentiate the target items from the phonological and semantic distracters. In contrast, no group differences for the SLD-group were found for the equivalent Rhyme-production-output task (independent of the group comprising of speech difficulties only children or all three subgroups). One reason may be that both real word and non-word rhymes were accepted, so children might have been less reliant on their lexical knowledge, an advantage in particular for children with vocabulary deficits.

A group difference on the Onset-rhyme-blending-output tasks was found only at T3 and this may be explained by the notion that output blending skills are still developing in the TD-group at T2. The gap between both groups only emerged when the typical children showed accelerated development of blending skills from T2 to T3 while the SLD-group did not.

The more distinct group differences on the phoneme awareness tests, highlighting the TD-children's superior performance, confirms the findings of earlier studies with English-speaking children (e.g. Hesketh et al., 2000; Thatcher, 2010; Gernand & Moran, 2007). Moreover, for some of these subtests (e.g. Sound-identification-output) these group differences increased over time, illustrating that the gap widened between the groups. This suggests that the period around the age of five is a developmentally sensitive time when German-speaking TD-children show a transition from implicit to explicit meta-phonological awareness, regardless of whether they receive formal literacy instruction or not. For German-speaking children with SLD, the speech processing system, and lexical representations in particular, might not be sufficiently established or differentiated enough to enable such a transition. As a consequence, they fall behind and might "miss the window" to develop sufficient phoneme awareness, or at least not be at the same point of readiness as TD children to receive more formal literacy instruction, which puts them at higher risk of developing literacy difficulties later on (Nathan, Stackhouse, Goulandris, & Snowling, 2004).

The fact that the Phoneme-deletion-output task did not reveal any group differences is in line with findings of previous studies and indicates that phoneme manipulation tasks are too difficult for both typically and atypically developing preschool children of this age (e.g. Hesketh et al., 2000; Gernand & Moran, 2007; Carroll et al., 2003; Schneider et al., 1997). It flags the importance of having realistic expectations of PA levels when testing children of different ages. Overall, the SLD-group's PA skills fell increasingly behind the TD-group over time, particularly at phoneme level. Although 17 out of 30 children received speech and language intervention at some point during the study, the group as a whole did not catch up with their typically developing peers. This suggests that PA deficits in German-speaking children are unlikely to resolve without specific PA intervention, and that support is needed

for children with SLD as early as possible before school entry, in order to promote development of PA skills.

Intervention planning should be informed by comprehensive assessment, but clinical time constraints require strategic use of sub-tests to establish accurate PA profiles. The findings of this study suggest that three sub-tests in particular would be strong candidates for a PA screening tool for German-speaking preschool age children. The first is *onset-rhyme-blending-output*. All other syllable/onset-rhyme tasks were relatively easy for both groups. This test can be usefully compared with the equivalent phoneme blending task. The second sub-test is *sound-identification-input*. Although both input and output tasks showed group differences, the input test includes matched semantic and phonological distracters, hence it allows for additional qualitative analysis of answers. Moreover, nonverbal responses are required, hence children's expressive speech difficulties do not impact on their performance. The third sub-test is *sound-blending-input and -output*. Both tasks revealed group differences and test crucial skills to acquire literacy. Performance was relatively high on the input version and hence could be used with younger children as well. The output test was sufficiently challenging to be used with older as well as younger children. Additional studies would be necessary to establish if these tasks can reliably predict later literacy skills and precisely identify children who are at risk for literacy difficulties.

Limitations

This was the first time that PA development in German-speaking preschool children was assessed using a fine-grained tool, comparing children with and without SLD over time. Nevertheless, the cohort of children with SLD in this study was heterogeneous and further studies may want to assess PA in more distinct subgroups of children with SLD (Leitao et al.,

1997; Lewis & Freebairn, 1997; Nathan et al., 2004; Raitano, Pennington, Tunick, Boada, & Shriberg, 2004).

Despite its comprehensive PA testing, the present study has only provided quantitative analyses. Qualitative information could be collected by adopting dynamic assessment methods in future studies. Presentation of different prompts during tests would indicate whether children with SLD need different strategies to successfully complete PA tasks, in comparison to their typically developing peers (Gillam & Ford, 2012). Finally, although the children were tested over three time points, without further follow-up study we do not know if the gap in PA performance between the TD- and SLD-groups closes or continues to increase over time, or if better phoneme skills are predictive of stronger literacy acquisition at a later stage.

Conclusion

In spite of some linguistic differences between the nature of German and English, the study has replicated findings from research with English speaking children: German-speaking preschool children with spoken language difficulties have weaker PA skills than their typically developing peers. The longitudinal perspective highlighted discrepancies between TD- and SLD-group performance, depending on the time of testing. For the TD-group, PA skills showed a typical progression from syllable, rhyme to phoneme, with phoneme awareness already observable before the start of school and formal teaching. In contrast, the development of PA on syllable and rhyme level in the SLD-group was slower and prolonged, and the development of phoneme level skills was delayed. Even though some of the children received speech and language therapy, this did not close the gap between the TD- and SLD-groups. It was still the case that the children in the TD-group managed phoneme awareness tasks better than those in the SLD-group, putting them in a better position to take advantage of literacy instruction when they start school. It is therefore recommended that, as for English

speaking children, the PA development of four- to five-year old German-speaking children with SLD is assessed in order to identify which children are in need of extra support.

Declaration of interest

The authors confirm that there are no conflicts of interest.

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Table I: Summary of the children with and without SLD

	Number of participants	Mean age in months (SD)	Gender
TD-group	T1 = 97 T2 = 93 T3 = 95	54.94 (3.28)	female = 53 male = 44
SLD-group	T1 = 30 T2 = 25 T3 = 25	52.90 (3.83)	female = 6 male = 24

Note. TD-group = typically developing children; SLD-group = children with speech and language difficulties, T1 = testing point 1; T2 = testing point 2; T3 = testing point 3

Table II: number of children who received speech and language therapy during the study

Therapy	After T1	After T2	After T3	None	No information
No. of children (n=30)	7	7	3	9	4

Note. None of the children received therapy prior to T1; T1 = testing point 1; T2 = testing point 2; T3 = testing point 3

Table III: Subtests of the German phonological awareness test battery

Linguistic unit	Level of explicitness	Response mode	Instruction	Abbreviation
syllable	segmentation	output	Children see a picture of a word and are asked to segment words into syllables. The tester does not name the picture.	SylSeg*out*
rhyme	identification	input	One picture is presented at the top of the page and three pictures underneath. Children have to point to the one of the three pictures that rhymes with the stimulus word. The tester does not name the picture.	RhymeID*in*
rhyme	manipulation	output	Children see a picture of a word and are asked to produce as many words as possible that rhyme with that word (time limit of 15 seconds for each item).	RhymeProd*out*
onset-rhyme	blending	input	Children are asked to blend onset-rhymes spoken by the tester and then point to the target picture (out of 3).	OnsetRhyme Blend*in*
	blending	output	Children are asked to produce a word by blending an onset and rhyme spoken by the tester.	OnsetRhyme Blend*out*
onset-phoneme	identification	input	One picture is presented at the top of the page and three pictures underneath. Children have to point to the item which shares the initial sound(s) with the stimulus word.	SoundID*in*
	identification	output	Children see two pictures and are asked to pronounce the shared sound(s).	SoundID*out*
phoneme	blending	input	Children are asked to blend phonemes and then point to the target picture (out of 3).	SoundBlend*in*
	blending	output	Children are asked to produce a word by blending phonemes spoken by the tester.	SoundBlend*out*
phoneme	deletion	input	The tester pronounces the word, followed by the sound(s) to be deleted. Children have to point to the picture of the word resulting from the deletion.	SoundDel*in*
	deletion	output	Children see a picture of a word and are asked to delete (a) specified initial sound(s) and pronounce the result.	SoundDel*out*

Running head: Phonological awareness and language deficits

Table IV: Descriptive results of all phonological awareness subtests at all times of testing (T1, T2, T3) in the group of typically developing children (TD) and the group of children with speech and language difficulties (SLD)

	T1						**T2**						**T3**					
	TD-group (n=97)			**SLD-group (n=30)**			**TD-group (n=93)**			**SLD-group (n=25)**			**TD-group (n=95)**			**SLD-group (n=25)**		
	M	SD	Range	M	SD	Range	M	SD	Range	M	SD	Range	M	SD	Range	M	SD	Range
Syl Seg*out*	8.13	2.43	0-12	7.53	1.96	4-10	9.26	2.23	1-12	8.40	2.12	4-12	10.24	1.72	6-12	9.72	2.26	6-12
Rhyme ID*in*	7.79	3.83	0-12	5.00	3.30	0-12	9.62	3.15	1-12	7.36	3.95	0-12	11.08	1.85	1-12	9.40	3.37	3-12
Rhyme Prod*out*	18.08	12.14	0-52	10.23	10.22	0-27	23.94	13.03	0-65	17.64	12.21	0-40	27.47	11.26	0-57	24.08	15.47	0-73
Onset Rhyme Blend*in*	8.56	1.81	4-12	8.27	1.26	5-10	9.08	1.37	6-12	8.36	1.50	5-11	9.41	1.80	5-12	8.64	1.04	7-11
Onset Rhyme Blend*out*	3.53	2.66	0-12	2.27	1.66	0-6	4.56	2.97	0-12	3.04	2.19	0-8	6.49	3.51	0-12	3.60	2.00	0-11
Sound ID*in*	-	-	-	-	-	-	5.87	3.16	0-12	4.00	2.20	1-9	7.49	3.05	0-12	4.92	2.60	1-10
Sound ID*out*	-	-	-	-	-	-	5.04	4.16	0-12	2.72	3.31	0-11	7.25	3.93	0-12	3.56	3.19	0-11
Sound Blend*in*	-	-	-	-	-	-	9.38	2.29	4-12	7.44	2.47	3-12	9.99	2.39	2-12	8.64	2.77	3-12
Sound Blend*out*	-	-	-	-	-	-	3.32	3.40	0-12	1.40	1.58	0-6	4.59	3.82	0-12	1.28	2.19	0-11
Sound Del*in*	-	-	-	-	-	-	6.09	2.49	0-11	4.63	2.45	1-9	7.16	2.66	1-12	5.92	3.00	1-11
Sound Del*out*	-			-	-	-	0.71	1.84	0-8	0.56	1.33	0-6	1.53	2.79	0-11	0.52	1.19	0-4

Table V: Effect sizes (r) for all phonological awareness subtests in the group of typically developing children (TD) and the group of children with speech and language difficulties (SLD)

	T1 → T2		T2 → T3	
	TD-group	SLD-group	TD-group	SLD-group
SylSeg*out*	0.37	0.35	0.42	0.46
RhymeID*in*	0.57	0.53	0.47	0.54
RhymeProd*out*	0.57	0.59	0.34	0.62
OnsetRhymeBlend*in*	0.29	0.10	0.21	0.20
OnsetRhymeBlend*out*	0.43	0.32	0.62	0.35
SoundID*in*	-	-	0.55	0.34
SoundID*out*	-	-	0.58	0.34
SoundBlend*in*	-	-	0.27	0.35
SoundBlend*out*	-	-	0.41	0.11
SoundDel*in*	-	-	0.35	0.38
SoundDel*out*	-	-	0.38	0.13

Note. TD-group = typically developing children; SLD-group = children with speech and language difficulties, T1 = testing point 1; T2 = testing point 2; T3 = testing point 3

Table VI: Phonological awareness task mean correct percentage for both groups over time

	TD-group			SLD-group		
	T1	T2	T3	T1	T2	T3
SylSeg*out*	67.75	77.17	85.33	62.75	70.00	81.00
RhymeID*in*	64.92	80.17	92.33	41.67	61.33	78.33
OnsetRhymeBlend*in*	71.33	75.67	78.42	68.92	69.67	72.00
OnsetRhymeBlend*out*	29.42	38.00	54.08	18.92	25.33	30.00
SoundID*in*	-	48.92	62.42	-	33.33	41.00
SoundID*out*	-	42.00	60.42	-	22.67	29.67
SoundBlend*in*	-	78.17	83.25	-	62.00	72.00
SoundBlend*out*	-	27.67	38.25	-	11.67	10.67
SoundDel*in*	-	50.75	59.67	-	38.58	49.33
SoundDel*out*	-	5.92	12.75	-	4.67	4.33

Note. TD-group = typically developing children; SLD-group = children with speech and language difficulties, T1 = testing point 1; T2 = testing point 2; T3 = testing point 3

Table VII: Significant group differences between TD- and SLD-group at different time points

Time point	Task	Result
T1	Rhyme-identification-input	F (1,111) = 4.928, p = 0.028
T2	Rhyme-identification-input	F (1,111) = 5.336, p = 0.023
	Sound-identification-input	F (1,111) = 4.137, p = 0.044
	Sound-identification-output	F (1,111) = 4.547, p = 0.035
	Sound-blending-input	F (1,111) = 6.079, p = 0.015
	Sound-deletion-input	F (1,111) = 4.992, p = 0.027
T3	Rhyme-identification-input	F (1,111) = 4.432, p = 0.038
	Onset-rhyme-blending-output	F (1,111) = 8.877, p = 0.004
	Sound-identification-input	F (1,111) = 11.033, p < 0.001
	Sound-identification-output	F (1,111) = 13.272, p < 0.001
	Sound-blending-input	F (1,111) = 4.333, p = 0.040
	Sound-blending-output	F (1,111) = 10.884, p = 0.001

Note. TD = typically developing children, SLD = children with spoken language difficulties.