Children's Phonological Awareness as a Predictor of Reading and Spelling: A Systematic Review of Longitudinal Research in German-Speaking Countries

Maximilian Pfost
University of Bamberg, Germany

Abstract

Numerous observational and experimental studies have shown that phonological awareness relates to reading and spelling. However, most studies were conducted in English-speaking countries, neglecting the issue of the generalizability of the findings across different orthographies. This meta-analysis focused exclusively on studies from German-speaking countries and explored how measures of phonological awareness relate longitudinally to reading and spelling. It summarized 19 manuscripts reporting the results of 21 independent studies. Results indicated a mean effect size of $Z_r = 0.318$ (r = .308) for the relation between phonological awareness and later reading and spelling. Moderator analyses showed that phonological awareness on the rhyme level was less related to reading and spelling than phonological awareness on the phoneme level. Furthermore, the predictive power of phonological awareness remained substantial even for children beyond 2nd grade. The findings suggest that research on reading and spelling development should take characteristics of the German orthography into account.

Keywords: phonological awareness, reading development, spelling, meta-analysis

Die Bedeutsamkeit der phonologischen Bewusstheit in der Vorhersage schriftsprachlicher Kompetenzen im Deutschen: Ein systematischer Literaturüberblick längsschnittlicher Studien

Zusammenfassung

Zusammenhänge von phonologischer Bewusstheit mit der Lese- und Rechtschreibkompetenz konnten vielfach nachgewiesen werden. Dennoch ist ein deutlicher Überhang an Studien aus englischsprachigen Ländern zu erkennen. Die Frage der Generalisierbarkeit dieser Befunde für das Deutsche bleibt dabei unklar. Die vorliegende Meta-Analyse zur Frage der prädiktiven Bedeutsamkeit der phonologischen Bewusstheit für den Schriftspracherwerb fokussiert daher exklusiv auf empirische Arbeiten aus dem deutschen Sprachraum. Insgesamt wurden 19 Arbeiten, die Ergebnisse von 21 unabhängigen Studien berichten, zusammengefasst. Die Ergebnisse zeigen einen mittleren Effekt in Höhe von $Z_r = .318$ (r = .308). Moderatoranalysen machen deutlich, dass die phonologische Bewusstheit im weiteren Sinne (Silben-bzw. Reimebene) weniger hoch mit den späteren Lese- und Rechtschreibfähigkeiten korreliert als die phonologische Bewusstheit im engeren Sinne (Phonemebene). Auch über die zweite Klassenstufe hinaus korreliert die phonologische Bewusstheit mit den schriftsprachlichen Kompetenzen. Die Ergebnisse deuten darauf hin, dass Charakteristika der deutschen Orthographie in der Forschung zum Schriftspracherwerb beachtet werden sollten.

Schlüsselwörter: Phonologische Bewusstheit, Schriftspracherwerb, Rechtschreibung, Meta-Analyse

---

More than 40 years have now passed since the concept of phonological awareness found its way into empirical research on the development of reading and spelling, particularly in English-speaking countries (e.g. Bradley & Bryant, 1978, 1983; Goswami & Bryant, 1990; Juel, Griffith, & Gough, 1986; Liberman, Shankweiler, Fischer, & Carter, 1974; Wagner & Torgesen, 1987), but also in German-speaking countries (e.g. Klicpera & Gasteiger-Klicpera, 1993; Landerl, Linortner, & Wimmer, 1992; Landerl & Wimmer, 1994; Schneider, 2009; Skowronek & Marx, 1989; Wimmer, Zwicker, & Gugg, 1991). Recognition of the significance of phonological skills for reading and spelling and the evaluation of approaches fostering such skills have become significant topics in education, reflecting one of the major contributions of psychological and educational research to students' cognitive development during the last decades. However, despite the great number of empirical studies, reading research has often neglected the issue of generalizability across different languages and educational systems (Share, 2008). In order to overcome this limitation, a few cross-linguistic studies have been conducted (e.g. Landerl et al., 2013; Moll et al., 2014; Vaessen et al., 2010; Ziegler et al., 2010). However, another approach would be to concentrate on research findings within one specific language. The current systematic review focuses exclusively on integrating observational longitudinal studies conducted in German-speaking countries. It concludes by comparing the integrated findings to the empirical results reported in the international literature.

Alphabetic Scripts and Phonological Awareness

When learning to read and write, an individual has to acquire a certain set of rules or standards on how written symbols relate to oral language. This is because all full writing systems contain a phonetic component (DeFrancis, 1989). However, scripts may relate to spoken language in different ways: they may represent different units such as consonants (as in Hebrew or Arabic), syllables (as in Japanese/Kana), or phonemes (as in Finnish or German). A script that relates phonemes to a set of characters (graphemes) is labelled alphabetic. Therefore, students wanting to learn to read and write an alphabetic script need to understand that printed symbols or graphemes represent phonemes, and therefore have to develop an awareness of the phonological nature of the language (Wagner & Torgesen, 1987). Consequently, children need to acquire sufficient knowledge of not only the relevant units of print but also the corresponding counterparts in oral language and how they relate to each other.

Phonological processing skills refer to the cognitive abilities in handling the phonological structure of oral language that children need to develop while learning to read. Typically, three distinct processes are distinguished (Lonigan, 2006; Wagner & Torgesen, 1987): phonological memory, which allows a temporal storage of verbal information; phonological access to the lexical store, which allows the retrieval of phonological information from long-term storage; and phonological awareness, which refers to the ability to reflect upon, detect, and manipulate the sound structure of oral language (see Anthony & Francis, 2005; Anthony & Lonigan, 2004; for a further discussion on the term phonological awareness). With regard to phonemic decoding, put very simply, written symbols are translated into sound by using acquired knowledge of letter–sound correspondences, they are blended together and stored throughout this process, and, at the end, they should activate some phonological and lexical knowledge of the word in long-term storage. Moreover, even more fluent aspects of reading and fast word recognition, which are based on the availability of an orthographic representation of the full word, develop in line with the availability of efficient phonemic decoding skills. This highlights the critical role of phonological processing skills for reading development (Phillips & Torgesen, 2006; Share, 1995). Comparable processes, although in the opposite direction, are to be found in spelling. Oral language is segmented into smaller sound units that are transformed into printed symbols by relying on knowledge of sound–spelling correspondence rules. Furthermore, orthographic knowledge can also be used, and there is a strong developmental trend towards relying increasingly on such orthographic knowledge with increasing print exposure (Rittle-Johnson & Siegler, 1999; Treiman & Bourassa, 2000). This article addresses the role and predictive power of the last of the three above-mentioned phonological processing skills, which is phonological awareness, for the acquisition of reading and spelling skills. Throughout the study, the term phonological awareness is used in a rather wide-ranging sense to encompass different sizes of sound units (see below) as well as a quite broad set of cognitive operations ranging from more implicit awareness tasks such as rhyme identification to more explicit awareness tasks such as phoneme deletion (see Fricke, Stackhouse, & Wells, 2007; Schnitzler, 2008).

Analyses of relations between phonological awareness and reading/spelling reveal an ongoing debate on which is the important size of sound units to take into account. When separating words into their constituent sounds, different units of sound segmentation can be differentiated (Goswami & Bryant, 1990; Skowronek & Marx, 1989; Wagner & Torgesen, 1987): first, words can be segmented into *syllables*. These constitute the smallest segments of the natural stream of speech that can be articulated independently (e.g. for German: "*Erd-bee-re*"; English: "straw-ber-ry"). Second, words can be segmented into smaller phonological units called *phonemes*. Phonemes are the smallest functional units of sound that may change a word's meaning (e.g. for German: "*Z-e-l-t*" and "*W-e-l-t*"; or for English: "b-a-t" and "h-a-t"). Third, as stressed by Goswami and Bryant (1990), it seems functional to further divide the syllabic unit into two intrasyllabic elements: the opening unit preceding the vowel, the *onset*, and the end unit, the *rime* (e.g. for German: "*Z-elt*"; or for English: "b-at"). However, it has yet to be confirmed empirically whether the hypothesized internal structure based on different units of sound segmentation can be reproduced by analysing children's prereading skills. Or, to express it in other words, we may ask whether tasks demanding a manipulation of language on the phoneme level (phonemic awareness; German: phonologische Bewusstheitsaufgaben im engeren Sinne; see Skowronek & Marx, 1989) can be well distinguished from tasks demanding a manipulation on the syllable or rhyme level (syllable/rhyme awareness; German: phonologische Bewusstheitsaufgaben im weiteren Sinne). Empirical research has delivered mixed evidence on whether phonological awareness should be regarded as a latent ability construct that is best represented by one phonological awareness factor (Anthony & Francis, 2005; Anthony & Lonigan, 2004), two phonological awareness factors (Blaser, 2002; Muter, Hulme, Snowling, & Stevenson, 2004; Muter, Hulme, Snowling, & Taylor, 1998; Treinies, Martschinke, Kirschhock, & Frank, 1999), or even three phonological awareness factors (Hoien, Lundberg, Stanovich, & Bjaalid, 1995). However, despite this discussion on the number of phonological awareness factors, substantial positive correlations have often been reported between different phonological awareness tasks (Barth & Gomm, 2008; Blaser, 2002; Hoien et al., 1995; Muter et al., 2004). Furthermore, confirmatory factor analyses have indicated positive relations between different phonological awareness factors (Muter et al., 2004; Treinies et al., 1999).

Phonological Awareness and Learning to Read

Individual differences in phonological awareness may relate to individual differences in reading for several reasons (Castles & Coltheart, 2004; Wagner & Torgesen, 1987): first, the better a child's phonological awareness, the more easily and successfully the child will learn to read and write. Evidence for this position comes from longitudinal studies measuring phonological awareness and relating it to reading and spelling skills observed at a later point in time. The frequently reported positive correlations (e.g. Bradley & Bryant, 1983; Cardoso-Martins, 1995; Frost, 2001; Juel, 1988; Juel et al., 1986; Landerl & Wimmer, 1994; Muter et al., 2004; Muter et al., 1998) are consistent with the assumption that phonological awareness fosters reading development. Second, reading instruction itself, or at least the knowledge of grapheme–phoneme correspondences (i.e. letter knowledge), promotes phonological awareness. Through encountering letters or text, children gain increasing insight into the sound structure of oral language, and this promotes the development of their phonological awareness. Furthermore, letter knowledge might lead to a qualitatively different representation of the sound structure of oral language (Lenel, 2005) and also affect the processing of phonological awareness tasks (Castles & Coltheart, 2004). Third, there may be bidirectional influences between phonological awareness and reading (Barron, 1991; Goswami & Bryant, 1990; Wagner, Torgesen, & Rashotte, 1994). An awareness of the syllabic and rhyme structure of oral language may already be present before children commence formal schooling (Fricke et al., 2007; Liberman et al., 1974), and this promotes students' reading development as well as their sensitivity to phonemes. In turn, an awareness of phonemes will increase rapidly when students start learning to read (Goswami, 1999; Goswami & Bryant, 1990; Wimmer, Landerl, Linortner, & Hummer, 1991). Finally, the association between phonological awareness and reading or spelling might arise due to some sort of third variable or underlying cause influencing the development of both skills (Castles & Coltheart, 2004; Scarborough, 2002). This has often been explained with the concept of heterotypic continuity. Accordingly, one underlying cause could lead to diverse cognitive deficits across ontogenesis (see Anthony & Francis, 2005; Caspi & Roberts, 1999; Scarborough, 1991).

Evidence From Correlation Studies

Numerous empirical analyses have found substantial relationships between measures of phonological awareness and reading and spelling skills (Ball, 1993; Goswami & Bryant, 1990; Liberman & Shankweiler, 1985; Wagner & Torgesen, 1987, for a review). Students who performed better on phonological awareness tasks also showed better reading and spelling skills. In addition, three meta-analyses have examined the association between phonological awareness and children's reading skills. However, they all integrated only studies published in English. In the first, Scarborough (1998) meta-analysed average correlations between predictor variables in kindergarten and later reading scores. Phonological awareness was one of the best predictors of later reading development. Based on 27 samples, the reported mean correlation was $r = .46$. Higher correlations between kindergarten predictors and later reading scores were reported for letter identification ($r = .52$) and rudimentary reading ($r = .57$). Lower correlations were found for several further language proficiency measures such as rapid serial naming speed ($r = .38$) and for nonverbal ability measures such as nonverbal IQ ($r = .26$). The second meta-analysis was conducted by the National Early Literacy Panel (2008). Using longitudinal data, the authors found substantial mean correlations between phonological awareness and basic reading skills ($r = .40$), reading comprehension ($r = .44$), and spelling ($r = .40$). Predictions for basic reading skills and spelling were equally strong when phonological awareness was assessed either before or after the beginning of formal education. For reading comprehension, predictions were stronger when phonological awareness was assessed in older children. However, no time trend was found for the assessment of student's reading and spelling. Finally, the third meta-analysis taking phonological awareness into account was conducted by Melby-Lervåg, Lyster, and Hulme (2012). It focused on relationships between different phonological abilities measures and accuracy as well as on the speed of reading words and non-words (basic reading skills). Results showed a strong correlation of $r = .57$ between measures of phonological awareness on the phoneme level and basic reading skills. Phonological awareness on the rhyme level also related substantially to reading, although with a lower magnitude ($r = .43$). The difference between the two average correlations was significant. Furthermore, measures of phonemic awareness and rhyme awareness correlated with each other ($r = .49$) and shared large parts of explained variance in basic reading skills. Hence, taken together, relations between measures of phonological awareness and reading have been proven repeatedly—at least in English-speaking countries. However, findings from students learning German orthography have been considered only rarely in these meta-analyses, because the primary studies were usually published in German and therefore hardly accessible to the international research community. Finally, because orthographies differ in terms of their phoneme–grapheme and grapheme–phoneme consistency, relations between phonological awareness and reading/spelling skills may vary as a function of language. Assessments of phonological awareness are often used to determine whether or not there is a risk of failing to learn to read with all the important practical consequences this may have for the individual child. Therefore, it would be interesting to know the exact magnitude of such a relation in order to evaluate whether and in which way practitioners should apply phonological awareness tests in their work.

Orthographic Transparency and Learning to Read and Write

European languages typically use an alphabetic writing system in which graphemes (letter and letter combinations) represent phonemes. Although the relation between the visual symbols and the corresponding sound units is systematic, it is far from perfect. Inconsistencies arise because graphemes may take several pronunciations, and single phonemes may have multiple spellings. Furthermore, the degree of (in-)transparency varies across orthographies (Borgwaldt, Hellwig, & Groot, 2005; Landerl et al., 2013; Seymor, Aro, & Erskine, 2003). Finnish, for example, has a writing system with a high level of transparency showing a quite consistent mapping between letters and sounds in both directions (grapheme–phoneme correspondence/feedforward consistency as well as phoneme–grapheme correspondence/feedback consistency). English, on the other hand, has a less transparent orthography containing strong ambiguities in grapheme–phoneme as well as phoneme–grapheme correspondence. Finally, German orthography has a medium level of transparency. A high level of consistency is found in grapheme–phoneme correspondence (the reading direction), but a lower level in phoneme–grapheme correspondence (the spelling direction; Landerl & Thaler, 2006). Inconsistent grapheme–phoneme relations can arise in order to preserve a morphological communality among words. This means that words sharing a common meaning will be spelled in the same way even if they are pronounced differently (e.g. heal and health). Furthermore, inconsistencies may arise out of historical and aesthetical reasons (Becker, 2012; Katz & Frost, 1992).

Several authors have stressed the importance of taking differences in the transparency of writing systems into account when studying the development of reading and spelling (e.g. Share, 2008; Wimmer, Hartl, & Moser, 1990; Ziegler & Goswami, 2005, 2006). This has stimulated empirical research on how orthographic transparency affects reading and spelling development (e.g. Georgiou, Parrila, & Papadopoulos, 2008; Goswami, Ziegler, & Richardson, 2005; Hanley, Masterson, Spencer, & Evans, 2004; Landerl et al., 2013; Mann & Wimmer, 2002; Moll et al., 2014; Seymor et al., 2003; Spencer & Hanley, 2003; Vaessen et al., 2010; Ziegler et al., 2010). In summary, most studies have shown that the development of word and non-word reading skills is affected by the orthographic consistency of a language. First, results show that the development of basic reading skills is more difficult and therefore takes longer in less transparent orthographies compared to more consistent writing systems (Ziegler & Goswami, 2005, 2006). For example, Seymor et al. (2003) compared 1st- and 2nd-grade students' reading performance across 14 European orthographies and found that children who were learning to read less transparent orthographies, especially English, made more reading errors and read more slowly than children who were learning to read a more consistent orthography. Even when comparing dyslexic children, reading skills seem lower for children having to learn more complex orthographies (Landerl, Wimmer, & Frith, 1997).

However, cross-linguistic studies have shown some inconsistent results on the role of phonological awareness in reading and spelling. Ziegler et al. (2010) showed that measures of phonological awareness were less important for measures of reading speed and accuracy in more transparent orthographies than in less transparent orthographies. Mann and Wimmer (2002) found similar results when comparing reading development in English- and German-speaking children from kindergarten to Grade 2: reading speed and accuracy were predicted by measures of phonological awareness in English-speaking children but not in German-speaking children. In the same way, Landerl et al. (2013) showed that poor phonological awareness is a more powerful predictor of dyslexia in more complex orthographies. In contrast, however, Caravolas et al. (2012) showed that phonemic awareness predicted the development of reading as well as spelling development equally well across different orthographies. And likewise, Moll et al. (2014) found no systematic relations to orthographic consistency for the relation of phonological awareness to reading speed, reading accuracy, or spelling. Furthermore, on average, the predictive power of phonological awareness was lower for reading speed than for reading accuracy and spelling.

In summary, several conclusions can be drawn from cross-linguistic studies. First, in general, relations between phonological awareness and reading can be expected to be lower or, at most, of equal size in students acquiring German orthography compared to students acquiring English orthography. Second, effects of phonological awareness should be lower for reading speed in comparison to reading accuracy measures (Moll et al., 2014). Third, with regard to spelling, the specifics of German orthography need to be taken into account. German orthography is characterized by a high level of consistency in grapheme–phoneme correspondence (the reading direction), but a lower level of consistency in phoneme–grapheme correspondence (the spelling direction). This asymmetry in orthographic consistency may result in phonological awareness playing a more important role in the development of spelling in comparison to reading (Landerl & Thaler, 2006). However, there is some uncertainty about this assumption, because of the relatively low number of cross-linguistic studies on spelling development (Caravolas, 2004).

Research Questions and Expectations

This meta-analysis focusing on children acquiring German orthography examined the predictive power of measures of phonological awareness for children's reading and spelling. In order to take a developmental perspective into account, it focused exclusively on longitudinal studies with at least two points of measurement. Such assessments of phonological awareness are often also used as a diagnostic tool to predict later reading difficulties. In general, I expected that measures of phonological awareness would positively predict later reading and spelling skills. The meta-analysis also considered different moderators. First, it took the sound unit of the phonological awareness task into account. Because German possesses a relatively transparent alphabetic script in which the graphemes represent phonemes, I expected higher correlations with reading and spelling for measures on the phoneme level than for measures of higher sound segmentation units (syllable or rhyme level). Second, the study explored relations between measures of phonological awareness and different outcome measures. This resulted in the following expectations: (a) due to German orthography, I expected higher correlations for spelling in comparison to measures of reading. (b) With regard to the different reading measures, I expected that phonological awareness would relate less to reading comprehension than to measures of reading accuracy and reading speed. This was because reading comprehension comprises not only basic reading skills but also further linguistic abilities that are less tied to phonological processes (Ebert & Weinert, 2013; Ennemoser, Marx, Weber, & Schneider, 2012; Scarborough, 2002). I had no clear expectations regarding the timing of measurement. The meta-analysis also took into account sample and source characteristics such as sample size, publication status, and year of publication. Again, I had no clear expectations here.

Method

Literature Search and Inclusion Criteria

To perform a comprehensive overview of longitudinal relations between phonological awareness and reading/spelling, I applied a broad systematic literature search strategy. First, I screened electronic databases using a combination of specific keywords. Within the German-language database PSYNDEX, I screened abstracts using the keywords[1] *Phon**, *Laut**, *Reim**, *Silben**, or *sprachliche** in combination with *Lesen**, *Wortschatz**, *Schrift**, *Dekodier**, or *Rechtschreib** (887 hits). I screened abstracts in the English-language database PsycINFO using a combination of the keywords *Phon**, *Rhyme**, *Syllable**, or *Onset** with the terms *Reading**, *Literacy**, *Vocabulary**, *Spelling**, or *Decoding** and the term *German** indicating the location (108 hits). Within GoogleScholar, I crossed the terms *Phonologische*

[1] An asterisk is a wildcard character. This will find all abstracts containing the specific word stem independent of the characters that follow.

Bewusstheit, *Phonemische Bewusstheit*, or *Lautbewusstheit* with the terms *Lesen*, *Schriftspracherwerb*, *Wortschatz*, or *Rechtschreibung* (1060 hits). I conducted the electronic literature search in September–November 2012. The second step was a manual search. I screened all available issues of the following representative journals for the time period from January 1985 (or the date of the first published issue of the journal) to October 2012: *Heilpädagogische Forschung, Kindheit und Entwicklung, Psychologie in Erziehung und Unterricht, Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie, Zeitschrift für Erziehungswissenschaft, Zeitschrift für Kinder- und Jugendpsychiatrie und Psychotherapie*, and *Zeitschrift für Pädagogische Psychologie*. Finally, I checked noticeable citations from the included articles. The literature search was updated in June 2013.

I applied the following inclusion criteria: (a) children's awareness of the phonological structure of the German language had to be assessed at kindergarten age or in the first grade of elementary school; (b) children's reading and/or spelling skills had to be assessed after the beginning of formal education; (c) the study had to be conducted in Germany, Austria, or the German-speaking part of Switzerland and the measures had to be applied in German; (d) observational studies had to have at least two points of measurement and phonological awareness was assessed prior to reading/spelling measures; and (e) the authors had to report a zero-order correlation or any other measure of effect size that could be transformed into such a correlation between measures of phonological awareness and measures of student's reading and/or spelling skills.

Coding

To guarantee a transparent and consistent coding of the studies, I developed a detailed coding manual to be used in combination with a corresponding coding form. In a first run, I coded the studies together with a second rater. After comparing the two ratings, I slightly modified the coding scheme. Then, in a second run, I coded every study again. The final coding scheme comprised information on general characteristics of the study and the sample such as (a) the year of publication; (b) the publication status (e.g. journal article, dissertation); and (c) the sample size (dropouts were subtracted from the original sample if no form of imputation was applied; in the case of varying sample sizes, e.g. due to missing data on some tests, the lower sample size was coded). Concerning the design of the study, I coded the following characteristics: (d) whether phonological awareness was measured before or after the beginning of primary school; (e) the grade level at which reading/spelling skills were measured; and (f) the time interval between the measurement of phonological awareness and the measurement of reading/spelling skills (1 year or less, 1–2 years, more than 2 years). I categorized measures of phonological awareness into three broad categories: (g) first, single tasks measuring the awareness of higher level sound units (syllable, rhyme). This category comprised tasks such as syllable segmentation/counting, rhyme identification, rhyme generation, rhyme oddity tasks, tasks requiring the blending of syllables/onset and rime, or alliteration recognition. The second category comprised single tasks measuring the awareness of sound units at the phoneme level such as sound-to-word comparison, phoneme blending, phoneme segmentation, phoneme deletion, single phoneme replacement, phoneme reversal, single phoneme identification, or phoneme oddity tasks. Finally, the third category contained all forms of composite scores. Composite measures combine different phonological awareness tasks that are only on the syllable/rhyme level, only on the phoneme level, or on both sound unit levels. I rated reading/spelling measures as tasks of (h) reading speed, reading accuracy, reading comprehension, spelling, and composite scores combining different reading/spelling tasks. I also differentiated spelling into measures focusing just on phonetic spelling errors and those that also took non-phonetic spelling errors into account (e.g. evaluating orthographic correctness of the word, correct upper and lower case writing, composite scores, etc.).[2] Finally, (i) I coded bivariate correlations between measures of

---

[2] The differentiation of spelling into measures relying on phonetically correct spelling and measures that take further non-phonetic components into account was not included in the original coding scheme. This coding was

phonological awareness and subsequent reading/spelling tasks. When several correlations were reported due to different measurement points, I coded all correlations. I treated articles reporting results of several studies with distinct datasets as separate samples. To maintain independent samples, I included each dataset only once in this review, regardless of the number of articles analysing this specific dataset. To provide an estimate of the reliability of the final coding, 10 papers reporting 12 studies and 121 individual effect sizes were additionally coded by a third rater. Interrater reliability for the reported ratings was very satisfactory and ranged from κ = 0.906 to κ = 1.00.

Procedure

To integrate the individual effect sizes, I first transformed the correlations between measures of phonological awareness and reading/spelling into Z_r using Fisher's transformation formula (see Card, 2012, p.89, for the exact formula). According to Cohen (1992), a Fisher's Z value of 0.10 (r = .10) may be interpreted as a small; a value of 0.31 (r = .30), as a moderate; and a value of 0.55 (r = .50), as a large effect.[3] Most studies reported more than one effect size per sample due to multiple measures and several points of measurement. Because these multiple effect sizes within one sample are not independent, I calculated the arithmetic mean of these effect sizes on the study level. Subsequently, I weighted the effect sizes of each study by the inverse variance weight of the point estimate within a fixed-effects model in order to determine a mean effect size across all studies. The overall mean effect was additionally estimated using a random-effects model. Random-effects models allow a better generalization of the findings beyond the studies included in the analysis. However, they have a lower statistical power. This is especially problematic when only a low number of studies and small sample sizes are available (Card, 2012).

I tested for the heterogeneity of effect sizes by calculating a Q statistic. A significant Q statistic indicates that effect sizes arise from different populations and do not just vary due to sampling error. Furthermore, I estimated an I^2 index to represent the magnitude of heterogeneity among studies. The I^2 index can vary between 0 and 100 with higher values indicating stronger heterogeneity. Finally, I conducted moderator analyses. For moderators on the study level such as the year of publication, I applied an analogue to the ANOVA approach using Wilson's SPSS macros (Lipsey & Wilson, 2001; Wilson, 2005). However, when the moderator was on the level of individual correlations within each single study (e.g. the measured reading/spelling construct), I computed a mean effect size on the study level for each value of the moderating variable. These effect sizes were subsequently integrated across studies using a fixed-effects model. Finally, in order to look for study artefacts, I created a funnel plot relating sample size to the estimated effect size of each study. In addition, I conducted a weighted regression analysis using Wilson's SPSS macros to regress effect sizes on their samples sizes (Lipsey & Wilson, 2001; Wilson, 2005).

Results

Descriptive Findings

The literature research yielded 19 manuscripts (14 journal articles, 3 dissertations, 1 book chapter, and 1 test manual) reporting results of 21 independent studies that met the above stated inclusion criteria. Thirteen of these 21 samples were drawn in Germany; the other 8, in Austria. Sample size ranged between 9 and 567 students with a mean of 153 and a total number of 3,222. Mean age at the first point of measurement ranged from 60 to 90 months with an arithmetic mean of 77 months.

---

added during revision of the manuscript following a reviewer's recommendation. Interrater reliability for this coding was κ = 0.862. I wish to thank the reviewer for this idea.

[3] Fisher's Z can be converted easily back to a correlation coefficient r using the following formula (see Card, 2012, p.89): $r = (e^{2Z} - 1) / (e^{2Z} + 1)$

Association Between Phonological Awareness and Reading/Spelling Outcomes

In summary, the 21 studies integrated here reported 240 longitudinal correlations of phonological awareness and reading/spelling measures. Therefore, my first step was to compute the average of the reported effect sizes within each study (Table 1). The descriptive findings indicated all studies but one reported a positive relationship between phonological awareness and reading or spelling. In a second step, I integrated the effect sizes across studies within a fixed and a random-effects model. Results showed a mean effect size of $Z_r = 0.318$ (r =.308) and a 95% confidence interval (CI) ranging from $Z_r =$ 0.283 to $Z_r = 0.353$ within a fixed-effects model and a mean effect size of $Z_r = 0.345$ (r =.332) with a 95% CI ranging from $Z_r = 0.279$ to $Z_r = 0.411$ within a random-effects model. Thus, across all studies and measures, an average of about one-tenth of the variation in reading and spelling skills could be predicted by children's phonological awareness. The Q statistic evaluating the heterogeneity of effect sizes, however, was significant ($Q = 54.29$, $df = 20$, $p < .001$) indicating a substantial variation in effect sizes beyond sampling error. Consequently, it seemed plausible to assume that further variables moderate the magnitude of the relation between phonological awareness and reading/spelling skills.

Table 1

Longitudinal Studies Reporting Correlations Between Phonological Awareness and Reading/Spelling

			Fisher's *Z*	
Study	*N*	*l*	*M* (*SE*)	95% CI
Ennemoser, Marx, et al. (2012), Study 1	165	13	0.47 (0.08)	[0.32, 0.63]
Ennemoser, Marx, et al. (2012), Study 2	175	14	0.39 (0.08)	[0.24, 0.54]
Fricke, Szcerbinski, et al. (2008)	69	44	0.25 (0.12)	[0.00, 0.49]
Goldammer, Mähler, et al. (2010)	47	3	0.29 (0.15)	[0.00, 0.59]
Grube & Hasselhorn (2006)	31	6	0.32 (0.19)	[-0.05, 0.69]
Jansen (1992)	32	1	-0.02 (0.19)	[-0.38, 0.34]
Klicpera, Ehgartner et al., (1993), Study 1	9	2	0.76 (0.41)	[-0.04, 1.56]
Klicpera, Ehgartner at al., (1993), Study 2	82	2	0.40 (0.11)	[0.18, 0.62]
Klicpera & Gasteiger-Klicpera (1998)	76	1	0.30 (0.12)	[0.07, 0.53]
Krajewski, Schneider, et al. (2008)	96	1	0.55 (0.10)	[0.35, 0.75]
Landerl, Linortner, et al. (1992)	50	12	0.27 (0.15)	[-0.01, 0.56]
Landerl & Wimmer (2008)	115	7	0.39 (0.09)	[0.20, 0.57]
Lenel (2005)	65	9	0.42 (0.13)	[0.17, 067]
Martschinke, Kirschhock, et al. (2004)	375	6	0.46 (0.05)	[0.35, 0.56]
Marx (1991)	39	4	0.99 (0.17)	[0.66, 1.31]
Mayringer, Wimmer, et al. (1998)	567	8	0.22 (0.04)	[0.14, 0.31]
Näslund & Schneider (1996)	89	63	0.17 (0.11)	[-0.04, 0.39]
Nicolussi (1999)	504	12	0.22 (0.04)	[0.14, 0.31]
Niklas, Möllers, et al. (2013)	489	4	0.28 (0.05)	[0.19, 0.37]
Troost, Brunner, et al. (2004)	97	6	0.18 (0.10)	[-0.02, 0.38]
Wimmer, Zwicker, et al. (1991)	50	22	0.43 (0.15)	[0.15, 0.72]

Note. N = effective sample size. *l* = number of reported correlations between phonological awareness and reading/spelling measures. CI = confidence interval.

Moderator Analyses

Measures. I first explored the effect of using different measures of phonological awareness on the prediction of reading and spelling (Table 2). Single measures of phonological awareness requiring an awareness of higher level sound units (syllables and rhymes) were used in nine studies and predicted reading/spelling with a mean effect size of $Z_r = 0.222$ ($r = .218$) and a 95% CI ranging from $Z_r = 0.177$ to $Z_r = 0.267$. The awareness of sound units at the phoneme level was also assessed in nine studies and predicted reading/spelling with a mean effect size of $Z_r = 0.355$ ($r = .341$) and a 95% CI ranging from $Z_r = 0.294$ to $Z_r = 0.417$. Finally, composite measures combining several phonological awareness tasks were applied in 11 studies. The mean effect size on reading/spelling was $Z_r = 0.414$ ($r = .392$) with a 95% CI ranging from $Z_r = 0.364$ to $Z_r = 0.463$. Taken together, phonological awareness tasks focusing on higher level sound units (syllables and rhymes) were less predictive of later reading/spelling outcomes than phonological awareness tasks on the phoneme level or all forms of composite measures of phonological awareness because the 95% CIs did not overlap.

In the next step, I analysed the role of phonological awareness in different outcome measures. Phonological awareness moderately predicted reading speed ($Z_r = 0.271$, $r = .264$), reading accuracy ($Z_r = 0.271$, $r = .264$), reading comprehension ($Z_r = 0.418$, $r = .395$), spelling ($Z_r = 0.349$, $r = .336$), and composite reading/spelling measures ($Z_r = 0.256$, $r = 0.250$). The 95% CI for reading comprehension did not overlap with the 95% CIs for reading speed, reading accuracy, or composite reading/spelling

Table 2

Mean Effect Sizes for Longitudinal Relations Between Phonological Awareness and Reading/Spelling Moderated by Task Characteristics

		Fisher's *Z*		Homogeneity statistics	
Variables	*k*	*M* (*SE*)	95% CI	Q	I^2
Total effect					
Fixed-effects model	21	0.318 (0.018)***	[0.283, 0.353]	54.29***	63.16
Random-effects model	21	0.345 (0.034)***	[0.279, 0.411]		
Level of phonological awareness					
Single tasks on syllable/rhyme level	9	0.222 (0.023)***	[0.177, 0.267]	13.06	38.72
Single tasks on phoneme level	9	0.355 (0.032)***	[0.294, 0.417]	31.00***	74.19
Composite scores	11	0.414 (0.025)***	[0.364, 0.463]	6.45	0.00
Type of reading/spelling test					
Reading speed	14	0.271 (0.019)***	[0.234, 0.308]	37.53***	65.36
Reading accuracy	9	0.271 (0.032)***	[0.207, 0.334]	26.71***	70.05
Reading comprehension	5	0.418 (0.034)***	[0.351, 0.485]	7.10	43.65
Spelling (overall)	15	0.349 (0.020)***	[0.310, 0.389]	23.21	39.69
Composite reading/spelling	2	0.256 (0.040)***	[0.178, 0.334]	0.15	0.00
Type of spelling test					
Phonetic spelling errors	4	0.290 (0.036)***	[0.219, 0.360]	4.85	38.20
Non-phonetic spelling errors	13	0.377 (0.023)***	[0.331, 0.423]	21.65*	44.58

Note. Homogeneity statistics: Under the null hypothesis of homogeneity of effect sizes, the Q statistic follows a χ^2 distribution with $df = k - 1$; I^2 is calculated as $(Q - (k - 1)) \times 100/Q$ when $Q > (k - 1)$ and is 0 when $Q \leq (k - 1)$. *k* = number of studies; CI = confidence interval.

*** $p < .001$

** $p < .01$

* $p < .05$

scores. In addition, the 95% CIs for spelling and reading speed did not overlap, indicating that differences in effect size could be interpreted as statistically significant. Finally, in spelling I differentiated measures relying exclusively on phonetic spelling errors from measures that took further non-phonetic spelling errors into account. Phonological awareness predicted phonetic spelling (Z_r = 0.290, r = .282) equally well as spelling that took further non-phonetic errors into account (Z_r = 0.377, r = .360).

Timing. I differentiated studies according to whether phonological awareness was assessed when the children were at kindergarten age or in Grade 1 (Table 3). Phonological awareness assessed before the beginning of formal education moderately predicted reading/spelling (Z_r = 0.321, r = .310) as did phonological awareness assessed in Grade 1 (Z_r = 0.318, r = .308). Then, I evaluated the time of assessment of reading and spelling. On average, phonological awareness predicted Grade 1 reading/spelling with an effect size of Z_r = 0.325 (r = .314), Grade 2 reading/spelling with an effect size of Z_r = 0.385 (r = .367), and reading/spelling in Grade 3 and above with an effect size of Z_r = 0.325 (r = .314). Finally, I evaluated the interval between the pre-test of phonological awareness and the post-

Table 3

Mean Effect Sizes for Longitudinal Relations Between Phonological Awareness and Reading/Spelling Moderated by Study and Source Characteristics

		Fisher's *Z*		Homogeneity statistics	
Variables	*k*	*M* (*SE*)	95% CI	Q	I^2
Time of pre-test					
Kindergarten	9	0.321 (0.028)***	[0.266, 0.376]	15.09	46.98
Grade 1	13	0.318 (0.023)***	[0.274, 0.362]	42.87***	72.01
Time of post-test					
Grade 1	17	0.325 (0.018)***	[0.289, 0.361]	50.80***	68.51
Grade 2	8	0.385 (0.031)***	[0.323, 0.446]	12.38	43.46
Grade 3+	7	0.325 (0.030)***	[0.265, 0.384]	19.47**	69.18
Interval between pre- and post-test					
Up to 12 months	16	0.332 (0.020)***	[0.292, 0.373]	45.10***	66.74
13 to 24 months	10	0.364 (0.025)***	[0.315, 0.413]	20.81*	56.75
More than 24 months	7	0.304 (0.030)***	[0.244, 0.363]	12.72*	52.85
Type of report[a]					
Journal article	16	0.317 (0.022)***	[0.275, 0.359]	38.82***	61.36
Dissertation	3	0.233 (0.041)***	[0.153, 0.314]	4.07	50.87
Test manual	1	0.457 (0.052)***	[0.355, 0.558]	0.00	0.00
Book chapter	1	0.321 (0.189)	[-0.049, 0.692]	0.00	0.00
Year of publication[a]					
1991–2000	10	0.258 (0.026)***	[0.207, 0.310]	27.84**	67.68
2001–2012	11	0.369 (0.024)***	[0.322, 0.417]	16.79	40.44

Note. Homogeneity statistics: Under the null hypothesis of homogeneity of effect sizes, the Q statistic follows a χ^2 distribution with df = k - 1; I^2 is calculated as (Q - (k - 1)) x 100/Q when Q > (k - 1) and is 0 when Q ≤ (k - 1). *k* = number of studies; CI = confidence interval.

[a]This moderator was evaluated using an analogue to the ANOVA approach. Only within-group homogeneity statistics (Q_{within}) are depicted in the table. Between-group homogeneity ($Q_{between}$) was 11.40, df = 3, $p < .01$, for type of report; and 9.66, df = 1, $p < .01$, for year of publication.

*** $p < .001$

** $p < .01$

* $p < .05$

test of reading/spelling. When both assessments took place within 1 year, the average effect size was Z_r = 0.332 (r = .321). When phonological awareness was assessed 1 to 2 years prior to reading/spelling, the mean effect size was Z_r = 0.364 (r = .349). And finally, after a time period of more than 2 years, phonological awareness still moderately predicted reading/spelling with an effect size of Z_r = 0.304 (r = .295). Based on these results, in summary, the predictive power of phonological awareness for later reading and spelling skills remained substantial even for students beyond 2nd grade and after more than 2 years of reading instruction.

Sample size and source characteristics. In the third section of the moderator analysis, I inspected some further aspects of the studies and source characteristics. First, I looked at the date of publication. Studies published up until the year 2000 reported a lower mean effect size of Z_r = 0.258 (r = .253), whereas newer studies published since 2001 reported higher effect sizes (Z_r = 0.369, r = .353). CIs did not overlap. Concerning the type of report, journal articles reported a mean effect size of Z_r = 0.317 (r = .307). Dissertations found lower effect sizes (Z_r = 0.233, r = .229), but CIs still overlapped. Test manuals reported a mean effect size of Z_r = 0.457 (r = .427), exceeding the effect size reported in dissertations. Book chapters reported a mean effect size of Z_r = 0.321 (r = .311). Finally, I considered sample size as a potential moderator and created a funnel plot (Figure 1). A first inspection of the funnel plot indicated a higher variation in effect sizes for smaller studies and a lower variation in effect sizes for studies with larger samples. A weighted regression analysis in which effect sizes were regressed onto sample sizes showed a negative association of effect size with sample size (B = -0.0003, SE = 0.0001, β = -.433, $p < .01$).[4] Studies with larger samples reported lower effect sizes.

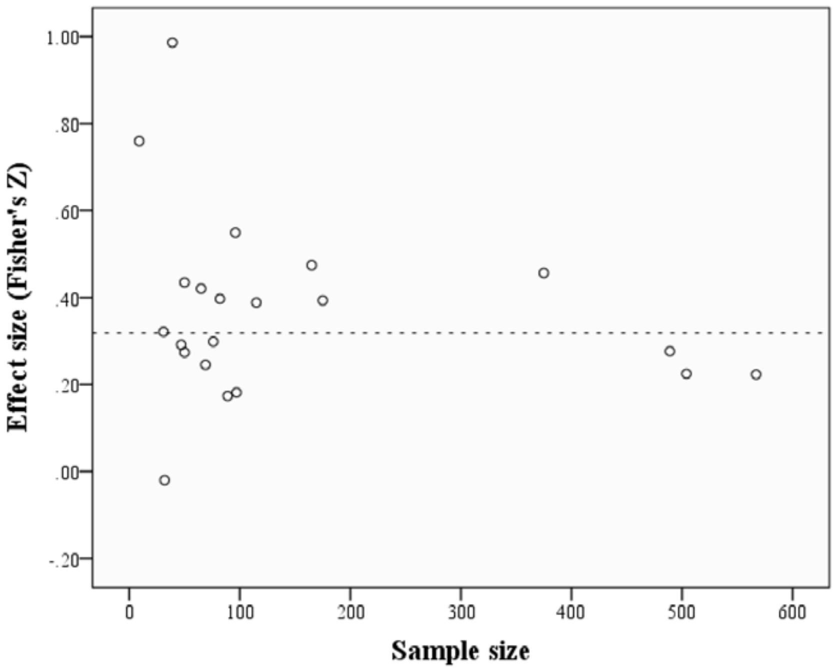

Figure 1. Funnel plot showing the association of sample size and effect size (Fisher's *Z*) in the summarized studies. The weighted mean effect size of all studies is indicated by the dashed line.

[4] Alternatively, the standard error ($SE_{Zr} = 1 / \sqrt{N-3}$, in which N denotes the sample size of the study; see Card, 2012, p. 90) has often been used instead of sample size. Results of regression analysis show a positive association between effect size and standard error (B = 1.044, SE = 0.451, β = .314, $p < .05$)

Discussion

The role of phonological awareness in learning to read and write has been studied extensively in the English-speaking world, and has also attracted considerable research in German-speaking countries. Results showed that phonological awareness predicts later reading and spelling skills. Studies produced a mean effect of Z_r = 0.318 (r = .308) within a fixed-effects model and Z_r = 0.345 (r = .332) within a random-effects model, indicating that about one-tenth of the variation in later reading/spelling skills can be predicted by phonological awareness. Therefore, within the German writing system as well, which showsa high feedforward consistency (grapheme–phoneme correspondence) and a low feedback consistency (phoneme-grapheme correspondence; Landerl & Thaler, 2006), measures of phonological awareness predict the development of reading and spelling skills at school. However, these results are based on correlation studies alone and should not be interpreted causally, especially because the present study did not rule out third variables or further alternative explanations for this association.

Considering that the current study focused exclusively on longitudinal research conducted in the German language, it would be interesting to compare these findings with those from meta-analyses of research on further languages or orthographies. Compared to findings reported by international meta-analyses (Melby-Lervåg et al., 2012; National Early Literacy Panel, 2008; Scarborough, 1998; for details see above), the correlations found in the German language context are either lower or just reach the size reported in meta-analyses of English-language studies containing research on English-speaking countries. This finding is, at least to some extent, in line with cross-language research focusing on the role of orthographic transparency for reading development. In languages with a more transparent orthography, efficient grapheme–phoneme recoding strategies are acquired more easily (Seymor et al., 2003; Ziegler & Goswami, 2005), and early differences in recoding skills should diminish because even impaired readers will successfully acquire such skills early on. Therefore, consequences of individual differences in phonological awareness for reading development should be less enduring, and relations of phonological awareness to reading should tend to be weaker (see Mann & Wimmer, 2002; Share, 2008; Ziegler et al., 2010).

Moderator Analyses

This review evaluated several variables that might moderate the association between phonological awareness and reading/spelling. Tasks at the syllable or rhyme level were less related to reading and spelling skills than tasks on the phoneme level and composite scores combining several phonological awareness tasks. This was in line with expectations. The German writing system is based on an alphabetic script. In addition, German orthography is relatively transparent, at least in terms of grapheme–phoneme correspondences. This might explain why an awareness of the phonemic structure of the German language relates more closely to later reading and spelling skills than an insight into its higher level sound unit structure. Concerning the predicted outcome, I expected higher correlations for spelling than for measures of reading. Furthermore, I expected phonological awareness to be related less to reading comprehension than to the more code-related measures of reading speed and accuracy. These expectations were only partially confirmed. Spelling was better predicted by phonological awareness than measures of reading speed. This might be attributed in part to characteristics of German orthography that show a higher consistency in the reading direction (grapheme–phoneme correspondence) than in the spelling direction (phoneme–grapheme correspondence). However, phonological awareness was a better predictor of reading comprehension than reading speed or reading accuracy. This ran counter to expectations. Nevertheless, it should be noted that in this early phase of schooling, tests of reading comprehension depend strongly on students' basic reading skills, and it is often not possible to differentiate the two tests from each other (see Ebert & Weinert, 2013). As long as word reading skills are deficient, the available resources for higher comprehension processes are in short supply. As a result, in an early phase of reading development, individual differences in basic reading skills are decisive for differences in reading comprehension (Perfetti, 1985; Perfetti, Landi, & Oakhill, 2005; Snow, 2010). When it comes to the magnitude of the prediction of spelling and reading comprehension, no significant differences were found. Nonetheless, and once again unexpectedly, this might be attributed to the unexpected high effect size reported for the association between phonological awareness and reading comprehension.

Finally, with regard to spelling, an additional analysis showed that phonological awareness was an equally good predictor of not only spelling measures focusing exclusively on phonetic spelling errors but also measures that took further spelling errors such as orthographic spelling errors or incorrect upper and lower case writing into account. At first glance, higher effect sizes for phonetically correct spelling in comparison to orthographically correct spelling could have been expected, because phonological awareness seems to be more involved in processes of phonetic spelling than in processes of orthographic spelling. However, according to the self-teaching hypothesis, the acquisition of word-specific orthographic representations depends strongly on efficient phonological recoding skills (Shahar-Yames & Share, 2008; Share, 1995), so that relations with phonological awareness emerge once more. Finally, results presented by Wimmer, Zwicker, et al. (1991), comparing the prediction of phonetic and orthographic correct spelling in Grade 1 and Grade 3, need to be discussed briefly. In their study, phonological awareness was related to phonetic but not to orthographic spelling in Grade 1, whereas in Grade 3, phonological awareness predicted both phonetic and orthographic spelling equally well. This may again be explained by the aforementioned self-teaching hypothesis (Share, 1995): among beginning readers/spellers, word-specific orthographic representations may be hardly developed in all students due to their lack of print experience. As students grow older, however, individual differences in orthographic representations may develop in accordance with pre-existing individual differences in phonological recoding skills, leading to higher relationships with phonological processing skills, and, inter alia, phonological awareness.

I conducted a second set of moderator analyses on the timing of measurements. Results showed that phonological awareness measured in kindergarten was almost equally predictive of individual differences in reading and spelling as phonological awareness measured in Grade 1. Moreover, phonological awareness predicted individual differences in reading and spelling to a comparable extent in Grade 1 as in Grades 2, 3, and beyond. These findings are in line with results from the international literature (National Early Literacy Panel, 2008), as well as with the concept of heterotypic continuity (Scarborough, 1991, 2002) or the Matthew effect in reading (Pfost, Hattie, Dörfler, & Artelt, 2014; Stanovich, 1986), highlighting continuity of individual differences in reading development. Furthermore, the finding that differences in phonological awareness still predicted individual differences in reading and spelling in Grade 3 and beyond clearly has practical implications: Tests of phonological awareness can be a useful diagnostic tool for identifying children at risk of later reading failure. Nevertheless, it should be borne in mind that phonological awareness tests alone explain only a limited amount of variance in later reading and spelling skills. In addition, poor phonological awareness does not necessarily result in impaired reading skills in the long term, especially with regard to phonemic decoding and spelling (Wimmer, Mayringer, & Landerl, 2000). Therefore, diagnostic tools used by practitioners should not favour phonological awareness tests to the exclusion of other tests such as naming speed (Kirby, Georgiou, Martinussen, & Parrila, 2010; Landerl et al., 2013; Landerl & Thaler, 2006). Finally, I evaluated moderating effects of sample size and characteristics of the report itself. First, there seemed to be no clear trend in the association between effect size and type of report. However, no unpublished reports were analysed, so a systematic bias between published and unpublished studies might still be present. Second, a time trend could be seen: newer studies reported higher effect sizes than older studies. This may reflect the development of better diagnostic tools during the last decade and the use of more effective measures. Finally, I related the sample sizes of studies to the reported effect sizes. An inspection of the funnel plot showed a higher variation in effect sizes for studies with smaller sample sizes. This is not unexpected, because sampling error should decrease with larger samples. However, and as confirmed by a regression analysis indicating a negative association between effect sizes and sample sizes, studies with smaller sample sizes seem to show larger effect sizes. There may be several reasons for this (Card, 2012): on the one hand, it may be due to publication practices. Small studies need larger effects to attain significance and significant results may be more likely to be published (Sterling, Rosenbaum, & Weinkam, 1995). On the other hand, however, studies may differ systematically from each other. For example, the availability of monetary and time resources or differences in the assessment methods applied may vary with the sample size of the study.

Limitations

One of the major limitations to this study is the combination of the low number of studies conducted in German-speaking countries and the low number of students per study. This led to quite wide CIs and restricted the power in detecting moderating effects. Because it is carried out mostly in individual sessions, testing children's phonological awareness is a very time- and money-consuming process compared to assessments in a classroom setting. Furthermore, due to the low number of studies, only fixed-effects models were estimated within moderator analyses, and this restricts any generalization of the findings beyond the studies considered. Another limitation is that I took only zero-order correlations into account. I did not consider studies evaluating the (causal) role of phonological awareness for learning to read and write by concurrently observing further skills such as rapid automatized naming or verbal intelligence, because most of these studies controlled for different covariates. Analyses controlling for different covariates can hardly be integrated systematically across studies and were therefore not included here. Consequently, the present results should not be interpreted in terms of confirming a causal relation between phonological awareness and reading/spelling development. Finally, due to severe deficits in documenting psychometric properties of the instruments applied in the primary studies, correlations between phonological awareness and reading/spelling measures were not corrected for measurement error. However, test batteries used by practitioners are also not free from measurement error, so the results presented in this review might well reflect the potential of using phonological awareness tests to correctly identify children at risk for reading difficulties. Nonetheless, future studies should document the psychometric properties of their instruments in more detail so that their findings will be easier to evaluate. In addition, it might be interesting for future research to consider the specific task demands of phonological awareness measures more explicitly. For example, tasks that require a blending of phonemes might differ in their predictive value from tasks that require their segmentation—especially if an interaction with the reading/spelling tasks is taken into account.

Conclusion

In summary, phonological awareness in young children successfully predicts later reading and spelling. However, it can explain only about 10–15% of the later variance in reading and spelling skills. Therefore, phonological awareness should be seen as just one factor alongside others such as naming speed (Kirby et al., 2010) that predict a successful acquisition of reading and spelling at school. Despite such positive correlations, fostering children's phonological awareness does not necessarily lead to significant improvements in later reading and spelling skills. Meta-analyses confirm significant positive effects of phonemic awareness instruction for reading and spelling, but effects tend to be higher when the language of instruction is English compared to other languages (Ehri et al., 2001). Several German-language training programmes of phonological awareness are available such as "Hören, lauschen, lernen" (Küspert & Schneider, 2008; Plume & Schneider, 2004), and evaluations of phonological awareness trainings in German orthography confirm that these programmes are, at least in parts, effective (e.g. Blatter et al., 2013; Schneider, Küspert, Roth, Visé, & Marx, 1997). However, two recent meta-analyses (Fischer & Pfost, 2015; Ise, Engel, & Schulte-Körne, 2012) raised serious doubts that training programmes of phonological awareness in German language are as effective as training programmes of phonological awareness in other languages, especially in English. Ise, Engel, and Schule-Körne (2012) compared different German-language approaches to reading interventions for struggling readers. They did not confirm any significant positive effects of training phonological awareness. Fischer and Pfost (2015) systematically reviewed research on phonological awareness trainings in German language for both children at risk and not at risk for developing reading difficulties. Although across all studies positive effects of training phonological awareness for reading and spelling were found, effect sizes were comparably small. The current study therefore joins findings from prior meta-analyses and cross-linguistic studies in emphasizing the need to question how far findings on how phonological awareness relates to reading and spelling actually generalize across languages.

Acknowledgment

I thank Cordula Artelt, Kristine Blatter, and Susanne Ebert (all University of Bamberg, Germany) for their support and helpful comments on an earlier draft of this article. I further thank Julia Scholz and Melanie Y. Fischer (both also University of Bamberg, Germany) for their assistance in conducting this study, and Jonathan Harrow for native-speaker advice.

References

(References marked with an asterisk indicate studies included in the meta-analysis)

Anthony, J. L., & Francis, D. J. (2005). Development of phonological awareness. *Current Directions in Psychological Science, 14*, 255-259. doi:10.1111/j.0963-7214.2005.00376.x

Anthony, J. L., & Lonigan, C. J. (2004). The nature of phonological awareness: Converging evidence from four studies of preschool and early grade school children. *Journal of Educational Psychology, 96*, 43-55. doi: 10.1037/0022-0663.96.1.43

Ball, E. W. (1993). Phonological awareness. *Reading and Writing, 5*, 141-159. doi:10.1007/BF01027481

Barron, R. W. (1991). Proto-literacy, literacy and the acquisition of phonological awareness. *Learning and Individual Differences, 3*, 243-255. doi:10.1016/1041-6080(91)90010-X

Barth, K., & Gomm, B. (2008). Gruppentest zur Früherkennung von Lese- und Rechtschreibschwierigkeiten. Phonologische Bewusstheit bei Kindergartenkindern und Schulanfängern (PB-LRS) [A group testing procedure for the early diagnosis of reading and spelling difficulties. Phonological awareness in preschool children and children starting school]. In W. Schneider, H. Marx & M. Hasselhorn (Eds.), *Diagnostik von Rechtschreibleistungen und -kompetenz* (pp. 7-43). Göttingen, Germany: Hogrefe.

Becker, T. (2012). *Einführung in die Phonetik und Phonologie des Deutschen [An introduction to German phonetics and phonology]*. Darmstadt, Germany: WBG Wissenschaftliche Buchgesellschaft.

Blaser, R. (2002). *Erprobung und Validierung des Konzeptes "Phonologische Bewusstheit" in der Frühdiagnostik und Prävention späterer Lesestörungen an einer Stichprobe Schweizer Kinder [Testing and validating the concept of phonological awareness for the early diagnosis and prevention of later reading difficulties in a sample of Swiss children]*. Unpublished doctoral dissertation, Universität Bern, Bern, Switzerland.

Blatter, K., Faust, V., Jäger, D., Schöppe, D., Artelt, C., Schneider, W., & Stanat, P. (2013). Vorschulische Förderung der phonologischen Bewusstheit und der Buchstaben-Laut-Zuordnung: Profitieren auch Kinder nichtdeutscher Herkunftssprache? [How effective is a preschool training of phonological awareness and letter sound correspondence for student's with migration background?]. In A. Redder & S. Weinert (Eds.), *Sprachförderung und Sprachdiagnostik: Interdisziplinäre Perspektiven* (pp. 218-238). Münster, Germany: Waxmann.

Borgwaldt, S. R., Hellwig, F. M., & Groot, A. M. B. d. (2005). Onset entropy matters: Letter-to-phoneme mappings in seven languages. *Reading and Writing, 18*, 211-229. doi:10.1007/s11145-005-3001-9

Bradley, L., & Bryant, P. E. (1978). Difficulties in auditory organisation as a possible cause of reading backwardness. *Nature, 271*, 746-747. doi:10.1038/271746a0

Bradley, L., & Bryant, P. E. (1983). Categorizing sounds and learning to read: A causal connection. *Nature, 301*, 419-421. doi:10.1038/301419a0

Caravolas, M. (2004). Spelling development in alphabetic writing systems: A cross-linguistic perspective. *European Psychologist, 9*, 3-14. doi:10.1027/1016-9040.9.1.3

Caravolas, M., Lervåg, A., Mousikou, P., Efrim, C., Litavský, M., Onochie-Quintanilla, E., . . . Hulme, C. (2012). Common patterns of prediction of literacy development in different alphabetic orthographies. *Psychological Science, 23*, 678-686. doi:10.1177/0956797611434536

Card, N. A. (2012). *Applied meta-analysis for social science research*. New York, NY: Guilford Press.

Cardoso-Martins, C. (1995). Sensitivity to rhymes, syllables and phonemes in literacy acquisition in Portuguese. *Reading Research Quarterly, 30*, 808-828.

Caspi, A., & Roberts, B. W. (1999). Personality continuity and change across the life course. In L. A. Pervin & O. P. John (Eds.), *Handbook of personality. Theory and research* (2 ed., pp. 300-326). New York, NY: Guilford Press.

Castles, A., & Coltheart, M. (2004). Is there a causal link from phonological awareness to success in learning to read? *Cognition, 91*, 77-111. doi:10.1016/S0010-0277(03)00164-1

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*, 155-159.

DeFrancis, J. (1989). *Visible speech. The diverse oneness of writing systems*. Honolulu, HI: University of Hawaii Press.

Ebert, S., & Weinert, S. (2013). Predicting reading literacy in primary school: The contribution of various language indicators in preschool. In M. Pfost, C. Artelt & S. Weinert (Eds.), *The development of reading literacy from early childhood to adolescence. Empirical findings from the Bamberg BiKS longitudinal studies* (pp. 93-149). Bamberg, Germany: University of Bamberg Press.

Ehri, L. C., Nunes, S. R., Willows, D. M., Schuster, B. V., Yaghoub-Zadeh, Z., & Shanahan, T. (2001). Phonemic awareness instruction helps children learn to read: Evidence from the National Reading Panel's meta-analysis. *Reading Research Quarterly, 36*, 250-287. doi:10.1598/RRQ.36.3.2

*Ennemoser, M., Marx, P., Weber, J., & Schneider, W. (2012). Spezifische Vorläuferfertigkeiten der Lesegeschwindigkeit, des Leseverständnisses und des Rechtschreibens. Evidenz aus zwei Längsschnittstudien vom Kindergarten bis zur 4. Klasse [Specific precursors of decoding speed, reading comprehension, and spelling: Evidence from two longitudinal studies from kindergarten to Grade 4]. *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie, 44*, 53-67. doi:10.1026/0049-8637/a000057

Fischer, M. Y. & Pfost, M. (2015). Wie effektiv sind Maßnahmen zur Förderung der phonologischen Bewusstheit? Eine meta-analytische Untersuchung der Auswirkungen deutschsprachiger Trainingsprogramme auf den Schriftspracherwerb [How effective are trainings of phonological awareness? A meta-analysis of German language training programs and their effects on the acquisition of reading and spelling skills]. *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie, 47,* 35-51.

Fricke, S., Stackhouse, J., & Wells, B. (2007). Phonologische Bewusstheitsfähigkeiten deutschsprachiger Vorschulkinder - eine Pilotstudie [Phonological awareness skills in German-speaking children: Test development and first comparative data]. *Forum Logopädie, 21*, 14-19.

*Fricke, S., Szcerbinski, M., Stackhouse, J., & Fox-Boyer, A. V. (2008). Predicting individual differences in early literacy acquisition in German. *Written Language & Literacy, 11*, 103-146. doi:10.1075/wll.11.2.02fri

Frost, J. (2001). Phonemic awareness, spontaneous writing, and reading and spelling development from a preventive perspective. *Reading and Writing, 14*, 487-513. doi:10.1023/A:1011143002068

Georgiou, G. K., Parrila, R., & Papadopoulos, T. C. (2008). Predictors of word decoding and reading fluency across languages varying in orthographic consistency. *Journal of Educational Psychology, 100*, 566-580. doi:10.1037/0022-0663.100.3.566

*Goldammer, A. von, Mähler, C., Bockmann, A.-K., & Hasselhorn, M. (2010). Vorhersage früher Schriftsprachleistungen aus vorschulischen Kompetenzen der Sprache und der phonologischen Informationsverarbeitung [Prediction of reading and spelling from preschool competencies in language and phonological information processing]. *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie, 42*, 48-56. doi:10.1026/0049-8637/a000005

Goswami, U. (1999). Causal connections in beginning reading: The importance of rhyme. *Journal of Research in Reading, 22*, 217-240. doi:10.1111/1467-9817.00087

Goswami, U., & Bryant, P. E. (1990). *Phonological skills and learning to read*. Hove, UK: Psychology Press.

Goswami, U., Ziegler, J. C., & Richardson, U. (2005). The effects of spelling consistency on phonological awareness: A comparison of English and German. *Journal of Experimental Child Psychology, 92*, 345-365. doi:10.1016/j.jecp.2005.06.002

*Grube, D., & Hasselhorn, M. (2006). Längsschnittliche Analysen zur Lese-, Rechtschreib- und Mathematikleistung im Grundschulalter: zur Rolle von Vorwissen, Intelligenz, phonologischen Arbeitsgedächtnis und phonologischer Bewusstheit [Longitudinal analyses of reading, spelling and mathematics achievement in primary school age. The role of prior knowledge, intelligence, phonological working memory and phonological awareness]. In I. Hosenfeld & F.-W. Schrader (Eds.), *Schulische Leistung. Grundlagen, Bedingungen, Perspektiven* (pp. 87-105). Münster, Germany: Waxmann.

Hanley, R., Masterson, J., Spencer, L. H., & Evans, D. (2004). How long do the advantages of learning to read a transparent orthography last? An investigation of the reading skills and reading impairment of Welsh children at 10 years of age. *The Quarterly Journal of Experimental Psychology Section A: Human Experimental Psychology, 57*, 1393-1410. doi:10.1080/02724980343000819

Hoien, T., Lundberg, I., Stanovich, K. E., & Bjaalid, I.-K. (1995). Components of phonological awareness. *Reading and Writing, 7*, 171-188. doi:10.1007/BF01027184

Ise, E., Engel, R. E., & Schulte-Körne, G. (2012). Was hilft bei Lese-Rechtschreibstörung? Ergebnisse einer Metaanalyse zur Wirksamkeit deutschsprachiger Förderansätze [Effective treatment of dyslexia: A meta-analysis of German-language intervention studies]. *Kindheit und Entwicklung, 21*, 122-136. doi:10.1026/0942-5403/a000077

*Jansen, H. (1992). *Untersuchungen zur Entwicklung lautsynthetischer Verarbeitungsprozesse im Vorschul- und frühen Grundschulalter [Studies on the development of sound synthesis processes in preschool and early school age]*. Egelsbach, Germany: Verlag Hänsel-Hohenhausen.

Juel, C. (1988). Learning to read and write: A longitudinal study of 54 children from first through fourth grades. *Journal of Educational Psychology, 80*, 437-447. doi:10.1037/0022-0663.80.4.437

Juel, C., Griffith, P. L., & Gough, P. B. (1986). Acquisition of literacy: A longitudinal study of children in first and second grade. *Journal of Educational Psychology, 78*, 243-255. doi:10.1037/0022-0663.78.4.243

Katz, L., & Frost, R. (1992). The reading process is different for different orthographies: The orthographic depth hypothesis. In R. Frost & L. Katz (Eds.), *Orthography, phonology, morphology, and meaning* (pp. 67-84). Amsterdam, Netherlands: Elsevier Science Publishers.

Kirby, J., Georgiou, G. K., Martinussen, R., & Parrila, R. (2010). Naming speed and reading: From prediction to instruction. *Reading Research Quarterly, 45*, 341-362. doi:10.1598/RRQ.45.3.4

*Klicpera, C., Ehgartner, M., Gasteiger-Klicpera, B., & Schabmann, A. (1993). Voraussetzungen für das Lesenlernen bei lernbehinderten Kindern in der Sonderschule und bei guten und schwachen Lesern in der Grundschule: Eine Längsschnittuntersuchung zur Entwicklung des phonematischen Bewußtseins in der ersten Schulstufe [Prerequisites of reading development in students with learning difficulties in special education schools and good as well as poor readers in primary school. A longitudinal study on the development of phonemic awareness in 1st grade]. *Heilpädagogische Forschung, 19*, 104-109.

Klicpera, C., & Gasteiger-Klicpera, B. (1993). *Lesen und Schreiben: Entwicklung und Schwierigkeiten [Reading and writing: Development and difficulties]*. Bern, Switzerland: Verlag Hans Huber.

*Klicpera, C., & Gasteiger-Klicpera, B. (1998). Die ersten Stadien der Entwicklung von Lese- und Rechtschreibschwierigkeiten [First stages in the development of reading and spelling problems]. *Heilpädagogische Forschung, 24*, 163-175.

*Krajewski, K., Schneider, W., & Nieding, G. (2008). Zur Bedeutung von Arbeitsgedächtnis, Intelligenz, phonologischer Bewusstheit und früher Mengen-Zahlen-Kompetenz beim Übergang vom Kindergarten in die Grundschule [On the importance of working memory, intelligence, phonological awareness, and early quantity-number-competencies for the successful transition from kindergarten to primary school]. *Psychologie in Erziehung und Unterricht, 55*, 100-113.

Küspert, P., & Schneider, W. (2008). *Hören, lauschen, lernen. Sprachspiele für Kinder im Vorschulalter. Würzburger Trainingsprogramm zur Vorbereitung auf den Erwerb der Schriftsprache [The Würzburg preschool training programme to promote children's reading acquisition]* (6th ed.). Göttingen, Germany: Vandenhoeck & Ruprecht.

*Landerl, K., Linortner, R., & Wimmer, H. (1992). Phonologische Bewusstheit und Schriftspracherwerb im Deutschen [Phonological awareness and spelling acquisition in German]. *Zeitschrift für Pädagogische Psychologie, 6*, 17-33.

Landerl, K., Ramus, F., Moll, K., Lyytinen, H., Leppänen, P. H. T., Lohvansuu, K., . . . Schulte-Körne, G. (2013). Predictors of developmental dyslexia in European orthographies with varying complexity. *Journal of Child Psychology and Psychiatry, 54*, 686-694. doi:10.1111/jcpp.12029

Landerl, K., & Thaler, V. (2006). Reading and spelling acquisition and dyslexia in German. In R. M. Joshi & P. G. Aaron (Eds.), *Handbook of orthography and literacy* (pp. 121-134). Mahwah, NJ: Erlbaum.

Landerl, K., & Wimmer, H. (1994). Phonologische Bewusstheit als Prädiktor für Lese- und Schreibfertigkeiten in der Grundschule [Phonological awareness as predictor for reading and spelling abilities after two, three and four years of reading instruction]. *Zeitschrift für Pädagogische Psychologie, 8*, 153-164.

*Landerl, K., & Wimmer, H. (2008). Development of word reading fluency and spelling in a consistent orthography: An 8-year follow-up. *Journal of Educational Psychology, 100*, 150-161. doi:10.1037/0022-0663.100.1.150

Landerl, K., Wimmer, H., & Frith, U. (1997). The impact of orthographic consistency on dyslexia: A German-English comparison. *Cognition, 63*, 315-334. doi:10.1016/S0010-0277(97)00005-X

*Lenel, A. (2005). *Schrifterwerb im Vorschulalter [Reading development in preschool age]*. Weinheim, Germany: Beltz.

Liberman, I. Y., & Shankweiler, D. (1985). Phonology and the problems of learning to read and write. *Remedial and Special Education, 6*, 8-17. doi:10.1177/074193258500600604

Liberman, I. Y., Shankweiler, D., Fischer, F. W., & Carter, B. (1974). Explicit syllable and phoneme segmentation in the young child. *Journal of Experimental Child Psychology, 18*, 201-212. doi:10.1016/0022-0965(74)90101-5

Lipsey, M. W., & Wilson, D. B. (2001). *Practical meta-analysis*. Thousand Oaks, CA: Sage.

Lonigan, C. J. (2006). Conceptualizing phonological processing skills in prereaders. In D. K. Dickinson & S. B. Neuman (Eds.), *Handbook of early literacy research* (Vol. 2, pp. 77-89). New York, NY: Guilford Press.

Mann, V., & Wimmer, H. (2002). Phoneme awareness and pathways into literacy: A comparison of German and American children. *Reading and Writing, 15*, 653-682. doi:10.1023/A:1020984704781

*Martschinke, S., Kirschhock, E.-M., & Frank, A. (2004). *Der Rundgang durch Hörhausen. Erhebungsverfahren zur phonologischen Bewusstheit [The tour of Hörhausen. A phonological awareness test]*. Donauwörth, Germany: Auer.

*Marx, H. (1991). Entwicklungsbedingte Verarbeitungsunterschiede bei phonologischen Syntheseaufgaben [Developmental differences in processing phonological synthesis tasks]. *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie, 23*, 330-349.

*Mayringer, H., Wimmer, H., & Landerl, K. (1998). Die Vorhersage früher Lese- und Rechtschreibschwierigkeiten: Phonologische Schwächen als Prädiktoren [The prediction of early reading and spelling difficulties: Phonological deficits as predictors]. *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie, 30*, 57-69.

Melby-Lervåg, M., Lyster, S.-A. H., & Hulme, C. (2012). Phonological skills and their role in learning to read: A meta-analytic review. *Psychological Bulletin, 138*, 322-352. doi:10.1037/a0026744

Moll, K., Ramus, F., Bartling, J., Bruder, J., Kunze, S., Neuhoff, N., . . . Landerl, K. (2014). Cognitive mechanisms underlying reading and spelling development in five European orthographies. *Learning and Instruction, 29*, 65-77. doi:10.1016/j.learninstruc.2013.09.003

Muter, V., Hulme, C., Snowling, M. J., & Stevenson, J. (2004). Phonemes, rimes, vocabulary, and grammatical skills as foundations of early reading development: Evidence from a longitudinal study. *Developmental Psychology, 40*, 665-681. doi:10.1037/0012-1649.40.5.665

Muter, V., Hulme, C., Snowling, M. J., & Taylor, S. (1998). Segmentation, not rhyming, predicts early progress in learning to read. *Journal of Experimental Child Psychology, 71*, 3-27. doi:10.1006/jecp.1998.2453

*Näslund, J. C., & Schneider, W. (1996). Kindergarten letter knowledge, phonological skills, and memory processes: Relative effects on early literacy. *Journal of Experimental Child Psychology, 62*, 30-59. doi:10.1006/jecp.1996.0021

National Early Literacy Panel. (2008). *Developing early literacy: Report of the National Early Literacy Panel*. Washington, DC: National Institute for Literacy.

*Nicolussi, B. (1999). *Phonologische Fertigkeiten und Schriftspracherwerb. Die Vorhersage früher Lese- und Rechtschreibschwierigkeiten mit Hilfe phonologischer Prädiktoren [Phonological abilities and literacy development. The prediction of early reading and writing difficulties by phonological predictors]*. Unpublished doctoral dissertation, Universität Salzburg, Salzburg, Austria.

*Niklas, F., Möllers, K., & Schneider, W. (2013). Die frühe familiäre Lernumwelt als Mediator zwischen strukturellen Herkunftsmerkmalen und der basalen Lesefähigkeit am Ende der ersten Klasse [The early learning environment provided by the family as a mediator between structural family background and basic reading abilities at the end of Grade 1]. *Psychologie in Erziehung und Unterricht, 60*, 94-111. doi:10.2378/peu2013.art08d

Perfetti, C. A. (1985). *Reading ability*. New York, NY: Oxford University Press.

Perfetti, C. A., Landi, N., & Oakhill, J. (2005). The acquisition of reading comprehension skill. In M. J. Snowling & C. Hulme (Eds.), *The science of reading: A handbook* (pp. 227-247). Malden, MA: Blackwell Publishing.

Pfost, M., Hattie, J., Dörfler, T., & Artelt, C. (2014). Individual differences in reading development: A review of 25 years of empirical research on Matthew effects in reading. *Review of Educational Research, 84*, 203-244. doi:10.3102/0034654313509492

Phillips, B. M., & Torgesen, J. K. (2006). Phonemic awareness and reading: Beyond the growth of initial reading accuracy. In D. K. Dickinson & S. B. Neuman (Eds.), *Handbook of early literacy research* (Vol. 2, pp. 101-112). New York, NY: Guilford Press.

Plume, E., & Schneider, W. (2004). *Hören, lauschen, lernen 2. Spiele mit Buchstaben und Lauten für Kinder im Vorschulalter. Würzburger Buchstaben-Laut-Training [The Würzburg preschool training programme for promoting children's reading acquisition including a training of letter-sound correspondence]*. Göttingen, Germany: Vandenhoeck & Ruprecht.

Rittle-Johnson, B., & Siegler, R. S. (1999). Learning to spell: Variability, choice, and change in children's strategy use. *Child Development, 70*, 332-348. doi:10.1111/1467-8624.00025

Scarborough, H. S. (1991). Antecedents to reading disability: Preschool language development and literacy experiences of children from dyslexic families. *Reading and Writing, 3*, 219-233. doi:10.1007/BF00354959

Scarborough, H. S. (1998). Early identification of children at risk for reading disabilities. Phonological awareness and some other promising factors. In B. K. Shapiro, P. J. Accardo & A. J. Capute (Eds.), *Specific reading disability. A view of the spectrum* (pp. 75-119). Timonium, MD: York Press.

Scarborough, H. S. (2002). Connecting early language and literacy to later reading (dis)abilities: Evidence, theory, and practice. In S. B. Neuman & D. K. Dickinson (Eds.), *Handbook of early literacy research* (pp. 97-110). New York, NY: Guilford Press.

Schneider, W. (2009). The development of reading and spelling. Relevant precursors, developmental changes, and individual differences. In W. Schneider & M. Bullock (Eds.), *Human development from early childhood to early adulthood. Findings from a 20 year longitudinal study* (pp. 199-220). New York, NY: Taylor & Francis.

Schneider, W., Küspert, P., Roth, E., Visé, M., & Marx, H. (1997). Short- and long-term effects of training phonological awareness in kindergarten: Evidence from two German studies. *Journal of Experimental Child Psychology, 66*, 311-340. doi:10.1006/jecp.1997.2384

Schnitzler, C. D. (2008). *Phonologische Bewusstheit und Schriftspracherwerb [Phonological awareness and literacy development]*. Stuttgart, Germany: Thieme.

Seymor, P. H. H., Aro, M., & Erskine, J. M. (2003). Foundation literacy acquisition in European orthographies. *British Journal of Psychology, 94*, 143-174.

Shahar-Yames, D., & Share, D. L. (2008). Spelling as a self-teaching mechanism in orthographic learning. *Journal of Research in Reading, 31*, 22-39. doi:10.1111/j.1467-9817.2007.00359.x

Share, D. L. (1995). Phonological recoding and self-teaching: Sine qua non of reading acquisition. *Cognition, 55*, 151-218. doi:10.1016/0010-0277(94)00645-2

Share, D. L. (2008). On the anglocentrics of current reading research and practice: The perils of overreliance on an "outlier"orthography. *Psychological Bulletin, 134*, 584-615. doi:10.1037/0033-2909.134.4.584

Skowronek, H., & Marx, H. (1989). Die Bielefelder Längsschnittstudie zur Früherkennung von Risiken der Lese-Rechtschreibschwäche: Theoretischer Hintergrund und erste Befunde [The Bielefeld longitudinal study for the early diagnosis of dyslexia risk factors: Theoretical background and first results]. *Heilpädagogische Forschung, 15*, 38-49.

Snow, C. E. (2010). Reading comprehension: Reading for learning. In P. Peterson, E. Baker & B. McGaw (Eds.), *International encyclopedia of education* (pp. 413-418). Oxford, UK: Elsevier.

Spencer, L. H., & Hanley, J. R. (2003). Effects of orthographic transparency on reading and phoneme awareness in children learning to read in Wales. *British Journal of Psychology, 94*, 1-28. doi:10.1348/000712603762842075

Stanovich, K. E. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly, 21*, 360-407. doi:10.1598/RRQ.21.4.1

Sterling, T. D., Rosenbaum, W. L., & Weinkam, J. J. (1995). Publication decisions revisited: The effect of the outcome of statistical tests on the decision to publish and vice versa. *The American Statistican, 49*, 108-112.

Treiman, R., & Bourassa, D. C. (2000). The development of spelling skill. *Topics in Language Disorders, 20, (3)*, 1-18.

Treinies, G., Martschinke, S., Kirschhock, E.-M., & Frank, A. (1999). *Die Entwicklung und Evaluation eines Erhebungsverfahrens zur phonologischen Bewußtheit im ersten Schuljahr [The development and evaluation of a phonological awareness test in 1st grade]*. Nürnberg, Germany: Institut für Grundschulforschung.

*Troost, J., Brunner, M., & Pröschel, U. (2004). Validität des Heidelberger Vorschulscreenings zur auditiv-kinästhetischen Wahrnehmung und Sprachverarbeitung [Validity of the Heidelberger Vorschulscreening (HVS)]. *Diagnostica, 50*, 193-201. doi:10.1026/0012-1924.50.4.193

Vaessen, A., Bertrand, D., Tóth, D., Csépe, V., Faísca, L., Reis, A., & Blomert, L. (2010). Cognitive development of fluent word reading does not qualitatively differ between transparent and opaque orthographies. *Journal of Educational Psychology, 102*, 827-842. doi:10.1037/a0019465

Wagner, R. K., & Torgesen, J. K. (1987). The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin, 101*, 192-212. doi:10.1037/0033-2909.101.2.192

Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (1994). Development of reading-related phonological processing abilities: New evidence of bidirectional causality from a latent variable longitudinal study. *Developmental Psychology, 30*, 73-87. doi:10.1037/0012-1649.30.1.73

Wilson, D. B. (2005). Meta-analysis macros for SAS, SPSS, and Stata (Version 2005.05.23). Retrieved from http://mason.gmu.edu/~dwilsonb/ma.html

Wimmer, H., Hartl, M., & Moser, E. (1990). Passen "englische" Modelle des Schriftspracherwerbs auf "deutsche" Kinder? Zweifel an der Bedeutsamkeit der logographischen Stufe [Are English models of literacy development valid for German children? Doubts concerning the significance of the logographic stage]. *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie, 22*, 136-154.

Wimmer, H., Landerl, K., Linortner, R., & Hummer, P. (1991). The relationship of phonemic awareness to reading acquisition: More consequence than precondition but still important. *Cognition, 40*, 219-249. doi:10.1016/0010-0277(91)90026-Z

Wimmer, H., Mayringer, H., & Landerl, K. (2000). The double-deficit hypothesis and difficulties in learning to read a regular orthography. *Journal of Educational Psychology, 92*, 668-680. doi:10.10371/0022-0663.92.4.668

*Wimmer, H., Zwicker, T., & Gugg, D. (1991). Schwierigkeiten beim Lesen und Schreiben in den ersten Schuljahren: Befunde zur Persistenz und Verursachung [Persistence and causes of reading and writing difficulties in the first school years]. *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie, 23*, 280-298.

Ziegler, J. C., Bertrand, D., Tóth, D., Csépe, V., Reis, A., Faísca, L., . . . Blomert, L. (2010). Orthographic depth and its impact on universal predictors of reading: A cross-language investigation. *Psychological Science, 21*, 551-559. doi:10.1177/0956797610363406

Ziegler, J. C., & Goswami, U. (2005). Reading acquisition, developmental dyslexia, and skilled reading across languages: A psycholinguistic grain size theory. *Psychological Bulletin, 131*, 3-29. doi:10.1037/0033-2909.131.1.3

Ziegler, J. C., & Goswami, U. (2006). Becoming literate in different languages: Similar problems, different solutions. *Developmental Science, 9*, 429-453. doi:10.1111/j.1467-7687.2006.00509.x