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Language abilities and phonological information processing mediate the association of spelling with bilingualism and socioeconomic status

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Introduction: Research to date has focused on the associations between spelling and (i) its precursors (phonological information processing and language) and (ii) socioeconomic status and bilingualism. Studies have also indicated that bilingualism and parental education are associated with spelling precursors. Whereas these associations have previously been analyzed individually, this study proposes a mediation model in which the effects of socioeconomic status and bilingualism on spelling are mediated by phonological information processing and language skills.

Methods: A total of 1,012 German-speaking first graders attending primary schools in Austria were assessed at the beginning of the first grade on their phonological information processing and language abilities, and their spelling abilities were tested again at the end of the first grade. Subsequently, a structural equation modeling approach was employed to evaluate the mediation model.

Results: In line with the mediation hypothesis, the results show indirect effects of parental education (as a measure of socioeconomic status) on spelling via language and phonological information processing. In addition to mediation, we also found a direct effect of SES on spelling performances. For bilingualism, the results support full mediation as an indirect effect via language abilities. Notably, we found no effect of bilingual status on phonological information processing.

Discussion: This study highlights the ongoing need for systematic oral language training for bilingual children and children from low-SES backgrounds that starts in preschool and continues throughout primary school. Moreover, given the predictive effect of phonological awareness on spelling achievement, phonological awareness should be part of the training for preschool and school-aged children.

KEYWORDS

Schnapp spelling test, bilingualism, first graders, phonological information processing, language abilities, word spelling

1 Introduction

The acquisition of spelling is a protracted cognitive undertaking that requires diligent effort irrespective of the specific orthographic system under consideration. Understanding the challenges associated with spelling acquisition is important to support spelling development. Since accurate spelling is a complex cognitive skill (Pan et al., 2021), numerous factors that influence spelling development must be considered, especially phonological awareness (phonemic manipulation, phonemic discrimination), working memory, rapid naming, multisyllable word naming, lexical and grammatical abilities, and nonverbal intelligence (Ennemoser et al., 2012; Strattman and Hodson, 2005). Socio-cultural factors, such as literacy in the home environment and income/socio-economic status (Niklas et al., 2023; Sirin, 2005) also affect spelling achievement. A bilingual biography is another influencing factor, but bilingualism is typically closely connected to oral language abilities and socioeconomic status (SES). Differences from age-matched monolinguals, if reported, are therefore often explained by factors other than bilingualism *per se* (see below). Research has hitherto targeted either the associations of spelling precursors and spelling or the associations of bilingualism, SES, and spelling. This study, in contrast, investigated the impact of oral language-related spelling precursors and language abilities and considered bilingualism and SES in German spelling development. We thus shed new light on the associations between phonological information processing skills, oral language skills, SES, and bilingualism in spelling attainment at the end of grade 1. German has an alphabetical writing system that is based on the Roman script (Coulmas, 2003; Neef, 2015; Ziegler and Goswami, 2006). While German is often described as a shallow orthography that maps letters and sounds relatively consistently like, for example, Dutch, Spanish and Finnish (Goswami et al., 2003; Goswami et al., 2001; Landerl et al., 2013), more recent analyses have challenged this view (e.g., Evertz and Primus, 2013; Fuhrhop, 2018; Maas, 2015). Even if the correct spelling can be deduced from phonographic principles in many German words, such as <Mist> [mist] 'dung', this does not hold for a large proportion of 'typical' German words. For example, applying phonographic principles to words such as <Tasse> 'cup' or <rennt> 'runs' results in the incorrect outcomes *<tase> and *<rent>, respectively. These words are spelled in accordance with so-called syllabic and morphological principles (Müller, 2010). Syllabic principles refer to the graphemic marking of tense vowels (i.e., <aa> in <Waage> 'scale' or <ah> in <Wahl> 'choice'), the spelling of ambisyllabic consonants as geminates (i.e., the <ss> in <Tasse> 'cup'), and the so-called silent <h> in words such as <ruhen> 'to rest' or <ziehen> 'to pull'. Correct spelling of these words does not solely rely on phonological information processing, but also requires knowledge of orthographical, grammatical principles that define prosodic patterns, which are the foundation of written word spelling in German. Language abilities, above all oral vocabulary and grammar, are important to infer such principles of German orthography and to construct analogies between words and phrasal units. Consequently, oral language abilities, bilingualism and SES (with SES operationalized as parental education in our study) are thought to impact language competencies and spelling development.

1.1 Oral language-related abilities as precursors: phonological information processing and oral language abilities

Written language development depends on phonological information processing, which relates – among other things – to the processing of acoustic signals of the spoken language (Ptok et al., 2008; Wagner and Torgesen, 1987) and is often described as a compound of four sub-domains: phonological awareness (PA), phonological working memory (PWM), rapid automatized naming (RAN) and letter knowledge (LK) (Vellutino et al., 2004; Wagner and Torgesen, 1987; Wolf and Bowers, 1999). In addition to PA, language abilities influence spelling achievement (Ennemoser et al., 2012; Fricke et al., 2016; Lervåg and Hulme, 2010).

Phonological awareness is a metalinguistic skill defined as awareness of the sound structure of language (Wagner and Torgesen, 1987) and the ability to analyze, segment, and manipulate phonological units (e.g., Schnitzler, 2008; Tunmer and Hoover, 1992). The term phonological awareness is used extensively in research and focuses on phonological units of various sizes: larger units are word, syllable, and rhyme, while the single phoneme is a small unit (Skowronek and Marx, 1989). Smaller units are acquired later than larger units and are more difficult to manipulate.

In addition to the size of the phonological unit, the operation process matters. Analysis is easier than segmentation or synthetization, and both are easier than manipulation (Schnitzler, 2008). Addressing the question of whether children with limited phonological competencies benefit in the long term from training, Schneider et al. (1998) reported significant training effects, particularly in spelling, when the training adhered precisely to instructions.

Phonological working memory allows temporary sound-based representations or linguistic information to be kept available until cognitive processing is complete (Baddeley, 1992). It is interrelated with PA and influences spelling development (Gindri et al., 2007; Steinbrink and Klatte, 2008). Working memory is described as a "capacity-limited system that serves the short-term storage of information" (Mähler and Schuchardt, 2014, p. 77). The capacity of working memory seems particularly relevant for children at the beginning of the reading acquisition process (Schneider, 2009). It is considered a stable trait-like ability that shows resistance to systematic training and has primarily predictive characteristics (Mayer, 2016, p. 77).

Rapid automatized naming (RAN) relates to the fast pronunciation of objects, colors, or digits (Georgiou et al., 2009). In their Double-Deficit Hypothesis, Wolf and Bowers (1999) described children with dyslexia not only in terms of deficits in phonological awareness but also in terms of differences in naming speed. There is strong agreement that children with reading difficulties, especially in consistent orthographies, can be characterized by deficits in naming speed (Brizzolara et al., 2006; Mayer, 2016). The most significant specific predictor for spelling, however, remains phonological awareness (Landerl and Wimmer, 2008). Korhonen (1995) presented RAN as a personality trait, which indicates that difficulties in rapid naming persist into early adulthood. The specific components of the complex construct of naming speed, which is determined by the interplay of visual processing speed and speed of access to phonological information, are subject of intense discussions (*cf.* Mayer, 2016). Given the well-established association between RAN and literacy acquisition, it is reasonable to assume that RAN-trainings have the potential to improve literacy, nevertheless, empirical evidence of the effectivity of RAN-based training methods is rare (Berglez, 2003; Mayer, 2016). Berglez (2003) posited that children exhibit slow naming speed due to insufficient practice, and suggested that their actions in early childhood have been insufficiently accompanied by speaking or naming. "This weakness is to be compensated by training children to

name different categories of objects faster" (p. 123). In a study in preschool children, she observed significant improvements in naming speed, which indicated its fundamental trainability. However, these improvements could not be attributed to specific training effects and even affected the control groups without training. Importantly, to date there have been no reports on the effects of training to improve rapid naming on later reading and writing.

Letter knowledge defines the explicit knowledge of letter names (e.g., Ennemoser et al., 2012; Foulin, 2005) and is an important predictor of reading (Foorman et al., 2016; Malling et al., 2022; Schatschneider et al., 2004). Its predictive accuracy depends on the transparency of the orthography (Martínez and Goikoetxea, 2019). Further, the relative contributions of rapid automatized naming, letter sound knowledge, and phonological awareness differ before and after school entry (Schmitterer and Schroeder, 2019).

There is ample evidence that – together with working memory (Berninger et al., 2010) – phonological awareness is the strongest predictor of later spelling abilities (e.g., for German-speaking children, see Ennemoser et al., 2012; Pfost, 2015 for a review). Wolf and Bowers (1999) emphasized the close connection between RAN and reading, and Ennemoser et al. (2012) postulated for RAN a persistent but lower correlation to spelling than to reading.

The vocabulary is built and expanded by recognizing new words and storing them in the mental lexicon together with the semantic, syntactic and morphological information and the phonetic-phonological form for each lexical unit in a network (Levelt, 1998). This organization and structure ensures efficient word retrieval in comprehension and in production and in the oral and written modalities (Aitchison, 1997). Although the size of the mental lexicon increases dramatically at preschool age (Clark, 1995; Kauschke, 2000 for German), it takes several years to establish the lexical representations in an adult-like manner because storage of detailed phonological, morphosyntactic, and semantic information requires children to hear words in various situations (Oller and Eilers, 2002). Two characteristics of lexical development are important with regard to our study: First, lexical development largely takes place on an item-by-item basis; that is, learners must hear the words in order to acquire them. Vocabulary size is thus strongly influenced by socio-cultural factors (Hoff, 2003, but see, e.g., Zaretsky and Lange, 2017; see section 1.2). Second, lexical development is never complete, because new words are integrated into the mental lexicon and existing representations are modified throughout one's entire life (Engelkamp and Rummer, 1999).

In both of the above regards, vocabulary differs from grammatical knowledge, which is largely based on rules that are mastered at a certain point in development (Schulz, 2007). Receptive and productive grammatical knowledge grows dramatically at preschool age. Between 2 and 3 years of age, German-speaking children produce main clauses with correct subject-verb agreement, and embedded clause structure is acquired between 2;6 and 4 years of age (e.g., Clahsen, 1986; Rothweiler, 1993). Due to complex rules and a high numbers of exceptions, other phenomena in morphosyntactic development, such as case and gender marking, plural formation, and inflection of irregular verbs, remain difficult until primary school age and beyond (Schulz, 2007). German-speaking children can rarely infer plural formation, gender marking, and irregular verbs by applying rules; instead, many derivations must be learned item by item (Clahsen, 1986). Given that written language encodes grammatical information (Bredel, 2015; Fuhrhop and Peters, 2023; Maas, 2015), grammatical (morphosyntactical) knowledge influences reading development (Ennemoser et al., 2012) and word spelling, even in first graders (Fricke et al., 2016; Lervåg and Hulme, 2010; Author et al., under review).

1.2 Socio-economic status

The spelling achievement of children is strongly associated with the socioeconomic status (SES) of their parents. SES – referring to the relative social position of individuals – is a multifaceted construct that is frequently measured using one or more of the following three indicators: income, education and occupational status (Bradley and Corwyn, 2002; Conger and Donnellan, 2007; Sirin, 2005). It has repeatedly been found that children from low-SES families show lower verbal academic achievement than children from high-SES backgrounds (Sirin, 2005; White, 1982). With regard to spelling, there is also consistent evidence that low-SES children have poorer orthographic skills than their peers (see Breit et al., 2016; Niemietz et al., 2023 for German speaking countries). On average, children from high-SES backgrounds have a larger vocabulary, can use more varied and complex grammatical forms and show greater phonological awareness than children from low-SES backgrounds (Fernald et al., 2013; Gilkerson et al., 2017; Hoff, 2003; Huttenlocher et al., 2010; Li et al., 2023; Noble et al., 2007; Pace et al., 2017; Rowe, 2008). This gap in language-related skills develops before school enrollment, and it influences academic achievement throughout elementary school (Hindman et al., 2010; Morgan et al., 2015; Von Stumm et al., 2020).

Pace et al. (2017) described several pathways by which SES may affect language development in general and consequently also spelling. In line with general models of the influence of SES on child development (e.g., Bradley and Corwyn, 2002; Conger and Donnellan, 2007), SES is considered to be associated with the quantity and quality of generic (e.g., quality and quantity of general parenting behaviors) and language-specific (e.g., quality and quantity of language input provided by parents) parent–child interactions. It is assumed that low-SES parents show less positive parenting (e.g., less sensitivity) due to, amongst others, strain associated with a low SES (Conger and Donnellan, 2007), and provide less (qualitative) language input, which in turn affects language development (e.g., vocabulary and grammatical knowledge). Limited economic resources of low-SES parents are also associated with limited availability of learning materials (e.g., number of books) relevant for language development. Finally, SES may be associated with other skills that are important for language learning (e.g., processing efficiency, fast mapping skills). Low-SES children may therefore be characterized by their lower levels of the skills needed for language development (Pace et al., 2017).

1.3 Bilingual status

According to Grosjean (2012), children are bilingual if they use two or more languages in their daily life. Learning the language of instruction as a second language is a further factor associated with spelling development. Overall, international large-scale studies such as PISA (Programme for International Student Assessment; OECD, 2023) indicate that children, who learn the language of instruction as a second language (and speak another language at home) often have a migration background. A migration background and the use of a

heritage language at home are strongly associated with lower academic achievement, particularly in German-speaking countries (e.g., OECD, 2023) – the context of the current study. There is consistent evidence that migration background and heritage language use are associated with lower reading scores in primary and secondary education. Notably, some of these differences are explained by the lower SES of migrant families (e.g., Breit et al., 2016; Henschel et al., 2023). Likewise, studies suggest that students who acquire German as their second language (Lenhart et al., 2019) and students with migration background (Henschel et al., 2023) lag behind their peers in their spelling skills. Again, lower SES accounts for some of the association of spelling achievement with migration background (Niemietz et al., 2023).

Bilinguals can differ from age-matched monolingual children not only in SES, but also in their oral language abilities. Due to dual language exposure, bilinguals can show accelerated or decelerated language development (Paradis and Genesee, 1996). Bilingualism can foster the acquisition of language and cognitive abilities, as expressed, for example, by the notion of a 'bilingual advantage' (Bialystok, 2011; Blom et al., 2014). A bilingual advantage has sometimes been reported for phonological awareness, which is a key predictor of written language achievement (Bialystok et al., 2003; but see Antoniou, 2019; Cat et al., 2018; Ross and Melinger, 2017 for recent evidence opposing a bilingual advantage). In addition, typological differences in the oral marking of word and sentence structure can increase the awareness of word boundaries (Veldhuis, 2015), which is relevant for spelling. However, at pre-school and primary-school age, bilinguals often lag behind monolinguals in their lexical (Czapka et al., 2019; Klassert et al., 2014; Seifert et al., 2019; for an international review see Bialystok and Luk, 2012) and grammatical (e.g., Schulz and Grimm, 2019) abilities. A decelerated acquisition is reported in particular for the sub-group of successively bilingual children, that is, children who start to acquire the ambient language with entry to kindergarten or with school enrolment (Paradis et al., 2021).

The oral language abilities are associated with the spelling outcome in several ways. Lexical and morphosyntactic abilities are required to conceptualize the text and to produce written morphemes and sentences (Ehri, 2017; Silverman et al., 2015). Due to dual language development, many bilingual children cannot rely on the same language resources as monolingual children when learning to spell, for example because they started to acquire the majority language successively to the heritage language (Schulz and Grimm, 2019). Bilingualism can thus indirectly – modulated by the oral language abilities – have a negative impact on spelling achievement. We emphasize that the difficulties are not caused by the factor bilingualism *per se* and that they do not represent a deficit of the child. Rather, spelling difficulties observed in bilingual children result from the education system (here: the Austrian), which takes monolingualism as the norm ('monolingual habitus', Gogolin, 2008), and from inadequate spelling instruction (Bredel et al., 2017). Taken together, bilingualism matters in spelling achievement; not because there is a general difficulty in learning to spell in an L2, but due to the lower SES, and because the Austrian (and similarly the German) education system does not take typical manifestations of dual language exposure into account.

1.4 The current study

As outlined above, there is evidence that bilingualism and SES are associated with spelling (see Figure 1, path c on the left; e.g., Breit et al., 2016; Henschel et al., 2023; Lenhart et al., 2019; Niemietz et al., 2023). There is also evidence that bilingualism and SES are associated with spelling precursors (see Figure 1, path a on the left). While low-SES children are considered to lag behind their peers in lexical and grammatical abilities (Gilkerson et al., 2017; Pace et al., 2017), for bilinguals differential effects are expected, specifically, lower language skill levels (grammar and vocabulary; Czapka et al., 2019; Schulz and Grimm, 2019; Seifert et al., 2019). Since findings regarding a potential bilingual advantage in phonological awareness are inconsistent (e.g., Antoniou, 2019; Cat et al., 2018; Ross and Melinger, 2017, see Section 1.3), we had no specific hypothesis in this regard. Finally, there is a large body of research highlighting the importance of language skills (grammar and vocabulary) and phonological information processing (Bigozzi et al., 2016; Ennemoser et al., 2012; von Goldammer, 2010; Kim et al., 2013; Pinto et al., 2015) to the development of spelling skills (see path b on the left side of Figure 1). Integrating these three paths into a single combined model produces a mediation model (MacKinnon, 2013; shown on the right-hand side of Figure 1) that – to the best of our knowledge – our study was the first to test. This model assumes that parental education (as a measure of SES) and bilingual status are associated with language skills and strongly with specific precursors of phonological information processing at the time of school enrollment (path a); these skills in turn predict spelling skills assessed at the end of grade 1 (path b). Path c' reflects the effect of bilingual status and parental education on spelling that is not accounted for by the mediators. Notably, we expected that – in line with a mediation hypothesis – there are significant indirect effects of bilingual status and parental education on spelling. Considering similar research into the prediction of reading (Li et al., 2023), we hypothesized that at least for parental education the c'-path is significant.

2 Method

2.1 Participants and recruitment

This study used data from two cohorts (2021/22 and 2022/23) of first graders from Upper Austrian schools, mainly from the school district Linz-Land. Recruitment proceeded as follows: First, we obtained written permission from the regional school board for Upper Austria to contact schools for participation. Second, we informed the head teachers of 11 schools about the project and invited them to participate. Since all head teachers agreed to join the project, we asked the first-grade teachers to distribute letters to parents that included general information about the project, a consent form, and a written questionnaire for them to complete and return to the school. 1,070 questionnaires were collected. For this study, the analysis excluded 58 children for the following reasons: 20 children were ill during both testing periods (i.e., at school entry and at the end of grade 1), and parental consent was not received for 38 children. Thus, data on 1,012 children (from a total of 61 classes) were used for this study. The sample comprised 48.5% girls, which reflects the proportion of girls among Upper Austrian first graders [46.7%; $\chi^2(1) = 0.736$, $p = 0.391$].

73.0% of the children grew up monolingually with Austrian German. This proportion of monolinguals corresponds to the rate of Upper Austrian first graders that speak exclusively German in their everyday life [78.9%; $\chi^2(1) = 0.014$, $p = 0.907$]. Reference values for the

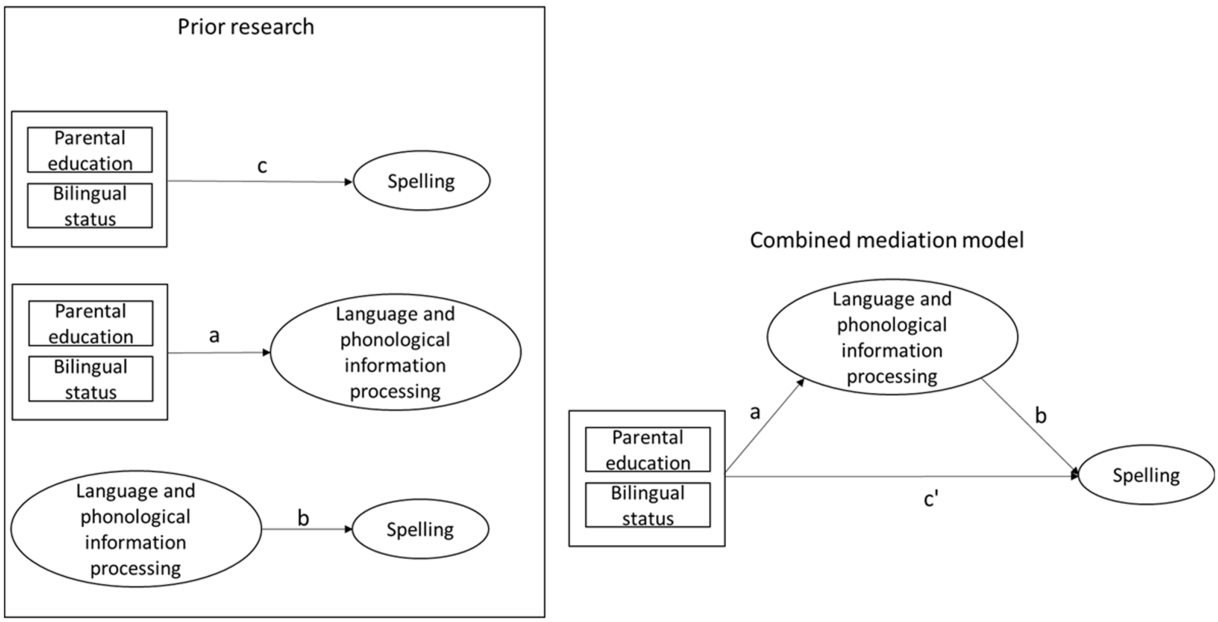

FIGURE 1
Prior research on the associations between spelling and (i) SES/parental education, bilingual status, (ii) spelling precursors and a combined mediation model.

percentages of girls and bilinguals, respectively, were taken from the Austrian School Statistics (Statistik Austria, 2024).

The overall sample consisted of parents from all educational backgrounds. Using the highest level of parental education (i.e., that of the parent with the higher level of education), in 44.6% of families at least one parent had a university degree. About a fifth (19.6%) had a university entrance qualification. Another 30% reported a vocational education or training, and in 5.9% of the families neither parent had a qualification beyond compulsory schooling. Compared to the Upper Austrian parent population of 4th graders in the school year 2017/18,[1] parents with a university degree were overrepresented (44.6% vs. 26.5%), and parents with vocational education or training were underrepresented (30.0% vs. 45.8%; $\chi^2(3) = 170.85$, $p < 0.001$). The sample was thus representative in terms of child gender and bilingual status, but not in terms of parental education, which is probably due to the sample including mostly schools in urban areas, where more parents with a higher level of education live (see also Elliott, 2018; Yulianti et al., 2023).

2.2 Procedure

The analyses described are part of a longitudinal project (SCHNAPP) that aims to assess and monitor early reading and writing development of children in primary schools. Two cohorts were assessed (a) at the very beginning of the first year of schooling (in 2021 and 2022) in terms of precursors of spelling (language and phonological information processing) and (b) at the end of first grade (in 2022 and 2023) by a spelling test.

The Schnapp spelling test (Schöfl, Steinmair, et al., 2023) was administered in class via tablet PCs. The items of this test are embedded in a cloze task, and sentences have been pre-recorded and presented as audio via headphones. Children were asked to write down the target words on the tablet using a digital pen. Unlimited repetitions and corrections were allowed. The mean duration was 15 min (SD = 7.2). Teachers were present but were asked not to interact with the children during the test. Written feedback about the performance of each class and a video-explanation were given to head teachers at the end of the assessment phase.

Oral language-related precursors and child-related information were assessed in a one-on-one setting (i.e., individual administration). Informed consent was gained from all parents, and only children whose parents had given permission participated. The assessments were carried out by trained students and project staff. The test was embedded in a magical story, presented on a tablet, to keep the children's attention and maintain motivation. Assessors adapted to the working pace of the children; the test took 19 min on average (SD = 5.2). A questionnaire was developed to collect information from parents about the child's age and whether s/he was growing up monolingually or bilingually, attested language difficulties, language use within the family, and the parent's socio-economic background (assessed via parental education).

2.3 Measures

2.3.1 Spelling

The app-based Schnapp spelling test (Schöfl et al., 2023b) comprises 22 words in 6 hierarchically organized categories of increasing spelling complexity. All items correspond to spoken and

1 We thank the IQS (Federal Institute for Quality Assurance in the Austrian School System) for providing detailed population data.

written trochees to meet the canonical prosodic (Wiese, 2006) and graphemic word shapes of German (Fuhrhop and Peters, 2023). The accuracy of children's spellings was coded in binary as correct (1) or incorrect (0). Correct means that the child's realization corresponds to the orthographic norm (i.e., whole-word accuracy). Any deviation from the normed spelling was coded as incorrect. A recent validation study (Schöfl et al., 2023b) using a Rasch modeling approach provided evidence of the unidimensionality of the spelling test and reported on its good reliability (0.86). In the current study, we were interested in the effects of multilingualism and SES on spelling. To accurately analyze spelling differences between mono- and bilingual children and among children with different parental educational backgrounds, the issue of measurement invariance of the test must be addressed (Bauer, 2023). For example, measurement invariance would be violated if – given the same latent spelling proficiency – bilingual children spelled a word (in)correctly more often than monolingual children (i.e., differential item functioning, DIF). Not adequately addressing DIF – for instance, by using a simple sum score for the spelling test or by using a factor score based on the 22 test items (given the high number of items, modeling spelling as a latent variable is not feasible) – will bias estimates of the association between spelling and bilingualism and SES, respectively (see, e.g., Bauer, 2023; Curran et al., 2018). Thus, we applied moderated nonlinear factor analysis (MNLFA; Bauer, 2017, 2023), a procedure that allows comprehensive evaluation of measurement invariance (DIF), to estimate covariate informed scale scores as the outcome variable. For details, see Supplementary material.

2.3.2 Language

Two aspects of language performance were used: (1) *Receptive vocabulary* was assessed using the digital version of the Graz Vocabulary Test (GraWo; Seifert et al., 2017), which comprises 30 matching tasks in which the child selects a picture that matches the audio-presented word. Reliability estimates provided for the paper form of GraWo (Cronbach's alpha = 0.89 at the end of first grade, retest reliability $r_{tt} = 0.93$) indicate good reliability. Internal consistency for the digital version estimated for our sample was high at 0.821. (2) *Morphosyntactic skills* were assessed by the German adaptation of the LITMUS-SRT (Hamann et al., 2013; Hamann and Abed Ibrahim, 2017 for German), a sentence-repetition task designed with a focus on multilingual children. The test comprises 15 items of varying complexity. Items were scored as correct (=1) when children repeated the sentence correctly. Internal consistency was acceptable at 0.750.

2.3.3 Phonological information processing

Phonological information processing was measured using the following subtests of the SCHNAPP Assessment (for more information see Schöfl et al., 2022; Schöfl et al., 2023b). (1) *Phonological awareness* was assessed with 10 items: children were asked to identify the initial phoneme of a word. The task used high-frequency words from the childLex database for the 6–8 years age group (Schroeder et al., 2015). A letter was presented visually and simultaneously as a speech sound, and children had to choose from three pictures that with the same initial phoneme ("Which word begins with I for Ines: Hase, Igel, Spiegel?"). Internal consistency was relatively low at 0.66. (2) *RAN* was assessed using two stimuli: objects and digits. In the object condition, five high-frequency monosyllabic words (hand, cow, tree, mouse, ice) were presented visually and orally, and the child named them as quickly as possible. The digit condition followed a similar procedure with monosyllabic digits (1, 2, 3, 6, 8). Recently collected data has confirmed the effects of both measures assessed at the beginning of grade 1 on reading skills at the end of grade 2 (Schöfl et al., 2023a). The time (measured in seconds) children needed to repeat the 5 words was recorded as a measure of RAN. The RAN modes correlated with $r = 0.603$ ($p < 0.001$). The mean of both measures was used in the subsequent analyses. (3) *Letter knowledge* was measured by displaying all the letters in random order on the screen, where each page contained three to four capital letters. Children, despite not having learned these letters at school, were asked to name any they recognized. The number of correctly named letters was recorded. (4) *Phonological working memory* was assessed using subtests of a broad-range intelligence test battery [IDS-2; Intelligence and Development Scales for Children and Adolescents (Grob et al., 2009)]. The children were asked to repeat increasingly long, and therefore increasingly difficult, digit-letter sequences in reverse order. The task ended after three unsolved or incorrectly solved tasks. Grob et al. (2009) reported high reliability (Cronbach's alpha = 0.89 at the end of the first grade, retest reliability $r_{tt} = 0.93$).

To test the assumed differentiation between language and phonological information processing skills, we applied a two-factor CFA model with (i) receptive vocabulary and morphosyntactic skills loading on the language factor and (ii) phonological awareness, RAN, letter knowledge and phonological working memory loading on the phonological information processing factor. CFI (0.952) and SRMR (0.049) indicated acceptable and good fits, respectively, whereas RMSEA (0.085, 90%-CI [0.067, 0.105]) and the ratio of χ^2/df (65.573/8 = 8.2) indicated poor model fit. The modification index suggests that allowing the errors of morphosyntactic skills and phonological working memory to covary would improve fit. Given that both tasks required children to repeat a stimulus (sentence, digit-letter sequence), error covariance is justified. The modified model yielded an overall acceptable fit (χ^2/df = 44.107/7 = 6.3; CFI = 0.969; RMSEA = 0.073 90%-CI [0.053, 0.094], SRMR = 0.039). Reliability – MacDonalds ω calculated based on the parameter estimates of the CFA (Hayes and Coutts, 2020) – indicated relatively low internal consistency for phonological information processing (ω = 0.590) and relatively high reliability for language skills (ω = 0.791). The latent correlation between two factors was $r = 0.497$ ($p < 0.001$).

2.4 Analysis

We applied a structural equation modeling (SEM) approach (e.g., González-Valenzuela et al., 2023) using Mplus 8 (Muthén and Muthén, 1998-2017) to test the mediation model outlined above. Notably, as the current study used clustered data (i.e., children in classes), variance in the spelling test might be due not only to bilingualism, parental education and precursors of spelling, but also to differences in the first year of schooling (e.g., differences in instruction and other teacher effects). However, our hypotheses focused on the individual level (level 1): We sought to explain individual differences in spelling that are not due to class-level variables (level 2). Thus, we applied multilevel SEM (see, e.g., Preacher et al., 2010), where we focused on the mediation

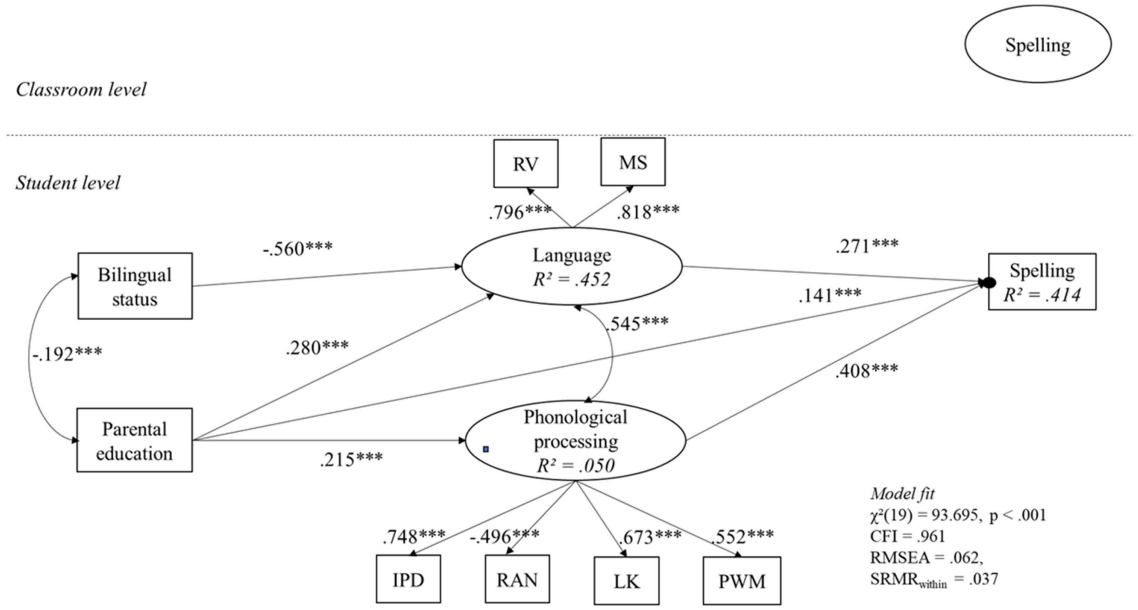

FIGURE 2
Mediation model (Standardized Coefficients). MS, morphosyntactic skills; LK, letter knowledge; RV, receptive vocabulary; IPD, initial phoneme detection; RAN, rapid automatized naming; PWM, phonological working memory. Only significant effects are shown. The graphic representation of the model follows the Mplus User's Guide (Muthén and Muthén, 1998-2017), where the black dot shown at the within level and the ellipse at between level represent the random intercept for spelling (i.e., intercepts are allowed to vary between classes). ***$p < 0.001$.

process at level 1 to explain variation in spelling within school classes[2]. Notably, although classes differed in terms of parental background, proportion of bilinguals, language skills and phonological information processing (see Supplementary Table A1), these differences were not due to schooling, as these variables were assessed at the very beginning of formal schooling and some are time-invariant (parental education, bilingualism). Therefore, these variables were not decomposed into individual and class-level components, but treated as individual-level variables.[3] The corresponding model is shown in Figure 2. The statistical significance of the indirect effects – supporting the proposed mediation hypotheses – was calculated using the delta method (MacKinnon, 2013). The preferable bias corrected bootstrap approach is not available for multilevel models in Mplus 8.

The rate of missing data ranged from 0% (bilingual status) to 16.4% (spelling). Little's Missing Completely at Random (MCAR; see, e.g., Enders, 2010) test as implemented in SPSS 29 was significant [$\chi^2(80) = 302.049$, $p < 0.001$], which indicates that nonresponse depended on the observed variables [i.e., Missing at Random (MAR)]. In detail, supplementary analyses indicated systematic dropout at time 2 (i.e., the spelling assessment). Children with missing data on the spelling test were more likely bilingual, had parents with lower education, and showed comparably lower scores on the subtests for language skills and phonological information processing. Since these results suggested a MAR mechanism, we applied a Full Information Maximum Likelihood Estimation to appropriately deal with missing values.

3 Results

The correlations of all variables are shown in Table 1.[4] Overall, we found that all variables were significantly correlated with spelling, with the highest correlations for morphosyntactic skills ($r = 0.458$, $p < 0.001$) followed by initial phoneme detection ($r = 0.397$, $p < 0.001$) and letter knowledge ($r = 0.390$, $p < 0.001$). The lowest correlation was found for bilingual status ($r = -0.197$; $p < 0.001$). Taken together, children achieved higher spelling scores at the end of grade 1 if they had better language and phonological information processing skills at

2 Notably, using a SEM-multilevel mediation approach (Preacher et al., 2010) would also allow testing for mediation at the classroom level. However, the mediation hypotheses outlined in this paper refer to the individual level. Mediation at the classroom level is not tenable because there is no basis for the a-paths at the classroom level: Since bilingual status, SES, and the mediators were assessed at the very beginning of formal schooling, any associations between these variables at the classroom level cannot be due to classroom-level mechanisms; it is therefore untenable to hypothesize that class differences in spelling precursors are affected by classroom SES and the proportion of bilingual children.

3 Following the argument that variation in the predictors and mediators cannot be due to schooling, we used no centering for these variables. Thus, for these variables the total covariance (i.e., at the within and between levels) is captured in the regression slopes. This issue has been discussed as conflation of within and between effects in the methodological literature (e.g., Preacher et al., 2010). However, if we consider the a-paths of the mediation model, it is not tenable to talk of conflation of individual and class-level effects, as the cause for the between-level covariation of the variables precedes school enrollment. The between-level variation is likely due to social and ethnic population differences in the catchment areas of the schools (Biedermann et al., 2016). Nonetheless, we also report results of a strictly within-level mediation in the Supplementary Tables A3, A4, using group-mean centering for the predictors and mediators (see also Preacher et al., 2010).

4 For correlations at the within and between levels see Supplementary Table A1.

TABLE 1 Correlations and descriptive statistics of all variables.

	BS	PE	MS	LK	RV	IPD	RAN	PWM	Spelling
PE	−0.192***								
MS	−0.487***	0.356***							
LK	−0.003	0.159***	0.214***						
RV	−0.513***	0.260***	0.663***	0.207***					
IPD	−0.023	0.151***	0.304***	0.517***	0.322***				
RAN	0.077*	−0.094**	−0.139**	−0.389***	−0.132**	−0.342***			
PWM	−0.131***	0.158***	0.389***	0.317***	0.345***	0.413***	−0.279***		
Spelling	−0.197***	0.331***	0.458***	0.390***	0.353***	0.397***	−0.312***	0.354***	
M	0.270	3.028	9.575	14.064	20.930	8.287	34.966	3.919	−0.099
SD	0.444	0.990	4.056	8.445	5.267	1.882	9.619	2.027	1.063

Correlations for spelling are based on the within class variance of spelling. For all other variables the total variance was used. BS, bilingual status; PE, parental education; MS, morphosyntactic skills; LK, letter knowledge; RV, receptive vocabulary; IPD, initial phoneme detection; RAN, rapid automatized naming; PWM, phonological working memory. ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

TABLE 2 Standardized indirect, direct and total effects of bilingual status and parental education on spelling.

	Indirect effects			Direct effect	Total effect
	Via language	Via phonological information processing	Total		
	β (SE)	β (SE)	β (SE)	β (SE)	β (SE)
Bilingual status	−0.152** (0.050)	−0.012 (0.018)	−0.164** (0.056)	0.024 (0.056)	−0.140*** (0.036)
Parental education	0.076** (0.026)	0.088*** (0.018)	0.163*** (0.027)	0.141*** (0.039)	0.305*** (0.036)

***$p < 0.001$, **$p < 0.01$.

school entry, grew up monolingually, and/or if they grew up in high-SES families. Further, SES was significantly correlated with all language and phonological information processing variables, with correlations ranging from $r = -0.094$ ($p < 0.01$) for RAN to $r = 0.663$ ($p < 0.001$) for receptive vocabulary. All language and phonological information processing variables correlated significantly. Finally, the negative correlation of $r = -0.193$ ($p < 0.001$) indicates that – as expected – parents of bilingual children had a significantly lower SES.

The results of the mediation model are shown in Figure 2[5] and Table 2. Overall, the model showed an acceptable fit [$\chi^2(19) = 93.69$, $p < 0.001$; CFI = 0.961, RMSEA = 0.062, SRMR = 0.032]. There was a strong effect ($\beta = -0.560$, $p < 0.001$) of bilingual status on language skills, which indicates that the monolingual children outperformed their bilingual peers in our language measures at school entry. The effect of bilingual status on phonological information processing, however, was close to zero and not significant ($\beta = -0.029$, $p > 0.05$). SES significantly predicted language skills ($\beta = 0.280$, $p < 0.001$) and phonological information processing ($\beta = 0.215$, $p < 0.001$). The higher the parental SES, the better were the spelling precursors of their children. Both language skills ($\beta = 0.270$, $p < 0.001$) and phonological information processing ($\beta = 0.408$, $p < 0.001$) predicted spelling at the end of grade 1, where the latter precursor turned out to be the strongest. Focusing on the mediation hypotheses for bilingual status, we found a non-significant direct effect close to zero on spelling ($\beta = 0.024$, $p > 0.05$). The indirect effect, however, was statistically significant ($\beta_{indirect\_total} = -0.164$, $p < 0.01$). This effect can be attributed almost completely to language skills as a mediator ($\beta_{indirect} = -0.152$, $p < 0.01$), which supports the hypothesis that bilingual children's lower spelling scores are due to less well developed language skills. Regarding parental SES, the results support partial mediation. There were significant indirect effects of parental SES on spelling via language skills ($\beta_{indirect} = -0.076$, $p < 0.01$) and via phonological information processing ($\beta_{indirect} = -0.088$, $p < 0.01$). However, even after controlling for the mediators, there was a direct effect on spelling ($\beta = 0.141$, $p < 0.001$). Thus, as proposed by Pace et al. (2017), there are apparently further mechanisms by which SES affects children's spelling.

Finally, since we tested mediation in a multilevel setting, focusing only on the individual level, we additionally report intraclass correlation (ICC) coefficients for spelling. In a null-model (i.e., no predictors), the ICC was 0.190. Thus, at the end of grade one, about 19% of the variance in spelling skills can be attributed to class differences. In the full mediation model, ICC was 0.09, indicating that

5 For detailed results see Supplementary Table A2. Notably, the standardized loadings on the phonological information processing factor were somewhat smaller than those on the language factor, which implies a somewhat smaller model-based reliability (McDonald's $\omega = 0.71$) for phonological information processing, than language (McDonald's $\omega = 0.79$). To evaluate whether reliability affected the parameter estimates (we thank the anonymous reviewer for the suggestion), we ran a small Monte Carlo simulation adapted from Thoemmes et al. (2010), where we varied the reliability of the latent mediator. The results (see Supplementary material) showed that the coefficients of the a-, b-, and c'-paths, as well as the indirect paths, are not affected by the reliability of the mediator.

about half of the class differences were due to differences in class composition in terms of bilingual status, parental education and spelling precursors. The remaining 9% of the variance were explained by other variables, such as differences in instruction method or personal characteristics of the teacher.

4 Discussion

This study took two well-documented sets of factors that influence children's spelling skills in primary school (i.e., oral language abilities and socio-demographic factors) and brought them together in a joint mediation model. In detail, we tested whether spelling differences related to SES and bilingual status are mediated by oral language-related precursors. First, our study supports prior findings which suggest that children with lower SES (Hindman et al., 2010; Morgan et al., 2015; Von Stumm et al., 2020) and bilingual children achieve lower spelling accuracy (Henschel et al., 2023; Breit et al., 2016; Lenhart et al., 2019). Second, our results are in line with studies that show an association between spelling and its precursors: Oral language-related precursors are best known to predict spelling, especially early word-spelling competencies (Caravolas et al., 2001; Niolaki et al., 2020; Treiman et al., 2023). Our findings corroborate the results published in an extensive body of literature. Both language skills and phonological information processing are powerful predictors of spelling at the end of grade 1. Interestingly, we found that phonological information processing abilities are a better predictor of spelling than language skills (vocabulary and grammar). Though this accords with the findings of some studies (e.g., Kim et al., 2013), other results contradict it (Von Goldammer et al., 2010).

Extending prior research (Segerer et al., 2013; Seifert et al., 2019 in the context of reading), our results suggest that the lower spelling abilities of bilingual children compared to their monolingual peers are due to lower language abilities, more specifically, in terms of vocabulary and grammar. In detail, the mediation model supports the notion that effects of bilingual status on spelling are fully mediated by language skills. Due to dual language exposure, bilinguals (as a group) may have limited oral lexical (Bialystok et al., 2010; Klassert et al., 2014, for German) and grammatical knowledge in the societal language, which in turn translates into difficulties dealing with the phonological and graphemic structure of words. Notably, we found no effect of bilingual status on phonological information processing, which matches recent findings that call into question a bilingual advantage in this area (Antoniou, 2019; Cat et al., 2018; Paap et al., 2014; Ross and Melinger, 2017). Limiting our findings in the process, this study took a binary perspective on bilingualism, differentiating only between monolinguals and bilinguals. Considering the language biography (i.e., measures such as age of onset of L2 use or language dominance; Grimm and Cristante, 2022; Thordardottir, 2015; Thordardottir and Brandeker, 2013) and the L1 system could help to better understand the role of bilingualism in spelling attainment.

The effect of SES on spelling is mediated by language and by phonological information processing. Notably, we also found a direct effect of SES on spelling. This suggests that, in addition to the two mediators under investigation, other mechanisms are also responsible for spelling difficulties of children growing up in low-SES families (see, e.g., Pace et al., 2017). It has been argued that children's later academic achievement is affected by parental involvement, which is likely to vary with SES, with less conducive forms of involvement being more prevalent among low-SES parents (Pomerantz and Grolnick, 2017; Weber et al., 2021); this negatively affects motivation in the educational context. As hypothesized by Pace et al. (2017), SES may affect spelling via other skills, such as processing efficiency and fast-mapping skills, which in turn also affect language development and spelling skills. Future research should thus additionally focus on further mediators that may account for the shared variance of SES and spelling. We did not consider further components of SES, such as income and occupational status (Conger and Donnellan, 2007), that may share unique variance with spelling above and beyond that of education (and may also confound the associations between bilingual status, spelling precursors, and spelling); nor did we consider potential correlations of SES and language biography with spelling in the bilingual group (i.e., age of onset to German, exposure to German and the L1). Hence, studying the variation of SES within the bilingual group would help to understand the role of SES in spelling development.

These results have several implications: First, our findings show the ongoing need for systematic oral language training for bilingual children and children from low-SES backgrounds that starts in preschool and continues throughout primary school. Providing sufficient and high-quality language training for these children should be a key concern of the educational system. Second, given that phonological awareness was a predictor of spelling achievement for all children, phonological awareness should be part of the training for preschool and school-aged children. Since our mediation model summarizes several subcomponents of phonological information processing into a single dimension, we cannot formulate clear suggestions for specific components teachers should focus on. Based on previous studies, letter knowledge seems to be a relevant factor in first graders (Elbro and Scarborough, 2004; Muter et al., 2004; Schulte-Körne et al., 2006; Foulin, 2005). Given the spelling system of German, letters should be taught in a way that allows insights to be gained into their function and graphotactic restrictions within the word. Finally, even for the regular graphemic structures implemented in the items of the SCHNAPP test, we found negative effects of SES and lower oral language achievement. This suggests that children from low-SES backgrounds and with lower language abilities have difficulties inferring basic graphemic principles of (Austrian) German independently (Bredel et al., 2017), and calls for alternative approaches to spelling instruction, for example, as suggested by Röber (2013), Bredel (2010), or Krauß (2010). These approaches explicitly address the role of syllabic and morphological principles in German language orthography and take these principles as a basis for written language instruction from the first grade onwards.

In conclusion, our study confirms the central roles of phonological awareness, oral language abilities and SES in children's spelling achievement, both as direct and indirect predictors. Importantly, our mediation model shows that negative effects of bilingualism disappear once these two factors are taken into account. Future studies will have to show whether explicit and systematic instruction based on graphemic principles indeed reduces effects of SES and oral language abilities.

Finally, there are several limitations of our study that should also be considered in future research. First, our mediation model focuses on the student level (i.e., our aim was to explain variation in spelling abilities within classes). However, there is a long tradition of research on the effects of class and school composition on student achievement (for meta-analyses see, e.g., van Ewijk and Sleegers, 2010a,b). Future research should therefore extend the analysis model to include class composition effects. Second, although the time sequence of the measurements justifies the mediation model tested, there are alternative models that may explain the covariance between variables. For example, Mehta et al. (2005) considered reading, spelling, writing, and phonological awareness as indicators of a unidimensional construct literacy. Testing such competing models would require repeated assessment of phonological information processing, language skills, and spelling over time, as this would allow application of statistical models that strengthen causal inference and make it possible to take a closer look on (bidirectional) developmental relationships between the variables (see, e.g., Lüdtke and Robitzsch, 2022; Mulder and Hamaker, 2021). Third, our analyses did not consider if language skills, phonological information processing, and SES may have different associations with spelling in mono- and bilingual children. Future research should also address such moderation effects. Lastly, although we tested the mediation model using a relatively large sample that is representative of the intake of the Austrian school system in terms of gender and the proportion of bilingual children, especially children of tertiary educated parents were overrepresented, which ultimately limits the generalizability of our results.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants/participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

MS: Data curation, Project administration, Writing – original draft, Writing – review & editing. CW: Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. GS: Writing – original draft, Writing – review & editing. SZ: Writing – original draft, Writing – review & editing. AG: Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2024.1383421/full#supplementary-material

References

Aitchison, J. (1997). Wörter im Kopf: Eine Einführung in das mentale Lexikon (M. Wiese, Trans.). Konzepte der Sprach- und Literaturwissenschaft, vol. *56*. Tübingen: Niemeyer.

Antoniou, M. (2019). The advantages of bilingualism debate. *Ann. Rev. Linguist.* 5, 395–415. doi: 10.1146/annurev-linguistics-011718-011820

Baddeley, A. (1992). Working memory. *Science (New York, N.Y.)* 255, 556–559. doi: 10.1126/science.1736359

Bauer, D. J. (2017). A more general model for testing measurement invariance and differential item functioning. *Psychol. Methods* 22, 507–526. doi: 10.1037/met0000077

Bauer, D. J. (2023). Enhancing measurement validity in diverse populations: modern approaches to evaluating differential item functioning. *Br. J. Math. Stat. Psychol.* 76, 435–461. doi: 10.1111/bmsp.12316

Berglez, A. (2003). Prävention von Lese-Rechtschreibschwierigkeiten. Ein Training der Benennungsgeschwindigkeit: Dissertation Universität Bielefeld.

Berninger, V. W., Abbott, R. D., Swanson, H. L., Lovitt, D., Trivedi, P., Lin, S.-J. C., et al. (2010). Relationship of word- and sentence-level working memory to reading and writing in second, fourth, and sixth grade. *Lang. Speech Hear. Serv. Sch.* 41, 179–193. doi: 10.1044/0161-1461(2009/08-0002)

Bialystok, E. (2011). Reshaping the mind: the benefits of bilingualism. *Can. J. Experiment. Psychol.* 65, 229–235. doi: 10.1037/a0025406

Bialystok, E., and Luk, G. (2012). Receptive vocabulary differences in monolingual and bilingual adults. *Biling. Lang. Congn.* 15, 397–401. doi: 10.1017/S136672891100040X

Bialystok, E., Luk, G., Peets, K. F., and Sujin, Y. A. N. G. (2010). Receptive vocabulary differences in monolingual and bilingual children. Biling.: Lang. *Cogn.* 13, 525–531. doi: 10.1017/S1366728909990423

Bialystok, E., Majumder, S. H. I. L. P. I., and Martin, M. M. (2003). Developing phonological awareness: is there a bilingual advantage? *Appl. Psycholinguist.* 24, 27–44. doi: 10.1017/S014271640300002X

Biedermann, H., Weber, C., Herzog-Punzenberger, B., and Nagel, A. (2016). "Auf die Mitschüler/innen kommt es an? Schulische Segregation – Effekte der Schul- und Klassenzusammensetzung in der Primarstufe und der Sekundarstufe I" in Nationaler Bildungsbericht Österreich 2015, Band 2: Fokussierte Analysen bildungspolitischer Schwerpunktthemen. eds. M. Bruneforth, F. Eder, K. Krainer, C. Schreiner, A. Seel and C. Spiel (Graz: Leykam), 133–174.

Bigozzi, L., Tarchi, C., Pezzica, S., and Pinto, G. (2016). Evaluating the predictive impact of an emergent literacy model on dyslexia in Italian children: a four-year prospective cohort study. *J. Learn. Disabil.* 49, 51–64. doi: 10.1177/0022219414522708

Blom, E., Küntay, A. C., Messer, M., Verhagen, J., and Leseman, P. (2014). The benefits of being bilingual: working memory in bilingual Turkish-Dutch children. *J. Exp. Child Psychol.* 128, 105–119. doi: 10.1016/j.jecp.2014.06.007

Bradley, R. H., and Corwyn, R. F. (2002). Socioeconomic status and child development. *Annu. Rev. Psychol.* 53, 371–399. doi: 10.1146/annurev.psych.53.100901.135233

Bredel, U. (2010). Der Schrift vertrauen. Wie Wörter und ihre Strukturen entdeckt werden können. *Praxis Deutsch* H.221, 14–21.

Bredel, U. (2015). "Grammatik und Literalität" in Deutschunterricht in Theorie und Praxis: Band 6. Deutschunterricht in Theorie und Praxis: Sprachreflexion und Grammatikunterricht. ed. H. Gornik (Baltmannsweiler: Schneider Verlag Hohengehren GmbH), 160–173.

Bredel, U., Fuhrhop, N., and Noack, C. (2017). Wie Kinder lesen und schreiben lernen. Tübinger: Narr Francke Attempo Verlag GmbH + Co.

Breit, S., Bruneforth, M., and Schreiner, C. (2016). Standardüberprüfung 2015 Deutsch, 4. Schulstufe: Bundesergebnisbericht. BMBWF.

Brizzolara, D., Chilosi, A., Cipriani, P., Di Filippo, G., Gasperini, F., Mazzotti, S., et al. (2006). Do phonologic and rapid automatized naming deficits differentially affect dyslexic children with and without a history of language delay? A study of Italian dyslexic children. *Cognit. Behav. Neurol.* 19, 141–149. doi: 10.1097/01.wnn.0000213902.59827.19

Caravolas, M., Hulme, C., and Snowling, M. J. (2001). The foundations of spelling ability: evidence from a 3-year longitudinal study. *J. Mem. Lang.* 45, 751–774. doi: 10.1006/jmla.2000.2785

Clahsen, H. (1986). Die Profilanalyse: Ein linguistisches Verfahren für die Sprachdiagnose im Vorschulalter. Berlin: Logotherapia. 3.

Clark, E. V. (1995). The lexikon acquisition. Cambridge studies in linguistics 65. Cambridge: Cambridge University Press.

Conger, R. D., and Donnellan, M. B. (2007). An interactionist perspective on the socioeconomic context of human development. *Annu. Rev. Psychol.* 58, 175–199. doi: 10.1146/annurev.psych.58.110405.085551

Coulmas, F. (2003). Writing systems: An introduction to their linguistic analysis. Cambridge textbooks in linguistics. Cambridge: Cambridge University Press.

Curran, P. J., Cole, V. T., Bauer, D. J., Rothenberg, W. A., and Hussong, A. M. (2018). Recovering predictor-criterion relations using covariate-informed factor score estimates. *Struct. Equ. Model. Multidiscip. J.* 25, 860–875. doi: 10.1080/10705511.2018.1473773

Czapka, S., Klassert, A., and Festman, J. (2019). Executive functions and language: their differential influence on mono- vs. multilingual spelling in primary school. *Front. Psychol.* 10:97. doi: 10.3389/fpsyg.2019.00097

Ehri, L. C. (2017). "Orthographic mapping and literacy development revisited" in Studies in written language and literacy. Theories of Reading development. eds. K. Cain, D. L. Compton and R. K. Parrila (Amsterdam: John Benjamins Publishing Company), 127–145.

Elbro, C., and Scarborough, H. S. (2004). "Early identification" in Handbook of Children's literacy. eds. T. Nunes and P. Bryant (Dordrecht: Kluwer), 339–359.

Elliott, J. (2018). Family engagement in urban education: the impact and factors affecting engagement. Master of Education Applied Research Projects. Available at: https://digitalcommons.cedarville.edu/education_research_projects/5 (Accessed March 18, 2024).

Enders, C. K. (2010). Applied missing data analysis. Methodology in the social sciences. New York: The Guilford Press.

Engelkamp, J., and Rummer, R. (1999). "Die Architektur des mentalen Lexikons" in Enzyklopädie der Psychologie: Themenbereich C Theorie und Forschung; Ser. 3 Sprache; Bd. 2. Sprachrezeption. ed. A. D. Friederici (Göttinger: Hogrefe Verl. für Psycholgie), 155–201.

Ennemoser, M., Marx, P., Weber, J., and Schneider, W. (2012). Spezifische Vorläuferfertigkeiten der Lesegeschwindigkeit, des Leseverständnisses und des Rechtschreibens. *Zeitschrift Entwicklungspsychologie Pädagogische Psychologie* 44, 53–67.

Evertz, M., and Primus, B. (2013). The graphematic foot in English and German. *Writ. Syst. Res.* 5, 1–23. doi: 10.1080/17586801.2013.765356

Fernald, A., Marchman, V. A., and Weisleder, A. (2013). Ses differences in language processing skill and vocabulary are evident at 18 months. *Dev. Sci.* 16, 234–248. doi: 10.1111/desc.12019

Foorman, B., Coyne, M., Denton, C. A., Dimino, J., Hayes, L., Justice, L., et al. (2016). Foundational skills to support Reading for understanding in kindergarten through 3rd grade. NCEE 2016–4008, U.S. Department Of Education. Available at: https://ies.ed.gov/ncee/wwc/Docs/practiceGuide/wwc_foundationalreading_040717.pdf (Accessed March 11, 2024).

Foulin, J. N. (2005). Why is letter-name knowledge such a good predictor of learning to read? *Read. Writ.* 18, 129–155. doi: 10.1007/s11145-004-5892-2

Fricke, S., Szczerbinski, M., Fox-Boyer, A., and Stackhouse, J. (2016). Preschool predictors of early literacy Acquisition in German-Speaking Children. *Read. Res. Q.* 51, 29–53. doi: 10.1002/rrq.116

Fuhrhop, N. (2018). "19. Graphematik des Deutschen" in Grammatiktheorie und Empirie in der germanistischen Linguistik. eds. A. Wöllstein, P. Gallmann, M. Habermann and M. Krifka (Berlin, Boston: De Gruyter), 587–616.

Fuhrhop, N., and Peters, J. (2023, 2023). Einführung in die Phonologie und Graphematik. 2nd Edn.

Georgiou, G. K., Parrila, R., and Kirby, J. R. (2009). RAN components and Reading development from grade 3 to grade 5: what underlies their relationship? *Sci. Stud. Read.* 13, 508–534. doi: 10.1080/10888430903034796

Gilkerson, J., Richards, J. A., Warren, S. F., Montgomery, J. K., Greenwood, C. R., Kimbrough Oller, D., et al. (2017). Mapping the early language environment using all-day recordings and automated analysis. *Am. J. Speech Lang. Pathol.* 26, 248–265. doi: 10.1044/2016_AJSLP-15-0169

Gindri, G., Keske-Soares, M., and Mota, H. B. (2007). Memória de trabalho, consciência fonológica e hipótese de escrita [working memory, phonological awareness and spelling hypothesis]. *Profono* 19, 313–322. doi: 10.1590/S0104-56872007000300010

Gogolin, I. (2008). Der monolinguale Habitus der multilingualen Schule. Internationale Hochschulschriften, vol. *101*. Münster: Waxmann Verlag.

González-Valenzuela, M.-J., Lopez-Montiel, D., Díaz-Giraldez, F., and Martín-Ruiz, I. (2023). Word writing and cognitive predictors in Spanish at the age of seven. *Int. J. Early Childhood*. doi: 10.1007/s13158-023-00359-w

Goswami, U., Grabherr, B., Ziegler, J. C., Dalton, L., and Schneider, W [Wolfgang] (2003). Nonword reading across orthographies: how flexible is the choice of reading units? Appl. Psycholinguist., 24, 235–247. doi: 10.1017/S0142716403000134

Goswami, U., Ziegler, J. C., Dalton, L., and Schneider, W. (2001). Pseudohomophone effects and phonological recoding procedures in Reading development in English and German. *J. Mem. Lang.* 45, 648–664. doi: 10.1006/jmla.2001.2790

Grimm, A., and Cristante, V. (2022). Deutsch als Zweitsprache - DaZ. Kurze Einführungen in die germanistische Linguistik: Band 28. Heidelberg: Universitätsverlag Winter.

Grob, A., Meyer, C., and Hagmann-von Arx, P. (2009). Intelligence and Development Scales (IDS). Intelligenz- und Entwicklungsskalen für Kinder von 5–10 Jahren. Bern: Hans Huber.

Grosjean, F. (2012). "Bilingualism: a short introduction" in The psycholinguistics of bilingualism. eds. F. Grosjean and P. Li. *1st* ed (New Jersey: John Wiley & Sons), 5–25.

Cat, C., Gusnanto, A., and Serratrice, L. (2018). Identifying a threshold for the executive function advantage in bilingual children. *Stud. Second. Lang. Acquis.* 40, 119–151. doi: 10.1017/S0272263116000486

Hamann, C., and Abed Ibrahim, L. (2017). Methods for Identifying specific language impairment in bilingual populations in Germany. *Front. Commun.* 2:16. doi: 10.3389/fcomm.2017.00016

Hamann, C., Chilla, S., Ruigendijk, E., and Abed Ibrahim, L. (2013). A German sentence repetition task: Testing bilingual Russian/German children.

Hayes, A. F., and Coutts, J. J. (2020). Use omega rather than Cronbach's alpha for estimating reliability. But…. *Commun. Methods Meas.* 14, 1–24. doi: 10.1080/19312458.2020.1718629

Henschel, S., Heppt, B., and Weirich, S. (2023). "Zuwanderungsbezogene Disparitäten" in IQB-Bildungstrend 2022: Sprachliche Kompetenzen am Ende der 9. Jahrgangsstufe im dritten Ländervergleich. eds. P. Stanat, S. Schipolowski, R. Schneider, S. Weirich, S. Henschel and K. A. Sachse (Münster: Waxmann), 299–344.

Hindman, A. H., Skibbe, L. E., Miller, A., and Zimmerman, M. (2010). Ecological contexts and early learning: contributions of child, family, and classroom factors during head start, to literacy and mathematics growth through first grade. *Early Child. Res. Q.* 25, 235–250. doi: 10.1016/j.ecresq.2009.11.003

Hoff, E. (2003). The specificity of environmental influence: socioeconomic status affects early vocabulary development via maternal speech. *Child Dev.* 74, 1368–1378. doi: 10.1111/1467-8624.00612

Huttenlocher, J., Waterfall, H., Vasilyeva, M., Vevea, J., and Hedges, L. V. (2010). Sources of variability in children's language growth. *Cogn. Psychol.* 61, 343–365. doi: 10.1016/j.cogpsych.2010.08.002

Kauschke, C. (2000). "Der Erwerb des frühkindlichen Lexikons: Eine empirische Studie zur Entwicklung des Wortschatzes im Deutschen" in Tübinger Beiträge zur Linguistik. Series A, language development, vol. *27* (Tübingen: G. Narr).

Kim, Y.-S., Apel, K., and Al Otaiba, S. (2013). The relation of linguistic awareness and vocabulary to word reading and spelling for first-grade students participating in response to intervention. *Lang. Speech Hear. Serv. Sch.* 44, 337–347. doi: 10.1044/0161-1461(2013/12-0013)

Klassert, A., Gagarina, N., and Kauschke, C. (2014). Object and action naming in Russian- and German-speaking monolingual and bilingual children. *Biling. Lang. Congn.* 17, 73–88. doi: 10.1017/S1366728913000096

Korhonen, T. T. (1995). The persistence of rapid naming problems in children with reading disabilities: a nine-year follow-up. *J. Learn. Disabil.* 28, 232–239. doi: 10.1177/002221949502800405

Krauß, A. (2010). "Orthographieerwerb von Beginn an. Ein silbenorientiertes Konzept für den Anfangsunterricht" in Reihe Germanistische Linguistik: Vol. 289.

Schriftsystem und Schrifterwerb: Linguistisch - didaktisch - empirisch (pp. 133–150). eds. U. Bredel, A. Müller and G. Hinney (Berlin: De Gruyter).

Landerl, K., Ramus, F., Moll, K., Lyytinen, H., Leppänen, P. H. T., Lohvansuu, K., et al. (2013). Predictors of developmental dyslexia in European orthographies with varying complexity. *J. Child Psychol. Psychiatry* 54, 686–694. doi: 10.1111/jcpp.12029

Landerl, K., and Wimmer, H. (2008). Development of word reading fluency and spelling in a consistent orthography: an 8-year follow-up. *J. Educ. Psychol.* 100, 150–161. doi: 10.1037/0022-0663.100.1.150

Lenhart, J., Marx, P., Segerer, R., and Schneider, W [Wolfgang] (2019). Rechtschreibung ohne Schreiben. Diagnostica, 65, 216–227. doi: 10.1026/0012-1924/a000229

Lervåg, A., and Hulme, C. (2010). Predicting the growth of early spelling skills: are there heterogeneous developmental trajectories? *Sci. Stud. Read.* 14, 485–513. doi: 10.1080/10888431003623488

Levelt, W. J. M. (1998). Speaking: From intention to articulation (5. Print). ACL-MIT press series in natural-language processing. Cambridge Mass: MIT Press.

Li, J., Peng, P., Ma, X., Ding, N., and Zhao, J. (2023). How does family socioeconomic status influence Children's Reading ability? Evidence from Meta-analytic structural equation modeling. *Educ. Psychol. Rev.* 35:119. doi: 10.1007/s10648-023-09834-1

Lüdtke, O., and Robitzsch, A. (2022). A comparison of different approaches for estimating cross-lagged effects from a causal inference perspective. *Struct. Equ. Model. Multidiscip. J.* 29, 888–907. doi: 10.1080/10705511.2022.2065278

Maas, U. (2015). "Laute und Buchstaben - zu den phonographischen Grundlagen des Schrifterwerbs" in Schriftsprach- und Orthographieerwerb: Erstlesen, Erstschreiben. eds. C. Röber and H. Olfert (Baltmannsweiler: Schneider Verlag), 135–161.

MacKinnon, D. P. (2013). Introduction to statistical mediation analysis: [CD included]. New York: Routledge.

Mähler, C., and Schuchardt, K. (2014). "Die Bedeutung des Arbeitsgedächtnisses für den Schriftspracherwerb" in Legasthenie und Dyskalkulie: Neue Methoden zur Diagnostik und Förderung // Legasthenie und Dyskalkulie: neue Methoden zu Diagnostik und Förderung: Mit 21 Tabellen. eds. G. Schulte-Körne, K. Brandelik and B. Estner (Bochum: Winkler), 77–86.

Malling, A. S. B., Juul, H., Gejl, A. K., Damsgaard, L., Wienecke, J., and Nielsen, A.-M. V. (2022). Word Reading, letter knowledge, and memory skills in Danish children (6-year-olds). *Scand. J. Educ. Res.* 66, 1237–1252. doi: 10.1080/00313831.2021.1983646

Martínez, N., and Goikoetxea, E. (2019). Predictors of Reading and spelling words change as a function of syllabic structure in Spanish. *Psicol. Educ.* 26, 37–48. doi: 10.5093/psed2019a20

Mayer, A. (2016). Lese-Rechtschreibstörungen (LRS). München, Basel: Ernst Reinhardt Verlag.

Mehta, P. D., Foorman, B. R., Branum-Martin, L., and Taylor, W. P. (2005). Literacy as a unidimensional multilevel construct: validation, sources of influence, and implications in a longitudinal study in grades 1 to 4. *Sci. Stud. Read.* 9, 85–116. doi: 10.1207/s1532799xssr0902_1

Morgan, P. L., Farkas, G., Hillemeier, M. M., Hammer, C. S., and Maczuga, S. (2015). 24-month-old children with larger Oral vocabularies display greater academic and behavioral functioning at kindergarten entry. *Child Dev.* 86, 1351–1370. doi: 10.1111/cdev.12398

Mulder, J. D., and Hamaker, E. L. (2021). Three extensions of the random intercept cross-lagged panel model. *Struct. Equ. Model. Multidiscip. J.* 28, 638–648. doi: 10.1080/10705511.2020.1784738

Müller, A. (2010). Rechtschreiben lernen: Die Schriftstruktur entdecken - Grundlagen und Übungsvorschläge//Die Schriftstruktur entdecken; Grundlagen und Übungsvorschläge; [mit CD-ROM (3. Auflage 2019, entspricht der 3. überarbeiteten Auflage 2019//1.Aufl.)]. Praxis Deutsch. Klett|Kallmeyer; Kallmeyer in Verb. mit Klett; Klett.

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

Muthén, L. K., and Muthén, B. O. (1998-2017). Mplus user's guide. *Eighth* Edn. Los Angeles, CA: Muthén & Muthén.

Neef, M. (2015). Writing systems as modular objects: proposals for theory design in grapholinguistics. *Open Linguist.* 1. doi: 10.1515/opli-2015-0026

Niemietz, J., Jindra, C., Schneider, R., Schumann, K., Schipolowski, S., and Sachse, K. A. (2023). "Soziale Disparitäten" in IQB-Bildungstrend 2022: Sprachliche Kompetenzen am Ende der 9. Jahrgangsstufe im dritten Ländervergleich. eds. P. Stanat, S. Schipolowski, R. Schneider, S. Weirich, S. Henschel and K. A. Sachse (Münster: Waxmann), 261–298.

Niklas, F., Wirth, A., Mues, A., and Birtwistle, E. (2023). "Children's early spelling development in the context of the home literacy environment" in Routledge international handbook of visual-motor skills, handwriting, and spelling. eds. Y. Ye, T. Inoue, U. Maurer and C. McBride (Abingdon: Routledge), 366–378.

Niolaki, G. Z., Vousden, J., Terzopoulos, A. R., Taylor, L. M., Sephton, S., and Masterson, J. (2020). Predictors of single word spelling in English speaking children: a cross sectional study. *J. Res. Read.* 43, 577–596. doi: 10.1111/1467-9817.12330

Noble, K. G., McCandliss, B. D., and Farah, M. J. (2007). Socioeconomic gradients predict individual differences in neurocognitive abilities. *Dev. Sci.* 10, 464–480. doi: 10.1111/j.1467-7687.2007.00600.x

OECD (2023). PISA 2022 results (volume I): The state of learning and equity in education. Paris: OECD Publishing.

Oller, K., and Eilers, R. (2002). Language and literacy in bilingual children. Blue Ridge Summit: Multilingual Matters.

Paap, K. R., Johnson, H. A., and Sawi, O. (2014). Are bilingual advantages dependent upon specific tasks or specific bilingual experiences? *J. Cogn. Psychol.* 26, 615–639. doi: 10.1080/20445911.2014.944914

Pace, A., Luo, R., Hirsh-Pasek, K., and Golinkoff, R. M. (2017). Identifying pathways between socioeconomic status and language development. *Ann. Rev. Linguist.* 3, 285–308. doi: 10.1146/annurev-linguistics-011516-034226

Pan, S. C., Rickard, T. C., and Bjork, R. A. (2021). Pan, Rickard, and Bjork (2021) does spelling still matter—And if so, how should it be taught?

Paradis, J., and Genesee, F. (1996). Syntactic Acquisition in Bilingual Children. *Stud. Second. Lang. Acquis.* 18, 1–25. doi: 10.1017/S0272263100014662

Paradis, J., Genesee, F., and Crago, M. (2021). Dual language development & disorders: a handbook on bilingualism and second language learning. *3rd* Edn. Newburyport: Brookes Publishing.

Pfost, M. (2015). Children's phonological awareness as a predictor of Reading and spelling. *Zeitschrift Entwicklungspsychol. Pädagog. Psychol.* 47, 123–138. doi: 10.1026/0049-8637/a000141

Pinto, G., Tarchi, C., and Bigozzi, L. (2015). The relationship between oral and written narratives: a three-year longitudinal study of narrative cohesion, coherence, and structure. *Br. J. Educ. Psychol.* 85, 551–569. doi: 10.1111/bjep.12091

Pomerantz, E. M., and Grolnick, W. S. (2017). "The role of parenting in children's motivation and competence: what underlies facilitative parenting?" in Handbook of competence and motivation: theory and application. eds. A. J. Elliot, C. S. Dweck and D. S. Yeager (The Guilford Press), 566–585.

Preacher, K. J., Zyphur, M. J., and Zhang, Z. (2010). A general multilevel SEM framework for assessing multilevel mediation. *Psychol. Methods* 15, 209–233. doi: 10.1037/a0020141

Ptok, M., Berendes, K., Gottal, S., Grabherr, B., Schneeberg, J., and Wittler, M. (2008). Phonologische Verarbeitung. *Monatsschr. Kinderheilkd.* 156, 860–866. doi: 10.1007/s00112-008-1770-3

Röber, C. (2013). Die Leistungen der Kinder beim Lesen- und Schreibenlernen. Grundlagen der Silbenanalytischen Methode: Ein Arbeitsbuch mit Übungsaufgaben. Schneider-Verlag Hohengehren.

Ross, J., and Melinger, A. (2017). Bilingual advantage, bidialectal advantage or neither? Comparing performance across three tests of executive function in middle childhood. *Dev. Sci.* 20. doi: 10.1111/desc.12405

Rothweiler, M. (1993). Der Erwerb von Nebensätzen im Deutschen: Eine Pilotstudie. *Linguistische Arbeiten* 302. doi: 10.1515/9783111355856

Rowe, M. L. (2008). Child-directed speech: relation to socioeconomic status, knowledge of child development and child vocabulary skill. *J. Child Lang.* 35, 185–205. doi: 10.1017/S0305000907008343

Schatschneider, C., Fletcher, J. M., Francis, D. J., Carlson, C. D., and Foorman, B. R. (2004). Kindergarten prediction of Reading skills: a longitudinal comparative analysis. *J. Educ. Psychol.* 96, 265–282. doi: 10.1037/0022-0663.96.2.265

Schmitterer, A. M., and Schroeder, S. (2019). Effects of reading and spelling predictors before and after school entry: evidence from a German longitudinal study. *Learn. Instr.* 59, 46–53. doi: 10.1016/j.learninstruc.2018.09.005

Schneider, W. (2009). "The development of reading and spelling: relevant precursors, developmental changes, and individual differences" in Human development from early childhood to early adulthood: Findings from a 20 year longitudinal study. eds. W. W. Schneider and M. Bullock (London: Psychology Press), 199–220.

Schneider, W., Roth, E., Küspert, P., and Ennemoser, M. (1998). Kurz- und langfristige Effekte eines Trainings der sprachlichen (phonologischen) Bewußtheit bei unterschiedlichen Leistungsgruppen: Befunde einer Sekundäranalyse. *Zeitschrift Entwicklungspsychol. Pädagog. Psychol.* 30, 26–39.

Schnitzler, C. (2008). Phonologische Bewusstheit und Schriftspracherwerb: 31 Tabellen. Forum Logopädie: Thieme.

Schöfl, M., Seifert, S., Steinmair, G., and Weber, C. (2023a). Are both object and alphanumeric rapid automatized naming measures required to predict word Reading fluency in German prereaders? *J. Psychoeduc. Assess.* 41, 811–827. doi: 10.1177/07342829231185375

Schöfl, M., Steinmair, G., Holzinger, D., and Weber, C. (2022). Predicting word Reading deficits using an app-based screening tool at school entry. *Front. Pediatr.* 10:863477. doi: 10.3389/fped.2022.863477

Schöfl, M., Steinmair, G., Zepnik, S., and Gnambs, T. (2023b). Entwicklung eines digitalen Rechtschreibtests für die erste Klasse Grundschule: Dimensionalität und Reliabilität des SCHNAPP-Rechtschreibtests. *Lernen Lernstörungen* 12, 188–200. doi: 10.1024/2235-0977/a000404

Schöfl, M., Steinmair, G., Zepnik, S., and Weber, C. (under review). Using an app-based screening tool to predict deficits in written word spelling at school entry. *Front. Educ.*

Schroeder, S., Würzner, K.-M., Heister, J., Geyken, A., and Kliegl, R. (2015). childLex–Eine lexikalische Datenbank zur Schriftsprache für Kinder im Deutschen. *Psychol. Rundsch.* 66, 155–165. doi: 10.1026/0033-3042/a000275

Schulte-Körne, G., Warnke, A., and Remschmidt, H. (2006). Zur Genetik der Lese-Rechtschreibschwäche [Genetics of dyslexia]. *Zeitschrift Kinder Jugendpsychiatrie Psychotherapie* 34, 435–444. doi: 10.1024/1422-4917.34.6.435

Schulz, P. (2007). "Erstspracherwerb Deutsch: Sprachliche Fähigkeiten von eins bis zehn" in Entwicklungslinien der Grundschulpädagogik: Vol. 4. Diagnostik und Förderung im Elementarbereich und Grundschulunterricht: Lernprozesse wahrnehmen, deuten und begleiten. eds. U. Graf and E. Moser Opitz (Baltmannsweiler: Schneider Verlag Hohengehren), 67–85.

Schulz, P., and Grimm, A. (2019). The age factor revisited: timing in acquisition interacts with age of onset in bilingual acquisition. *Front. Psychol.* 9:2732. doi: 10.3389/fpsyg.2018.02732

Segerer, R., Marx, A., Stanat, P., Schneider, W, and Roick, T., & Marx, P. (2013). Determinanten der Lesekompetenz bei Jugendlichen nicht deutscher Herkunftssprache. Zur Bedeutung der Spracherwerbsreihenfolge im Falle von Mehrsprachigkeit. PISA 2009 - Impulse für die Schul- und Unterrichtsforschung, Zeitschrift für Pädagogik, Beiheft

Seifert, S., Paleczek, L., and Gasteiger-Klicpera, B. (2019). Rezeptive Wortschatzleistungen in der Grundschule: Unterschiede zwischen Kindern mit Deutsch als Erst- und Zweitsprache. *Empirische Sonderpädagogik* 4, 259–278.

Seifert, S., Paleczek, L., Schwab, S., and Gasteiger-Klicpera, B. (2017). GraWo – Grazer Wortschatztest: Hogrefe.

Silverman, R. D., Coker, D., Proctor, C. P., Harring, J., Piantedosi, K. W., and Hartranft, A. M. (2015). The relationship between language skills and writing outcomes for linguistically diverse students in upper elementary school. *Elem. Sch. J.* 116, 103–125. doi: 10.1086/683135

Sirin, S. R. (2005). Socioeconomic status and academic achievement: a Meta-analytic review of research. *Rev. Educ. Res.* 75, 417–453. doi: 10.3102/00346543075003417

Skowronek, H., and Marx, H. (1989). "The Bielefeld longitudinal study on early identification of risks in learning read and write: theoretical background and first results" in Children at risk: Assessment, longitudinal research and intervention. eds. M. Brambring, F. Lösel and H. Skowronek, 268–294.

Statistik Austria. (2024). STATcube – Statistische Datenbank von STATISTIK AUSTRIA: Schulstatistik; Schüler:innen ab 2006. Available at: https://statcube.at (Accessed February 17, 2024).

Steinbrink, C., and Klatte, M. (2008). Phonological working memory in German children with poor reading and spelling abilities. *Dyslexia* 14, 271–290. doi: 10.1002/dys.357

Strattman, K., and Hodson, B. W. (2005). Variables that influence decoding and spelling in beginning readers. *Child Lang. Teach. Therapy* 21, 165–190. doi: 10.1191/0265659005ct287oa

Thoemmes, F., MacKinnon, D. P., and Reiser, M. R. (2010). Power analysis for complex mediational designs using Monte Carlo methods. *Struct. Equ. Model.* 17, 510–534. doi: 10.1080/10705511.2010.489379

Thordardottir, E. (2015). 12. Proposed diagnostic procedures for use in bilingual and cross-linguistic contexts. In S. Armon-Lotem, JongJ. de and N. Meir (Eds.), Communication disorders across languages. Assessing multilingual children: Disentangling bilingualism from language impairment // assessing multilingual children: Disentangling bilingualism from language impairment (pp. 331–358). Blue Ridge Summit: Multilingual Matters

Thordardottir, E., and Brandeker, M. (2013). The effect of bilingual exposure versus language impairment on nonword repetition and sentence imitation scores. *J. Commun. Disord.* 46, 1–16. doi: 10.1016/j.jcomdis.2012.08.002

Treiman, R., Hulslander, J., Olson, R. K., Samuelsson, S., Elwér, Å., Furnes, B., et al. (2023). Predicting later spelling from kindergarten spelling in U.S., Australian, and Swedish children. *Sci. Stud. Read.* 27, 428–442. doi: 10.1080/10888438.2023.2186234

Tunmer, W. E., and Hoover, W. A. (1992). "Cognitive and linguistic factors in learning to read" in Reading acquisition. eds. P. B. Gough, L. C. Ehri and R. Treiman (Lawrence Erlbaum Associates, Inc), 175–214.

van Ewijk, R., and Sleegers, P. (2010a). The effect of peer socioeconomic status on student achievement: a meta-analysis. *Educ. Res. Rev.* 5, 134–150. doi: 10.1016/j.edurev.2010.02.001

van Ewijk, R., and Sleegers, P. (2010b). Peer ethnicity and achievement: a meta-analysis into the compositional effect. *Sch. Eff. Sch. Improv.* 21, 237–265. doi: 10.1080/09243451003612671

Veldhuis, T. M. (2015). Effects of literacy, typology and frequency on children's language segmentation and processing units [Ph.D Dissertation]. University of Tilburg

Vellutino, F. R., Fletcher, J. M., Snowling, M. J., and Scanlon, D. M. (2004). Specific reading disability (dyslexia): what have we learned in the past four decades? *J. Child Psychol. Psychiatry* 45, 2–40. doi: 10.1046/j.0021-9630.2003.00305.x

Goldammer, A.von. (2010). Von der Sprache zur Schriftsprache: Diagnostische und prognostische Validität der Erfassung von Vorläuferkompetenzen der Schriftsprache im Vorschulalter.

Goldammer, A.Von, Mähler, C., Bockmann, A.-K., and Hasselhorn, M. (2010). Vorhersage früher Schriftsprachleistungen aus vorschulischen Kompetenzen der Sprache und der phonologischen Informationsverarbeitung. *Zeitschrift Entwicklungspsychol. Pädagog. Psychol.*, 42, 48–56. doi: 10.1026/0049-8637/a000005

Von Stumm, S., Rimfeld, K., Dale, P. S., and Plomin, R. (2020). Preschool verbal and nonverbal ability mediate the association between socioeconomic status and school performance. *Child Dev.* 91, 705–714. doi: 10.1111/cdev.13364

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

Weber, C., Helm, C., and Kemethofer, D. (2021). Are social and ethnic Reading inequalities increasing during school closures?—the mediating role of parental involvement in distance learning. *Front. Educ.* 6:737064. doi: 10.3389/feduc.2021.737064

White, K. R. (1982). The relation between socioeconomic status and academic achievement. *Psychol. Bull.* 91, 461–481. doi: 10.1037/0033-2909.91.3.461

Wiese, R. (2006). The phonology of German. Oxford: Oxford University Press.

Wolf, M., and Bowers, P. G. (1999). The double-deficit hypothesis for the developmental dyslexias. *J. Educ. Psychol.* 91, 415–438. doi: 10.1037/0022-0663.91.3.415

Yulianti, K., Denessen, E., and Droop, M. (2023). The effects of parental involvement on children's education: a study in elementary schools in Indonesia. *Int. J. Parents Educ.* 10, 14–32. doi: 10.54195/ijpe.14123

Zaretsky, E., and Lange, B. P. (2017). Sociolinguistic factors associated with the subjectively and objectively measured language development in German preschoolers in three follow-up studies. *Linguistics* 55:0.1515/ling-2016-0036. doi: 10.1515/ling-2016-0036

Ziegler, J. C., and Goswami, U. (2006). Becoming literate in different languages: similar problems, different solutions. *Dev. Sci.* 9, 429–436. doi: 10.1111/j.1467-7687.2006.00509.x