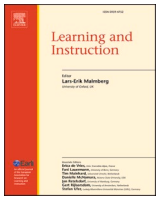
Learning and Instruction 93 (2024) 101969

Contents lists available at ScienceDirect

Learning and Instruction

journal homepage: www.elsevier.com/locate/learninstruc



A scoping review on word-reading resilience in literacy: Evaluating empirical evidence for protective factors

Sanne Appels [a,*], Sietske van Viersen [a], Sara van Erp [b], Lisette Hornstra [c], Elise de Bree [a,d]

[a] Department of Development & Education of Youth in Diverse Societies, Utrecht University, Heidelberglaan 1, 3584 CS, Utrecht, the Netherlands
[b] Department of Methodology and Statistics, Utrecht University, Padualaan 14, 3584 CH, Utrecht, the Netherlands
[c] Department of Education, Utrecht University, Heidelberglaan 1, 3584 CS, Utrecht, the Netherlands
[d] Research Institute of Child Development and Education, University of Amsterdam, P.O. Box 15780, 1001NG, the Netherlands

ARTICLE INFO

Keywords:
Literacy development
Academic resilience
Promotive factors
Protective factors
Skill-enhancing factors

ABSTRACT

Background: To date little is known about factors that might contribute to positive literacy outcomes in children with (a risk of) reading difficulties (RD). Research into resilience in literacy is needed to understand why some children with (a risk of) RD can overcome their difficulties in the face of adversity.
Aim: This scoping review aims to 1) provide a framework and operationalize study designs and statistical approaches for studying academic resilience; and 2) systematically review empirical evidence for promotive, protective, and skill-enhancing factors involved in resilience in atypical literacy development of children with (a risk of) word-level RD.
Method: The systematic literature search included empirical studies with a focus on compensation in literacy development, including samples of 6- to 16-year-old children with a detectable (risk of) word-level RD. Outcome measures had to include at least one relevant literacy measure.
Results: Analysis of the 22 included studies revealed two main findings: 1) most studies had (very) small sample sizes and thus low statistical power to find relevant effects; 2) study designs and/or statistical analyses used were often insufficient to distinguish between promotive, protective, and skill-enhancing factors. Furthermore, findings point towards underrecognition of evidence for promotive and skill-enhancing factors as well as overinterpretation of the same evidence towards protective effects.
Conclusion: Overall, empirical evidence for protective factors is sparse and at present based on only a few studies. Based on the current findings, we state implications for the field of educational psychology in planning and conducting research into resilience in literacy.

1. A scoping review on word-reading resilience in literacy: Evaluating empirical evidence for protective factors

1.1. Resilience in literacy

Good literacy skills are essential for children's academic outcomes, future employment, participation in society, and overall well-being (OECD, 2019). It is therefore crucial to understand the mechanisms of literacy acquisition. While research has focused on trajectories into literacy (e.g., Hjetland et al., 2019; Hulme et al., 2015; van Viersen et al., 2018) and on identifying risk factors for reading difficulties (RDs; e.g., McGrath et al., 2020; Peng et al., 2019; van Viersen et al., 2017, 2018), we know very little about factors that might contribute to positive literacy outcomes in children with (a risk of) word-level RD. Such research into resilience in literacy is needed for understanding why some children with (a risk of) word-level RD can overcome their difficulties given the right circumstances (e.g., Catts et al., 2012; Eloranta et al., 2018; Torppa et al., 2015; van Viersen et al., 2019). Therefore, a first aim of this study is to build on and further operationalize recent translations of existing approaches for studying socio-emotional resilience in developmental psychopathology (i.e., focusing on positive socio-emotional development in case of risk due to adverse conditions) into a practical framework for studying *academic resilience* in educational psychology (i.e., focusing on positive literacy development in case of (risk of) word-level

* Corresponding author.
E-mail addresses: s.c.t.appels@uu.nl (S. Appels), s.vanviersen@uu.nl (S. van Viersen), s.j.vanerp@uu.nl (S. van Erp), t.e.hornstra@uu.nl (L. Hornstra), e.h.debree@uva.nl (E. de Bree).

https://doi.org/10.1016/j.learninstruc.2024.101969
Received 30 November 2023; Received in revised form 13 June 2024; Accepted 19 June 2024

RD).

In the context of literacy, academic resilience can be defined as the trajectory from a clear risk for and/or presence of low literacy outcomes towards positive adaptation and successful literacy acquisition (Masten & Barnes, 2018; Slomowitz et al., 2021, 2024). In line with the definition of a specific learning difficulty in the DSM-5 (American Psychiatric Association, 2013), RD is defined as a developmental learning disability concerning severe and persistent reading difficulties at the word level (e.g., Peterson & Pennington, 2015; Snowling et al., 2020; Vellutino et al., 2004), also known as dyslexia. Prevalence varies roughly between 5 and 10% of children across different languages and writing systems (Verhoeven et al., 2019). Although RD is established on the basis of word-level literacy outcomes, its impact extends beyond word-level literacy. Having (a risk of) word-level RD also affects reading comprehension and thus potentially limits the amount of knowledge that can be obtained from text (Hulme et al., 2015; van Viersen et al., 2018). Resilience to word-level RD is thus essential for children to prevent negative effects on educational outcomes. Hence, a second aim of this study is to use the operationalization of the academic resilience framework in the context of literacy to evaluate existing empirical evidence on factors involved in resilience in literacy to learn more about successful literacy development in children with (a risk of) word-level RD.

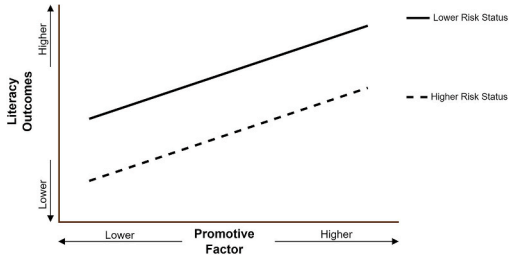
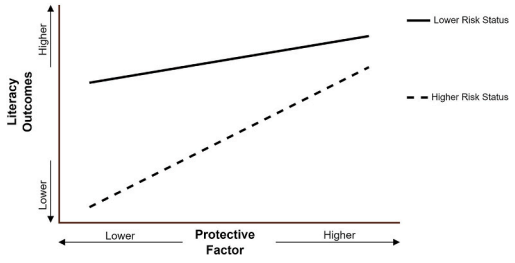
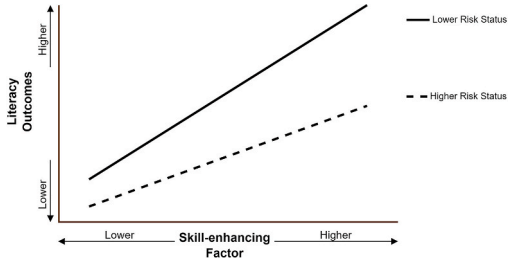
1.2. Definitions for understanding and studying academic resilience

Factors relevant for resilience in literacy refer to a wide variety of aspects and circumstances that contribute to positive literacy outcomes in children with (a risk of) word-level RD. This includes, for example, cognitive, neural, socio-emotional, educational, motivational, and interpersonal factors. Moreover, these factors can refer to inherent characteristics or abilities of children (e.g., memory skills), to factors which result from the interplay between abilities and environmental input (e.g. vocabulary skills), or refer to contextual factors (e.g., educational quality).

To study academic resilience, a specified framework is needed, including explicit definitions of key concepts. We therefore relied on previous research from the field of developmental psychopathology, which has been translated to the field of educational psychology by Slomowitz et al. (2021, 2024, see also Masten & Barnes, 2018). Slomowitz et al. (2021) identified three types of factors that are relevant in the context of academic resilience. These definitions form the basis of this scoping review and are consistently used to 1) illustrate how specific study designs can facilitate discovering resilience-related factors and 2) evaluate existing empirical evidence for academic resilience in literacy development.

First, *promotive* factors are defined as factors associated with positive literacy outcomes regardless of the presence or degree of (a risk of) RD (Masten & Barnes, 2018; Slomowitz et al., 2021). Promotive factors thus foster literacy development of children with (a risk of) RD *as well as* typically developing (TD) children and work equally beneficially for everyone. Promotive factors therefore do not decrease the literacy gap between children with (a risk of) RD and typical readers but consolidate it. Consequently, promotive factors have *gap-maintaining* effects on literacy outcomes (see Table 1a). Statistically, promotive factors correspond to a main effect without interaction. An intuitive example of a promotive factor supporting literacy development in all children is print exposure (see Mol & Bus, 2011, for an overview). The more time children spend reading, the more proficient they become in word-level

Table 1
Overview of Definitions of Factors, their Effects, and Graphical Representations of these Effects on Literacy.

Factor	Definition	Type of effect	Graphical representation
a. Promotive factor	Factor associated with positive reading and/or spelling outcomes regardless of the presence or degree of (a risk of) RD	Main effect (Gap-maintaining)	
b. Protective factor	Factor leading to better-than-expected outcomes specifically for children with (a risk of) RD	Interaction effect (Gap-closing)	
c. Skill-enhancing factor	Factor leading to even better-than-expected outcomes for children at lowest risk for RD	Interaction effect (Gap-widening)	

Note. Graphical representations adapted from 'In Search of Cognitive Promotive and Protective Factors for Word Reading', by Slomowitz et al., 2021, *Scientific Studies of Reading, 25(5),* p. 3.

reading and spelling, as well as in reading comprehension.

Second, *protective* factors are defined as factors leading to better-than-expected outcomes particularly for children with (a risk of) RD compared to children at lower risk of RD (Masten & Barnes, 2018; Slomowitz et al., 2021; Wright et al., 2013). Protective factors foster literacy development specifically of children with (a risk of) RD and thus allow them to (partially) catch up with their TD peers. Protective factors therefore have *gap-closing* effects on literacy outcomes (see Table 1b). Statistically, protective factors are interaction effects indicating a decreasing gap in literacy between (at-risk of) RD groups and low-risk/TD groups at increasing levels of a moderating (protective) variable. Semantic bootstrapping has been proposed as a protective factor: children with dyslexia have been found to benefit more from context when reading sentences than their TD peers and seem to use this mechanism to compensate for their poor decoding skills (see e.g., Klimovich-Gray et al., 2023; Nation & Snowling, 1998).

Third, *skill-enhancing* factors lead to even better-than-expected outcomes for children at lowest risk for RD. Therefore, skill-enhancing factors foster literacy development of children that are already good readers, while they have a weaker effect on children with (a risk for) RD. Alike the Matthew effect, they create a rich-get-richer pattern (Protopapas et al., 2016; Stanovich, 1986). As such, skill-enhancing factors have *gap-widening* effects on literacy outcomes (Table 1c) and thus do not contribute to academic resilience. Statistically, skill-enhancing factors are interaction effects indicating an increasing gap in literacy between (at risk of) RD groups and low-risk/TD groups at increasing levels of a moderating (skill-enhancing) variable. Slomowitz et al. (2021) provide a clear example of a skill-enhancing factor. They found that vocabulary functions as a promotive factor for all children, but also that children at low risk of RD (i.e., with higher phonological awareness [PA]) benefitted even more from higher vocabulary skills than children at risk for RD (i.e., with low PA) in their word-reading outcomes.

Academic resilience is the outcome of a positive developmental trajectory that results from processes in which promotive and protective factors help to *compensate* for risk factors of literacy over time. There are multiple theoretical models of reading development, such as the Simple View of Reading (Gough & Tunmer, 1986; Hoover & Gough, 1990) and the Direct and Indirect Effects model of Reading (DIER; Kim, 2019). The DIER model, for example, illustrates that many skills are involved in reading development. Reading comprehension draws on word reading, listening comprehension, and text reading fluency. While the component skill of accurate and fluent word-level reading requires knowledge of phonology, semantics, and orthography, the component skill listening comprehension in turn relies on foundational oral language skills such as vocabulary and grammar, as well as higher-order skills such as inference making, reasoning, and perspective taking. The DIER model also proposes direct, indirect, and bidirectional relations among the skills needed for reading comprehension. Yet, the DIER model, as well as other models, do not specifically describe the role of potential promotive and protective factors. This additional information is needed to make explicit how the different skills in the model may be involved in compensatory mechanisms of reading development.

Regarding compensation, the possible levels at which compensation takes place may differ depending on a learner's current level of development and thereby on the literacy skill assessed. When focusing on children (with a risk of word-level RD) who start to learn to read words, compensation might exist in the underlying factors related to word-level literacy outcomes. Yet, when focusing on children who have developed actual word-level literacy problems, compensation might involve factors contributing to more complex literacy skills, such as text reading fluency and/or reading comprehension. Therefore, we propose that *resilience* can take place on different levels of literacy outcomes, based on a learner's current level of development. For example, young children at risk of word-level RD show resilience when they achieve average word-level reading despite impairments in precursor skills. Likewise, older children with RD, who already display poor word-level skills, show resilience when they attain better-than-expected performance on text reading fluency or reading comprehension.

Furthermore, we also propose to include context factors and non-cognitive skills, besides cognitive skills, in studying academic resilience. This constellation of factors refers to a wide variety of aspects and circumstances that contribute to reading development in general and positive literacy outcomes in children with (a risk of) word-level RD in specific. We acknowledge that literacy is an interactive process, in which interactions between underlying skills and word-level literacy can take place, as well as interactions between word-level literacy and reading comprehension (e.g., Hjetland et al., 2019; Kim, 2019). Yet, for now, we opt to approach resilience by looking at the potential contributions of cognitive, non-cognitive, and context factors, before further complicating the underlying theory. We hope this (simplified) approach can constitute a building block for further frameworks on academic resilience.

1.3. Study designs and approaches for understanding and studying resilience

In literacy research, compensation and academic resilience have been gaining increasing attention (e.g., Liew et al., 2018; Slomowitz et al., 2021; van Viersen et al., 2015, 2016, 2019; Zuk et al., 2021). The distinction between promotive and protective (as well as skill-enhancing) factors is essential, for example for developing interventions with specific gap-closing effects on the literacy outcomes of children with (a risk of) word-level RD (Slomowitz et al., 2024). Several recent proposals and guidelines (Catts & Petscher, 2021; Masten & Barnes, 2018; Slomowitz et al., 2021, 2024) are available for the application of suitable study designs and statistical techniques in resilience research. However, these guidelines need further operationalization for studying literacy development and allowing evaluation of both new and previous empirical findings. Here, we focused solely on descriptive studies in which we distinguished between variable-centered and person-centered approaches. Within these approaches, we considered both continuous and subgroup designs using cross-sectional or longitudinal data.

In the context of resilience in literacy, variable-centered studies can provide essential information about associations between risk variables, potential promotive and protective factors, and literacy outcomes at the sample or subgroup level. Slomowitz et al. (2024) state that distinguishing between promotive and protective factors in these studies requires 1) testing main *and* interaction effects, and 2) a full 2×2 matrix of presence/absence of risk factors *and* presence/absence of potential resilience variables (see also Masten, 2001). In continuous designs, samples of children generally cover the full range of possible scores on both risk and resilience-related factors. Testing of main effects and interactions to distinguish between promotive and protective/skill-enhancing factors can be done without dichotomizing based on risk and resilience variables. Subsequent plotting of the interaction can be helpful to further distinguish between gap-closing and gap-widening effects.

In subgroup designs, however, a 2×2 matrix is generally not complete. One reason is that children's performance on a specific resilience factor is often not known or fully mapped in low risk/TD groups (Slomowitz et al., 2024). To accommodate common practice in literacy research and enable the evaluation of previous empirical evidence, we propose that comparing three groups (e.g., a high-risk RD group, a high-risk resilient group, and a low-risk TD control group), as opposed to four groups, can also provide important insights. However, this only suffices if all subgroup comparisons are included: 1) RD vs. Resilient, to indicate whether an underlying skill is a strength for the resilient group relative to the RD group, 2) Resilient vs. TD, to determine the potential impact of the strength, with equal performance to the TD group increasing the potential of a protective effect more than performance in between RD and TD groups, and 3) RD vs TD, to confirm that the

strength is absent in RD children and thus likely explains differences in literacy outcomes between RD and Resilient groups over time.

Ideally, resilience is investigated using longitudinal data (Catts & Petscher, 2021; Slomowitz et al., 2024), which is amply available in literacy research (e.g., prospective studies), but cross-sectional designs can also provide relevant information. For example, when inclusion criteria for subgroups are based on information about previous performance or family history, cross-sectional designs can establish strengths in specific skills and potential effects on development. Cross-sectional variable-centered studies presenting data from only one time point can thus provide important leads for potential protective factors that deserve further investigation. Whereas variable-centered studies can provide us with relevant information on resilience, these approaches do not capture individual variability *within* groups or populations (person-centered approaches).

Contrary to variable-centered approaches, person-centered approaches can be used to map and summarize information about individuals based on their profiles of literacy and underlying skills (Masten, 2001; Masten & Barnes, 2018). For example, a latent profile analysis can be used to identify which individual profiles of underlying skills are associated with resilient developmental trajectories for literacy outcomes. Person-centered and variable-centered approaches can complement each other in mixed-level studies. If a latent profile analysis is used to form subgroups based on patterns of individual differences, this information can subsequently be used in a variable-centered approach (e.g., regression or group comparison) to examine relations with outcome variables (including interactions if informative; Bergman & Magnusson, 1997; Catts & Petscher, 2021). These approaches and related design principles are further operationalized and described in more detail in the results section, where they are applied to various categories of studies in current research on resilience in literacy.

1.4. Current study: A scoping review

In this study, we conducted a systematic scoping review on studies focusing on resilience in literacy. Through consistent use and application of proposed key concepts, definitions, and design guidelines for research on academic resilience (Slomowitz et al., 2021, 2024), we aimed to 1) further operationalize study designs and statistical approaches for studying resilience in literacy with descriptive empirical studies, and 2) evaluate existing empirical evidence on promotive, protective, and skill-enhancing factors in literacy development.

Academic resilience in literacy is an emerging field of research (e.g., Catts and Petscher, 2021; Haft et al., 2016; Slomowitz et al., 2024) and it is not clear to what extent previous studies have distinguished between promotive, protective, and skill-enhancing factors (both conceptually and statistically). Because of the anticipated limited available studies that target resilience in literacy, we conducted a scoping review rather than a systematic review or meta-analysis. In our search, we deliberately excluded studies on risk factors without a focus on resilience. Even though there is a large body of evidence on risk factors (e.g., McGrath et al., 2020; Peng et al., 2019; van Viersen et al., 2017, 2018), these studies generally do not evaluate their data from a resilience perspective. Inclusion of risk-factor-only-studies are thus unlikely to provide specific information about factors related to resilience in literacy.

Restricting the focus of this scoping review should allow us to create a common ground for investigating academic resilience in literacy and should help shape studies in effective ways. Moreover, a state-of-the-art review on current knowledge of resilience-related factors in literacy acquisition serves as a useful starting point for channeling future research efforts. This knowledge is essential to move towards investigating the compensatory *mechanisms* behind resilient trajectories in atypical literacy acquisition.

2. Method

For this scoping review, we followed the five phases of the methodological framework for scoping reviews of Arksey and O'Malley (2005), extended by Levac et al. (2010): 1) specifying the research question; 2) identifying relevant studies; 3) selecting studies; 4) charting the data; and 5) collating, summarizing, and reporting the results. The findings were reported following the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Shamseer et al., 2015); the relevant items applicable to a scoping review were addressed.

2.1. Phase 1: Specifying the research questions

Based on the aforementioned aims, the following research questions were formulated: a) How can relevant study designs and approaches in literacy research be further operationalized to provide solid evidence for academic resilience in literacy? and b) Which promotive, protective, and skill-enhancing factors can be identified from the current literature based on empirical evidence?

2.2. Phase 2: Identifying relevant studies

The starting point for the scoping review was a systematic literature search with the following inclusion criteria.

1. Included studies had to concern children from Grade 1 (approximately age 6) up until age 16, thus from the start of *formal* literacy instruction (Grade 1) to the point where foundational education ends or where most educational systems become increasingly tracked (Grade 10). Please note that this can include studies in which precursor skills were obtained at earlier ages. Furthermore, when classroom grades were not provided, the age limit of 6 years was used;
2. Studied samples had to include children with identified word-level RD (e.g., severe word-level reading difficulties or dyslexia) on the basis of screening or diagnostic assessment (McArthur et al., 2000; Ramus et al., 2013), or children with a detectable risk of word-level RD on the basis of a family risk (FR) for RD, diagnosed developmental language disorder (DLD; Catts et al., 2005; McArthur et al., 2000; Snowling et al., 2019), or low pre-literacy skills (phonological awareness [PA], rapid automatized naming [RAN], verbal short term memory [VSTM], letter knowledge [LK]). It is important to note that for all of these children, the nature of the risk and/or underlying cause of the word-level RD is at the *cognitive* level (i.e., referring to skills directly involved in word-level reading, such as PA, RAN, LK; McGrath et al., 2020; Peng et al., 2019; Snowling et al., 2021; Snowling & Melby-Lervag, 2016; van Viersen et al., 2017, 2018). We deliberately opted for a definition of risk that was as specific as needed but as broad as possible, as we did not know in advance how many studies would be eligible for inclusion. If a substantial number of studies for different risk groups were to be found, further categorization could aid synthesis of the findings;
3. Outcome measures had to include at least one relevant literacy measure (i.e., word-reading accuracy or fluency, text-reading fluency, or reading comprehension). Studies on word-level spelling were also included. In this case, at least one reading outcome also had to be present;
4. To assess resilience, at least one literacy measure of higher complexity than the level on which the (risk of) word-level RD occurred had to be available. Thus, for example, when *risk of* word-level RD was determined based on poor precursor skills, word-level reading needed to be included as an outcome measure. Likewise, in case of *identified* RD, text reading fluency or reading comprehension needed to be included as an outcome measure. The study should focus on resilience *or* protective factors and allows for assessment of

promotive, protective, and skill-enhancing effects in literacy development. Alternative search terms, such as strengths, buffer, or compensation/compensatory mechanisms are also taken into account.

We excluded (1) studies that did not report on literacy measures or only reported on literacy measures before Grade 1 or Year 2; (2) studies for which the full-text was unavailable; and (3) studies that were not published in English.

It is important to note that whether, for example, language-related factors such as orthographic transparency can be taken into account in evaluating empirical evidence for resilience in literacy depends on the amount of and variation in relevant studies eligible for inclusion in the scoping review. To maximize the number of possibly eligible papers, we did not take any additional variables into account for the search, but this information was coded after initial inclusion of studies (see Appendix B).

2.2.1. Information sources

The search strategy consisted of three steps. In step 1, we developed a set of search terms for the PsychInfo and ERIC databases (both Ovid, see Appendix A). Together, these databases include all major journals on literacy development. The search conducted in PsycInfo is provided as an example: "protective factors/or resilience/or (promotive factor* or protective factor* or compensat* factor* or resilienc* or strength* or buffer).ti,ab,id,tm.". For step 2, these search terms were entered into the databases in September 2022. The searches were limited to the publication years 2010 and onwards as research on resilience in literacy development is rather recent and to our knowledge, no records exist prior to 2010. The search strategy was adapted to meet the truncation and Boolean operations of each database, and both Subject Headings and Keywords were used in the databases. In step 3, all retrieved articles were entered into Zotero for deduplication and subsequently entered into Rayyan (Ouzzani et al., 2016) for further screening.

2.3. Phase 3: Selecting studies

Screening of studies, using Rayyan for organization and tracking, took place in two steps. In step 1, the first and second author screened titles and abstracts using the in- and exclusion criteria. Subsequently, in step 2 remaining full-texts were assessed for eligibility. In case of doubt or contrasting decisions, papers were discussed by the first and second author to make a final decision on inclusion or exclusion. The flow chart of the review procedure is displayed in Fig. 1.

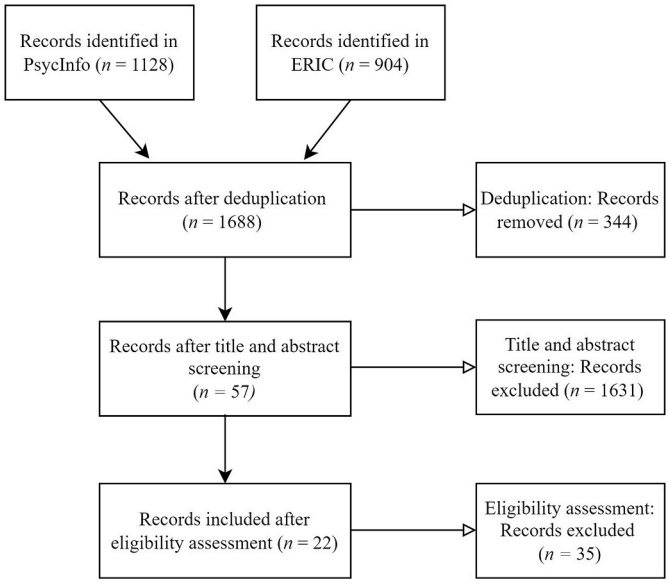


Fig. 1. Flow chart of the scoping review procedure.

2.4. Phase 4: Charting the data

Phase 4 of the scoping review consisted of data extraction for the 22 studies that were subsequently analyzed in the scoping review. In this step, specific study aspects were coded (see Table 2 and Appendix B).

2.5. Phase 5: Collating, summarizing, and reporting the results

Subsequently, a qualitative analysis was performed on the 22 included studies for which the first, second, and third author coded the following: (a) main aim of the study; (b) authors' conclusions on research questions; (c) authors' conclusions on resilience, promotive, and protective factors; and (d) *our* conclusions on resilience, promotive, and protective factors based on the terms, definitions, and statistical requirements presented above (see also Table 1). We also coded (e) the literacy measure at which the resilience was evident (e.g., word-level reading, text reading fluency, and/or reading comprehension) and (f) the presence of power issues (i.e., indicating studies with low statistical power in general or with small subgroups).

3. Results

In the scoping review, a total of 22 studies were included. Most of these studies have been conducted in English-speaking countries (USA, $n = 10$; Canada, $n = 2$; UK, $n = 1$). Furthermore, five studies were conducted in the Netherlands, two in Finland, one in Norway, and one in Spain. Total sample sizes in these studies varied from 36 to 5480 children. In studies with subgroup designs, the minimum subgroup sample size was 12 and the maximum subgroup sample size was 147 (see Appendix B for a complete overview of study characteristics).

3.1. General observations

Analysis of the 22 included studies resulted in two general findings that seem to characterize the current body of literature on resilience in literacy development. First, many of the included studies have (very) small sample sizes and thus low statistical power for finding relevant effects (e.g., Diamond, 2016; Esmaeeli et al., 2019; Plakas et al., 2013; Powell et al., 2014; Saralegui et al., 2014; Zuk et al., 2021). None of the included studies reported a power analysis to confirm that their sample size was sufficient for the performed analyses and it seems that at least some studies lack the power required to detect relevant effects. To illustrate, Esmaeeli et al. (2019), for example, compared various subgroups including reading-disabled children without ($n = 12$) and with a family risk ($n = 13$). Assuming equal standard deviations in both groups, the power to find a large significant difference (Cohen's $d = 0.8$) is less than 50% and only 22% for a medium effect (Cohen's $d = 0.5$). To reach a power of 80% to find a medium effect, at least 82 children per group

Table 2
Category and description of the extracted data.

Category	Description of coded information
Citation	Author(s), publication year, title, journal
Publication type	Journal article, dissertation
Age participants	Age range or mean age in years
Sample size	Total and group sample sizes
(Risk of) RD	Risk of reading difficulties or diagnosed RD
Outcome measure	Literacy related outcome measure(s)
Level of outcome measure	Word-level reading, text-reading fluency and/or reading comprehension
Study design	Longitudinal, cross-sectional
Statistical approach	Variable-centered or Person-centered
Subcategorization	Risk study, Diagnosis of dyslexia study, Family-risk study, Neurostudy, LPA/LCA study, Mixed-level descriptive study.

would be needed (based on Faul et al., 2009).

Second, study designs and/or statistical analyses used are often insufficient to distinguish between promotive, protective, and skill-enhancing factors. For example, studies may contain relevant subgroups and perform group comparisons and/or regression analyses, but complementary interaction analyses to check for the presence and nature of differential effects within subgroups are not performed (e.g., Adlof et al., 2021; Powell et al., 2014; Kiuru et al., 2013; van Viersen et al., 2016). As a consequence, conclusions can only be drawn regarding *potential* protective effects or cannot go beyond promotive effects. These findings may then be relevant for future studies or inform teaching and learning in general but provide only limited information about academic resilience.

Below, we further discuss the findings from the included studies in different categories. Variable-centered studies cover Family-risk studies, (Early and Underlying) risk studies, Diagnosis of dyslexia studies, and Neurostudies. Person-centered studies cover Latent profile/class analysis (LPA/LCA) studies and Mixed-level descriptive studies. Per category, a short description of the study category is given, providing a further operationalization of design requirements for evaluating evidence for resilience. Subsequently, evidence for promotive, protective, and skill-enhancing factors is summarized. Finally, we elaborate on the reasons (i.e., design and statistical aspects) why some studies within a category were not able to provide solid evidence on specific resilience factors. In case of found strengths, but incomplete statistical testing, we speak of potential protective factors. An overview of both potential and established protective factors, as well as promotive and skill-enhancing factors with empirical support, is provided in Table 3.

3.2. Promotive, protective, and skill-enhancing factors in variable-centered studies

3.2.1. Family-risk studies

In family-risk (FR) studies, children who have a FR of dyslexia have a first degree relative (e.g., a parent or sibling) with dyslexia. Consequently, these children are assumed to have a greater genetic as well as environmental risk for developing dyslexia (Snowling & Melby-Lervag, 2016). Required subgroups to evaluate evidence for protective factors concern (1) a FR-dyslexia group (FRD, the high-risk RD group), (2) a FR-no dyslexia group (FRND, the high-risk resilient group), and (3) a no FR-typical reader group (TD, the low-risk TD group). FR studies are inherently prospective; including later RD outcomes can thus render solid insight into protective effects and indications for compensation over time. For continuous designs, main and moderation analyses (and plotting of interaction effects) are essential to distinguish between promotive, protective, and skill-enhancing factors.

Two FR studies were included in this scoping review. These studies pointed to LK and phoneme isolation (Esmaeeli et al., 2019) and language comprehension, expressive language, VSTM, and phoneme deletion (Plakas et al., 2013) as potential protective factors. However, as both studies reported the group comparisons between FRD and FRND children and between FRND and TD children, but did not conduct the group comparison between FRD and TD children, no firm conclusions can be drawn regarding protective effects. We did not find FR studies with a focus on resilience that reported all three comparisons. As a consequence, we cannot draw definite conclusions regarding protective factors based on FR studies.

3.2.2. Risk studies

In risk studies, the risk for word-level RD is determined based on deficits in, for example, PA, RAN, and LK. These skills function as precursors for later literacy development at a pre-reading age and are also considered underlying risk factors associated with the presence of word-level RD at later ages (e.g., Eklund et al., 2013; van Viersen et al., 2018). If the risk assessment was conducted at a pre-reading age, studies were further categorized as Early-risk studies; when risk assessment was conducted after the onset of reading instruction, they were categorized as Underlying-risk studies.

To provide evidence for protective factors, risk studies with subgroup designs should include children at risk for word-level RD that go on to develop word-level RD (i.e., high-risk RD group), at-risk children who resolved their literacy difficulties over time (i.e., high-risk resilient group), as well as a TD comparison group (i.e., low-risk TD group). Necessary group comparisons cover similar steps as in the FR studies (see section 3.2.1): 1) at-risk RD vs. at-risk resilient, 2) at-risk resilient vs. TD, and 3) at-risk RD vs. TD. In risk studies with continuous designs, testing for main and interaction/moderation effects remains essential.

3.2.2.1. Early-risk studies. Four longitudinal early-risk studies were included. Regarding protective factors, evidence was found for behavioral self-regulation (Kehoe et al., 2021), speech production accuracy, functional activity in the right superior longitudinal fasciculus, and vocabulary (Zuk et al., 2021). Furthermore, evidence was found for positive teacher affect, peer acceptance, and cumulative environmental support as promotive factors (Kiuru et al., 2013). Kiuru et al. (2013) took a continuous approach to assess later reading outcomes of children with and without an early risk of word-level RD. Their path models showed that the influence of kindergarten risk on Grade 4 reading fluency outcomes was partly *mediated* by positive teacher affect, peer acceptance, and cumulative environmental support as environmental factors. Subsequent multi-group analyses showed that RD risk did not moderate the effect of the environmental factors. Their findings thus provide evidence for promotive effects. Lastly, no evidence on protective factors was found in the study of Catts et al. (2017) comparing an at risk RD group with an at-risk resilient group. As a TD-comparison group was missing, relevant group comparisons could thus not be made.

3.2.2.2. Underlying-risk studies. Four underlying-risk studies were included, of which three longitudinal and one cross-sectional. Kruk et al. (2013) investigated associations between cumulative Early Childhood and Care (ECEC) hours during early and late preschool and later growth in three aspects of reading, and also plotted interaction effects. Their findings provided evidence for quantity of *late* preschool ECEC on reading comprehension as protective factor. Furthermore, they found evidence for quantity of *early* preschool ECEC on reading comprehension and quantity of *late* preschool ECEC on decoding as skill-enhancing factors. Liew et al. (2018) performed mediation analyses including *only* at-risk children. Hence, the significant mediation effect provided evidence of temperament-based adaptability as potential protective factor. The longitudinal study of Powell et al. (2014) could not provide empirical evidence for protective factors. This study contained a low RAN group with a strength in orthographic learning. However, this group still displayed poor reading skills and could thus not be considered resilient. Finally, the cross-sectional study of Frijters et al. (2018), taking a continuous approach, provided evidence for motivation – conceptualized as causal attributions that children make about experiences of success or failure – as a promotive factor. As moderation was not tested, this study could not indicate further whether motivation might also be a protective factor.

3.2.3. Diagnosis of dyslexia studies

In studies in which RD is operationalized as a diagnosis of dyslexia, finding evidence for protective factors requires the inclusion of an RD group, an RD group that has shown resilience, and a TD control group. Subgroup studies (longitudinal and cross-sectional) require the following group comparisons; 1) RD vs. resilient, 2) resilient vs. TD, and 3) RD vs. TD. In addition, both studies with continuous approaches and cross-sectional subgroup studies should test moderation to provide solid evidence for protective factors.

Four studies were included, providing evidence for *relative* strengths in verbal WM (VWM) and grammar (van Viersen et al., 2016), and

Table 3
Evidence for Promotive, Protective, and Skill-enhancing Factors and Location of Compensation.

Category	Factor	Promotive	Protective	Skill-enhancing	Compensation on		
					WR	TRF	RC
Cognitive	RAN	Yes[n]			X		
	LK		Potential[e]		X		
	Phoneme isolation		Potential[e]		X		
	Phoneme deletion		Potential[e]		X		
	Phonological recognition		Potential[a]		X		
	Processing speed	Yes[n]	Potential[b]		X		X
	Language comprehension		Potential[l]		X		
	Listening comprehension		Potential[c]		X		
	Expressive language		Potential[l]		X		
	Speech production accuracy		Yes[r]		X		
	Grammar		Potential[q]		X		
	Vocabulary	Yes[n]	Yes[r]; Potential[c,p,q]	Yes[n]	X		
	Semantic recognition		Potential[a]		X		
	Semantics	Yes[o]			X		
	Nonverbal semantic recall		Potential[a]		X		
	Nonverbal problem solving		Potential[b]				X
	Orthographic skills		Potential[c]		X		
	Verbal STM		Potential[l,q]		X		
	Verbal WM	Yes[k,n]	Potential[p,q]; No[k]		X		X
	Visuospatial STM		Potential[p,q]		X		
	Visuospatial WM		Potential[p,q]		X		
	Verbal IQ		Potential[p]		X		
	Cognitive control	Yes[k]	No[k]				X
Neural	Functional activity in SLF		Yes[r]		X		
	Gray matter volume in left DRC	Yes[k]	No[k]				X
	Pattern of underactivation in brain areas related to the phonological route and overactivation in brain areas related to the orthographic route	No[m]					
Socio-emotional	Behavioral self-regulation		Yes[g]		X		
	Temperament-based adaptability		Potential[j]		X	X	X
Educational	Quantity of early preschool ECEC			Yes[i]			X
	Quantity of late preschool ECEC		Yes[i]	Yes[i]	X		X
Motivational	Motivation	Yes[f]			X		
	Teacher-reported task-focused behavior (Grade 1)		Yes[d]		X	X	
	Teacher-reported task-focused behavior (Grade 2)		No[d]				
Interpersonal	Positive teacher affect	Yes[h]	No[h]			X	
	Peer acceptance	Yes[h]	No[h]			X	
	Cumulative environmental support	Yes[h]	No[h]			X	

Note. Yes = empirical evidence found for promotive factor (e.g., sig. main effects), protective factor (e.g., sig. interaction effect with gap-closing effect), and/or skill-enhancing factor (e.g., sig. interaction effect with gap-widening effect). No = no empirical evidence found (e.g., no significant main and/or interaction effects). Potential protective = strengths found, but no interaction effects tested.
WR = Word Reading; TRF = Text Reading Fluency; RC = Reading Comprehension; RAN = Rapid Automatized Naming; LK = Letter Knowledge; STM = Short Term Memory; WM = Working Memory; IQ = Intelligence Quotient; SLF = Superior Longitudinal Fasciculus; DRC = Dorsolateral Prefrontal Cortex; ECEC = Early Childhood Education and Care.
Bold footnote letters indicate longitudinal studies.

[a] Adlof et al. (2021).
[b] Compton et al. (2012).
[c] Diamond (2016).
[d] Eklund et al. (2013).
[e] Esmaeeli et al. (2019).
[f] Frijters et al. (2018).
[g] Kehoe et al. (2021).
[h] Kiuru et al. (2013).
[i] Kruk et al. (2013).
[j] Liew et al. (2018).
[k] Patael et al. (2018).
[l] Plakas et al. (2013).
[m] Saralegui et al. (2014).
[n] Slomowitz et al. (2021).
[o] van Rijthoven et al. (2018).
[p] van Viersen et al. (2019).
[q] van Viersen et al. (2016).
[r] Zuk et al. (2021).

phonological recognition, nonverbal semantic recall, and semantic recognition (Adlof et al., 2021), and *absolute* strengths in VSTM, visuospatial WM, and vocabulary (van Viersen et al., 2016).[1] Evidence for semantics (van Rijthoven et al., 2018), and RAN, VWM, and processing speed as promotive factors was also found (Slomowitz et al., 2021). Lastly, the pattern of the interaction effect for vocabulary skills found in Slomowitz et al. (2021) was indicative of vocabulary functioning as a skill-enhancing factor. Different types of factors could thus be identified through these studies. However, both van Viersen et al. (2016) and Adlof et al. (2021) included all relevant subgroups but did not perform additional moderation analyses. Therefore, the relative and absolute strengths in resilient/less impaired RD groups remain potential protective factors and require further investigation. Also, van Rijthoven et al. (2018) conducted a mediation analysis with the goal of testing compensation. However, as their study did not include a TD control group, their results on semantics indirectly contributing to decoding efficiency could at most be interpreted as a promotive factor.

3.2.4. Neurostudies

A final category comprises neurostudies in which the neural basis underlying literacy and RD is studied, either through continuous approaches or subgroup designs. Saralegui et al. (2014) found a pattern in fMRI-results of underactivation in brain areas related to the phonological route and overactivation in brain areas related to the orthographic route in children with dyslexia compared to TD children. This overactivation in brain areas related to the orthographic route might suggest that compensation for phonological difficulties occurs at the neural level. However, this differentiating activation pattern did not result in higher reading outcomes and no comparison was made with an RD group who did not display this pattern of overactivation in the orthographic route. Therefore, no support was found for either promotive or protective factors.

Related, Patael et al. (2018) examined the neural basis underlying reading discrepancy, which was defined as a marked difference between decoding skills and reading comprehension. They found associations between gray matter volume in the dorsolateral prefrontal cortex and reading discrepancy, potentially indicating compensation at the neural level. As working memory and cognitive control were proposed cognitive skills associated with the left dorsolateral prefrontal cortex area, they could thus be potential protective factors. However, given that the samples in this study contained very limited numbers of children with *very* low reading ability/dyslexia *and* that moderation effects by group were not significant, the study currently provides at most evidence for WM and cognitive control as promotive factors.

3.3. Protective, skill-enhancing, and promotive factors in person-centered studies

3.3.1. LPA/LCA studies

To provide evidence for protective factors, LPA/LCA studies should find at least one resilient score profile characterized by the presence of a risk factor but with better-than-expected literacy outcomes. Again, relevant group comparisons between identified score profiles should be made, including reading- impaired, resilient, and TD groups, and moderation should be tested in case of continuous approaches or cross-sectional subgroup designs.

Three studies were included, providing evidence for an *absolute* strength in orthographic skills (Diamond, 2016) and *relative* strengths in processing speed, nonverbal problem solving (Compton et al., 2012), and receptive vocabulary and listening comprehension (Diamond, 2016) in children with resilient profiles. Specifically, the resilient group in Compton et al. (2012) involved students with an absolute weakness in word reading in combination with a relative strength in reading comprehension. The resilient group in Diamond (2016) included students with a strong deficit in PA in combination with only mild difficulties in word identification. Yet, as both studies did not conduct additional regression analyses with moderation, the relative and absolute strengths remain potential protective factors. Finally, the study by Archibald et al. (2019) included a candidate resilient profile of students with a relative reading efficiency weakness. However, as they did not include a more complex reading measure (text reading fluency or reading comprehension), resilience was not established and no conclusions regarding (potential) protective factors could be drawn.

3.3.2. Mixed-level descriptive studies

In the mixed-level descriptive studies, person-centered and variable-centered approaches were combined but did not necessarily feed into each other. For this category, the same conditions hold as previously described in the person-centered (LPA/LCA) and variable-centered approaches.

Three studies were included that all involved a resilient group. Eklund et al. (2013) found evidence for teacher-reported task-focused behavior in Grade 1 as a protective factor. They identified subgroups using mixture modeling and subsequently examined the development of early cognitive skills of these subgroups using a longitudinal design in which children were followed from the start of Grade 1 until the end of Grade 2. Yet, after one year of schooling, the teacher-reported task-focused behavior of the high-risk groups with and without RD no longer differed, indicating that this protective factor (i.e., identified at Grade 1) did not last over time.

Van Viersen et al. (2015, 2019) both combined case series analyses with group comparisons. In both studies the approaches were used separately, providing information at the individual and group level. Van Viersen et al. (2015) found no evidence for compensation or protective factors, as indicated by comparable profiles of strengths in gifted children with mild literacy difficulties and gifted children with dyslexia both in terms of size of strenghts (group level) and combinations of strengths (individual level). Yet, additional moderation analyses were not performed for confirmation. In contrast, van Viersen et al. (2019) rendered evidence for a relative strength in verbal IQ, and absolute strengths in VWM, grammar, visuospatial STM and WM, and vocabulary in gifted students with resolved dyslexia. In contrast to van Viersen et al. (2015), which reported on a primary school sample, they showed that the resilient group of secondary school students had clear strengths in specific areas that were also more pronounced and more often involved a combination of strengths than in gifted students with persistent dyslexia. Combined with information about underlying weaknesses, van Viersen et al. (2019) provided evidence that the relative and absolute strengths found in these resilient students could at least partly explain why they were able to resolve their word-level RD and the group with persistent dyslexia was not. However, as moderation was not tested, the aforementioned strengths remain potential protective factors.

4. Discussion

4.1. Summary of results

The aims of this scoping review were to 1) further operationalize study designs and statistical approaches for studying academic resilience in literacy research, and 2) evaluate existing empirical evidence on promotive, protective, and skill-enhancing factors involved in literacy development. Our main finding is that solid evidence for protective factors contributing to positive literacy outcomes in children with (a risk of) word-level reading difficulties is still limited, despite a substantial emerging body of research focusing on resilience in literacy development. This has four reasons. First, available empirical evidence is limited

[1] A relative strength concerns higher performance (but not necessarily attaining average levels) on a specific skill compared to an impaired group. An absolute strength concerns higher performance (above average levels) compared to a TD group.

due to the low number of studies on academic resilience in literacy. Only 22 studies were eligible for this scoping review. Furthermore, relevant studies are not always consistent in their findings (e.g., mixed effects across studies for vocabulary). Third, many studies do not have a suitable design to draw conclusions regarding protective factors (e.g., Archibald et al., 2019; Esmaeeli et al., 2019; Powell et al., 2014; Saralegui et al., 2014; van Rijthoven et al., 2018). Finally, many studies report incomplete statistical analyses, lacking essential interaction/moderation analyses (e.g. Adlof et al., 2021; Compton et al., 2012; Diamond, 2016; Esmaeeli et al., 2019; Frijters et al., 2018; Kiuru et al., 2013; Plakas et al., 2013; Powell et al., 2014; van Viersen et al., 2016; Zuk et al., 2021), or have low statistical power due to small sample sizes (e.g., Compton et al., 2012; Diamond, 2016; Esmaeeli et al., 2019; Patael et al., 2018; Saralegui et al., 2014; Zuk et al., 2021).

Hence, to date there is no basis to provide concrete practical recommendations for educational or clinical practice to help remediate the literacy difficulties of children with word-level RD in new ways. Yet, our findings do point to various potential protective factors which deserve further investigation and may prove to help children with (a risk of) word-level RD to improve their literacy outcomes and (partly) overcome their reading difficulties. Research on resilience in literacy thus has great promise to advance the field and further our understanding of literacy development. Below, we provide a further integration of the empirical evidence on promotive, protective, and skill-enhancing factors. These involve cognitive as well as non-cognitive factors, for which higher scores leads to better literacy outcomes.

4.1.1. Empirical evidence on promotive, protective, and skill-enhancing factors

Overall, several factors have been identified as promotive factors, contributing to positive literacy outcomes for all children regardless of the presence or degree of (a risk of) word-level RD. These include mainly child-related factors: empirical evidence for cognitive factors was found for RAN, VWM, processing speed (Slomowitz et al., 2021), and semantics (van Rijthoven et al., 2018). In addition, evidence was found for behavioral self-regulation (Kehoe et al., 2021), motivation (Frijters et al., 2018), positive teacher affect, peer acceptance, and environmental support (Kiuru et al., 2013) as non-cognitive promotive factors. It should be noted that for studies in which no interaction is tested, these factors could turn out to also be protective or skill-enhancing.

Furthermore, several factors have been identified as protective factors, contributing to better-than-expected literacy outcomes for children with (a risk of) word-level RD. These mostly include child-related cognitive factors associated with word-level literacy outcomes: empirical evidence was found for speech production accuracy and vocabulary (Zuk et al., 2021). Additionally, empirical support was found for the non-cognitive factors functional activity in superior longitudinal fasciculus (Zuk et al., 2021), teacher reported task-focused behavior (Eklund et al., 2013) and quantity of *late* ECEC (Kruk et al., 2013) as protective factors. Hence, the evidence indicates that the presence of these factors can 'close the gap' and help children with (a risk of) word-level RD to catch up with their TD peers on word-level literacy. The study of Eklund et al. (2013) also provided evidence for teacher-reported task-focused behavior as protective factor on text reading fluency. Empirical evidence for protective factors on reading comprehension was found only for quantity of *late* preschool ECEC (Kruk et al., 2013). For other – mostly cognitive – child-related factors, empirical evidence was insufficient mainly due to missing subgroups and/or incomplete statistical testing. The factors in these studies – with found strengths, but incomplete statistical testing – therefore remain *potential* protective factors. (Re)analyzing the data from these studies with additional moderation analyses can reveal whether these factors turn out to have actual gap-closing effects.

Regarding skill-enhancing factors, empirical evidence on word-level reading was found for vocabulary (Slomowitz et al., 2021) and quantity of *late* preschool ECEC (Kruk et al., 2013). Kruk et al. (2013) also found quantity of *early* preschool ECEC to have gap-widening effects on reading comprehension. Results from Kruk et al. (2013) provide an example of the importance of 1) distinguishing between promotive, protective, and skill-enhancing factors, and 2) reporting on the literacy outcome in which compensation becomes apparent. The information that arises from these distinctions is essential for developing effective interventions.

Overall, these results for promotive, protective, and skill-enhancing factors combined yield the evident interpretation that future research into resilience-related factors needs to encompass child-related cognitive and non-cognitive factors as well as environmental cues/support.

4.2. Moving academic resilience research forward

Our findings reveal several recurring issues and simultaneously demonstrate the potential for investigating resilience-related factors in the context of literacy development. To encourage further research on protective factors and compensation, we present a set of considerations to advance the field of educational psychology in planning and conducting research into academic resilience in literacy.

4.2.1. Focus on various literacy outcomes

Our study established that the empirical base on resilience in reading is limited. Therefore, further research is needed to understand resilience in various literacy outcomes. Research focusing on resilience in word-level literacy outcomes remains important for at-risk populations and children with poor precursor skills. However, research on resilience in word-level literacy outcomes in children with *established* word-level RD has yielded limited results. Theoretically, the potential for compensation on word-level reading is limited, as it is a basic skill with restricted possibilities for compensatory *mechanisms* to arise, and the children involved already have word-level RD. Therefore, research on resilience in text reading fluency and reading comprehension has added value for children with word-level RD. Both literacy outcomes involve complex higher-order skills that leave more room for the development of mechanisms that compensate for risk factors or affect component skills. This shift in focus provides ample opportunities for detecting relevant protective factors that can subsequently be used in designing effective reading interventions.

4.2.2. Choosing a research design and statistical analyses

This scoping review has demonstrated that a variety of study types are suitable for testing resilience when applying the correct research design. Variable-centered studies need to include complementary interaction analyses and/or include all pairwise comparisons covering at least three subgroups (i.e., high-risk RD group, high-risk resilient group, and low-risk TD group) to discern between promotive, protective, and skill-enhancing factors. Person-centered or mixed-level studies can help to identify naturally occurring subgroups of children displaying different combinations of risk and resilience factors and how these differ in literacy outcomes. Thereby, these studies can provide relevant new insights into how certain resilience variables may compensate for the presence of a risk factor (see also Catts & Petscher, 2021; Slomowitz et al., 2024). Furthermore, Slomowitz et al. (2021, 2024) stress the importance of longitudinal research designs for testing resilience mechanisms over time. In this context, we want to specifically add mediation analyses as a useful approach within longitudinal designs, because mediation analyses can provide insights into the causal chain behind compensatory mechanisms. The study of Liew et al. (2018) has provided an excellent example of how mediation analyses over time, including both child and contextual factors, can shed more light on compensatory mechanisms underlying academic resilience in literacy. Finally, a promising statistical method to quantify resilience as an outcome is residualization. In residualization of academic outcomes with risk scores, an expected level of adjustment to risk is predicted through regression such that negative residuals indicate maladaptation

whereas positive residuals indicate resilience (see e.g., Höltge & Ungar, 2022; Marquez et al., 2023). Although this method was used in one of the records assessed for this scoping review (Patael et al., 2018), an additional evaluation of the metric used was beyond the scope of the current study.

4.2.3. Handling power issues

The finding that many studies showed power issues points to the evident need of either using larger samples or applying statistical analyses suited for relatively small sample sizes. For example, an additional benefit of longitudinal designs is that they are typically more powerful: the total variation is split into within-group variation and between-group variation, reducing the error variation. In other words, some of the random variation between participants can be removed by following the same individuals over time. Another alternative is to use a Bayesian approach (see e.g., van de Schoot et al., 2014, van de Schoot et al., 2015). This allows for the inclusion of prior information, which increases the total amount of information in the analysis. Thereby, Bayesian analyses with reasonable informative priors, as compared to traditional frequentist approaches, can achieve sufficient power with smaller samples. In addition, the use of Bayes factors instead of *p*-values enables 1) a more intuitive interpretation of the amount of evidence compared to the use of traditional cut-off values; and 2) obtaining evidence for the null-hypothesis, which is needed to draw conclusions about gap-maintaining promotive factors. In relevant previous studies with relatively small sample sizes (e.g., van Viersen et al., 2015, 2019), the application of a Bayesian approach has proven useful. Therefore, we propose to extend the use of Bayesian approaches within the resilience framework.

4.3. Limitations and future research

Our scoping review has several limitations, most of which are related to the deliberately sharp focus. Our search targeted empirical studies specifically referring to resilience, compensation, protective factors, strengths, or relevant variations to these search terms. These search terms have excluded studies on, for example, risk factors for word-level RD. Although studies on risk factors generally contain potentially relevant data, the lack of a focus on resilience prevents them from revealing information about promotive and/or protective effects in their current form. Even if designs are fitting, a re-analyses of the data would be required to add to the empirical base for resilience-related factors. Naturally, this lies beyond the scope of the current study.

The inclusion criteria we applied to further define the scope of our study have also excluded studies on compensated dyslexia in tertiary education (i.e., as a result of the age range; e.g., Cavalli et al., 2017). The body of literature on dyslexia in college and university students is substantial and can provide important insights into factors that lead to resilience in older age groups, with the added value that the data can often be considered in a prospective way. Hence, we contend that these studies would deserve their own review.

Likewise, our definition of the nature of the risk and/or underlying cause for word-level RD was limited to the cognitive level (i.e., referring to PA, RAN, LK, etc.; Snowling et al., 2021). These skills are also affected in children with DLD, but generally not in children with literacy problems due to behavioral risk factors, such as autism spectrum disorder (ASD; e.g., McIntyre et al., 2017), leading to exclusion of samples tapping into the latter group. In future studies, it would be interesting to broaden the definition of risk for word-level RD to children whose difficulties result from non-cognitive factors. A broader focus may also contribute to the investigation of additional aspects relevant for literacy acquisition, which requires a higher number of included studies with sufficient variation. Due to the low number of studies in this scoping review, we were not able to differentiate our findings based on orthographic transparency, for example, as the included studies covered only five different languages.

It is important to note that our exclusive focus on descriptive empirical studies did not necessarily contribute to these low numbers. Although some experimental and intervention studies are available (Tilanus et al., 2016), they are still sparse and may also lack the application of a clear resilience framework (e.g., van Rijthoven et al., 2021). Ideally, resilience is assessed on the basis of longitudinal studies, incorporating child as well as environmental factors that speak to literacy resilience. Understanding the specific factors in (compensation of poor) literacy is needed to further develop experimental studies and interventions focusing on specific promotive and protective factors that contribute to positive literacy outcomes and help children with (a risk of) word-level RD catch up with their TD peers as much as possible.

Finally, regarding the synthesis of our findings, it is important to note that we evaluated empirical evidence for promotive, protective, and skill-enhancing factors based on traditional arbitrary cut-offs for *p*-values (with an α-level of .05), as this is how results are generally reported in current literacy research. Accordingly, effects with a *p*-value just above this cut-off were judged as *not* providing evidence for resilience-related factors, while *p*-values just below this cut-off were judged as providing sufficient evidence for resilience-related factors. The aforementioned use of Bayes factors, or evaluations focusing on effect sizes (which should be reported according to APA guidelines, but are often omitted; American Psychological Association; 7th ed.; APA7, 2020), could address this issue in future research. Evaluating these alternative outcomes would add both nuance and relevance to the findings for individual promotive, protective, and skill-enhancing effects.

4.4. Conclusion

Overall, this study provided a further operationalization of the translation from previous approaches to socio-emotional resilience in developmental psychopathology into a framework for studying *academic resilience* in educational psychology. Furthermore, this study evaluated current empirical evidence for promotive, protective, and skill-enhancing factors using consistent terminology to gain more insight into resilience in atypical literacy development. While strong empirical evidence for protective factors was sparse, existing research revealed multiple *potential* cognitive and non-cognitive protective factors which may allow children with (a risk of) RD to catch up with their TD peers. Likewise, important additional information about promotive factors – which also contribute to positive literacy outcomes – and skill-enhancing factors was acquired. Understanding the paths in literacy development in relation to promotive, protective, and skill enhancing factors is essential for informing educational practices, interventions, and clinical practice. Based on the current findings, we proposed several considerations to advance the field of educational psychology in planning and conducting research into resilience in literacy.

Funding

This research is funded by a workload grant from the Department of Education and Pedagogy of Utrecht University awarded to Sietske van Viersen and Sara van Erp.

Data and scripts are available through the OSF at https://osf.io/q4895/.

CRediT authorship contribution statement

Sanne Appels: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Sietske van Viersen:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Sara van Erp:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Funding acquisition, Formal analysis, Conceptualization.

Lisette Hornstra: Writing – review & editing, Supervision, Conceptualization. **Elise de Bree:** Writing – review & editing, Supervision, Conceptualization.

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.learninstruc.2024.101969.

References

Adlof, S. M., Baron, L. S., Bell, B. A., & Scoggins, J. (2021). Spoken word learning in children with developmental language disorder or dyslexia. *Journal of Speech, Language, and Hearing Research, 64*, 2734–2749. https://doi.org/10.1044/2021_JSLHR-20-00217

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.).

American Psychological Association. (2020). *Publication manual of the American psychological association* (7th ed.) https://dio.org/10.1037/0000165-000.

Archibald, L. M. D., Cardy, J. O., Ansari, D., Olino, T., & Joanisse, M. F. (2019). The consistency and cognitive predictors of children's oral language, reading, and math learning profiles. *Learning and Individual Differences, 70*, 130–141. https://doi.org/10.1016/j.lindif.2019.02.003

Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology, 8*(1), 19–32. https://doi.org/10.1080/1364557032000119616

Bergman, L. R., & Magnusson, D. (1997). A person-centered approach in research on developmental psychopathology. *Development and Psychopathology, 9*, 291–319. https://doi.org/10.1017/S095457949700206X

Catts, H. W., Adlof, S. M., Hogan, T. P., & Weismer, S. E. (2005). Are specific language impairment and dyslexia distinct disorders? *Journal of Speech, Language, and Hearing Research, 48*(6), 1378–1396. https://doi.org/10.1044/1092-4388(2005/096

Catts, H. W., Compton, D., Tomblin, J. B., & Bridges, M. S. (2012). Prevalence and nature of late-emerging poor readers. *Journal of Educational Psychology, 104*(1), 166–181. https://doi.org/10.1037/a0025323

Catts, H. W., McIlraith, A., Bridges, M. S., & Nielsen, D. C. (2017). Viewing a phonological deficit within a multifactorial model of dyslexia. *Reading and Writing, 30*(3), 613–629. https://doi.org/10.1007/s11145-016-9692-2

Catts, H. W., & Petscher, Y. (2021). A cumulative risk and resilience model of dyslexia. *Journal of Learning Disabilities, 55*(3), 171–184. https://doi.org/10.1177/00222194211037062

Cavalli, E., Duncan, L. G., Elbro, C., El Ahmadi, A., & Colé, P. (2017). Phonemic—morphemic dissociation in university students with dyslexia: An index of reading compensation? *Annals of Dyslexia, 67*(1), 63–84. https://doi.org/10.1007/s11881-016-0138-y

Compton, D. L., Fuchs, L. S., Fuchs, D., Lambert, W., & Hamlett, C. (2012). The cognitive and academic profiles of reading and mathematics learning disabilities. *Journal of Learning Disabilities, 45*(1), 79–95. https://doi.org/10.1177/0022219410393012

Diamond, J. E. (2016). Examining language and literacy profiles of adolescent struggling readers. *Dissertation Abstracts International Section A: Humanities and Social Sciences, 76*, 9-A(E)), No-Specified.

Eklund, K. M., Torppa, M., & Lyytinen, H. (2013). Predicting reading disability: Early cognitive risk and protective factors: Reading disability: Risk and protective factors. *Dyslexia, 19*(1), 1–10. https://doi.org/10.1002/dys.1447

Eloranta, A., Närhi, V. M., Eklund, K. M., Ahonen, T. P. S., & Aro, T. I. (2018). Resolving reading disability—childhood predictors and adult-age outcomes. *Dyslexia, dys, 1605*. https://doi.org/10.1002/dys.1605

Esmaeeli, Z., Kyle, F. E., & Lundetræ, K. (2019). Contribution of family risk, emergent literacy and environmental protective factors in children's reading difficulties at the end of second-grade. *Reading and Writing, 32*(9), 2375–2399. https://doi.org/10.1007/s11145-019-09948-5

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods, 41*, 1149–1160.

Frijters, J. C., Tsujimoto, K. C., Boada, R., Gottwald, S., Hill, D., Jacobson, L. A., Lovett, M. W., Mahone, E. M., Willcutt, E. G., Wolf, M., Bosson-Heenan, J., & Gruen, J. R. (2018). Reading-related causal attributions for success and failure: Dynamic links with reading skill. *Reading Research Quarterly, 53*(1), 127–148. https://doi.org/10.1002/rrq.189

Gough, P., & Tunmer, W. (1986). Decoding, reading, and reading disability. *Remedial and Special Education, 7*, 6–10.

Haft, S. L., Myers, C. A., & Hoeft, F. (2016). Socio-emotional and cognitive resilience in children with reading disabilities. *Current Opinion in Behavioral Sciences, 10*, 133–141. https://doi.org/10.1016/j.cobeha.2016.06.005

Hjetland, H. N., Lervåg, A., Lyster, S. A. H., Hagtvet, B. E., Hulme, C., & Melby-Lervåg, M. (2019). Pathways to reading comprehension: A longitudinal study from 4 to 9 years of age. *Journal of Educational Psychology, 111*(5), 751–763. https://doi.org/10.1037/edu0000321

Höltge, J., & Ungar, M. (2022). Quantifying resilience as an outcome: Advancing the residual approach with influence statistics to derive more adequate thresholds of resilience. *Adversity and Resilience Science, 3*(4), 381–390. https://doi.org/10.1007/s42844-022-00078-6

Hoover, W., & Gough, P. (1990). The simple view of reading. *Reading and Writing: An Interdisciplinary Journal, 2*, 127–160.

Hulme, C., Nash, H. M., Gooch, D., Lervåg, A., & Snowling, M. J. (2015). The foundations of literacy development in children at familial risk of dyslexia. *Psychological Science, 26*(12), 1877–1886. https://doi.org/10.1177/0956797615603702

Kehoe, K. F., McGinty, A. S., Williford, A. P., & Whittaker, J. V. (2021). Behavioral self-regulation as a protective factor for children at risk of reading failure: Predicting first-grade reading from kindergarten entry assessment (KEA) data. *Early Education & Development, 32*(7), 994–1015. https://doi.org/10.1080/10409289.2020.1857540

Kim, Y.-S. G. (2019). Hierarchical and dynamic relations of language and cognitive skills to reading comprehension: Testing the direct and indirect effects model of reading (DIER). *Journal of Educational Psychology, 112*(4), 667–684. https://doi.org/10.1037/edu0000407

Kiuru, N., Lerkkanen, M.-K., Niemi, P., Poskiparta, E., Ahonen, T., Poikkeus, A.-M., & Nurmi, J.-E. (2013). The role of reading disability risk and environmental protective factors in students' reading fluency in grade 4. *Reading Research Quarterly, 48*(4), 349–368. https://doi.org/10.1002/rrq.53

Klimovich-Gray, A., Di Liberto, G., Amoruso, L., Barrena, A., Agirre, E., & Molinaro, N. (2023). Increased top-down semantic processing in natural speech linked to better reading in dyslexia. *NeuroImage, 273*, Article 120072. https://doi.org/10.1016/j.neuroimage.2023.120072

Kruk, R. S., Prentice, S., & Moen, K. B. (2013). Early childhood education and care (ECEC) and reading acquisition in at-risk readers: Does quantity matter? *Canadian Journal of Behavioural Science/Revue Canadienne des Sciences du Comportement, 45*(1), 49–63. https://doi.org/10.1037/a0022706

Levac, D., Colquhoun, H., & O'Brien, K. K. (2010). Scoping studies: Advancing the methodology. *Implementation Science, 5*(1), 69. https://doi.org/10.1186/1748-5908-5-69

Liew, J., Cao, Q., Hughes, J. N., & Deutz, M. H. F. (2018). Academic resilience despite early academic adversity: A three-wave longitudinal study on regulation-related resiliency, interpersonal relationships, and achievement in first to third grade. *Early Education & Development, 29*(5), 762–779. https://doi.org/10.1080/10409289.2018.1429766

Marquez, J., Francis-Hew, L., & Humphrey, N. (2023). Protective factors for resilience in adolescence: Analysis of a longitudinal dataset using the residuals approach. *Child and Adolescent Psychiatry and Mental Health, 17*(1), 140. https://doi.org/10.1186/s13034-023-00687-8

Masten, A. S. (2001). *Ordinary magic: Resilience processes in development*. New York, NY, USA: Guilford Press.

Masten, A., & Barnes, A. (2018). Resilience in children: Developmental perspectives. *Children, 5*(7), 98. https://doi.org/10.3390/children5070098

McArthur, G. M., Hogben, J. H., Edwards, V. T., Heath, S. M., & Mengler, E. D. (2000). On the "specifics" of specific reading disability and specific language impairment. *Journal of Child Psychology and Psychiatry, 41*(7), 869–874. https://doi.org/10.1111/1469-7610.00674

McGrath, L. M., Peterson, R. L., & Pennington, B. F. (2020). The multiple deficit model: Progress, problems, and prospects. *Scientific Studies of Reading, 24*(1), 7–13. https://doi.org/10.1080/10888438.2019.1706180

McIntyre, N. S., Solari, E. J., Gonzales, J. E., Solomon, M., Lerro, L. E., Novotny, S., Osward, T. M., & Mundy, P. C. (2017). The scope and nature of reading comprehension impairments in school-aged children with higher-functioning Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders, 47*(9), 2838–2860. https://doi.org/10.1007/s10803-017-3209-y

Mol, S. E., & Bus, A. G. (2011). To read or not to read: A meta-analysis of print exposure from infancy to early adulthood. *Psychological Bulletin, 137*(2), 267–296. https://doi.org/10.1037/a0021890

Nation, K., & Snowling, M. J. (1998). Individual differences in contextual facilitation: Evidence from dyslexia and poor reading comprehension. *Child Development, 69*(4), 996–1011. https://doi.org/10.1111/j.1467-8624.1998.tb06157.x

OECD. (2019). *PISA 2018 results (volume I): What students Know and can do, PISA*. Paris: OECD Publishing. https://doi.org/10.1787/5f07c754-en

Ouzzani, M., Hammady, H., Fedorowicz, Z., & Elmagarmid, A. (2016). Rayyan — a web and mobile app for systematic reviews. *Systematic Reviews, 5*, 210. https://doi.org/10.1186/s13643-016-0384-4

Patael, S. Z., Farris, E. A., Black, J. M., Hancock, R., Gabrieli, J. D. E., Cutting, L. E., & Hoeft, F. (2018). Brain basis of cognitive resilience: Prefrontal cortex predicts better reading comprehension in relation to decoding. *PLoS One, 13*(6), Article e0198791. https://doi.org/10.1371/journal.pone.0198791

Peng, P., Fuchs, D., Fuchs, L. S., Elleman, A. M., Kearns, D. M., Gilbert, J. K., Compton, D. L., Cho, E., & Patton, S. (2019). A longitudinal analysis of the trajectories and predictors of word reading and reading comprehension development among at-risk readers. *Journal of Learning Disabilities, 52*(3), 195–208. https://doi.org/10.1177/0022219418809080

Peterson, R. L., & Pennington, B. F. (2015). Developmental dyslexia. *Annual Review of Clinical Psychology, 11*(1), 283–307. https://doi.org/10.1146/annurev-clinpsy-032814-112842

Plakas, A., van Zuijen, T., van Leeuwen, T., Thomson, J. M., & van der Leij, A. (2013). Impaired non-speech auditory processing at a pre-reading age is a risk-factor for dyslexia but not a predictor: An ERP study. *Cortex, 49*(4), 1034–1045. https://doi.org/10.1016/j.cortex.2012.02.013

Powell, D., Stainthorp, R., & Stuart, M. (2014). Deficits in orthographic knowledge in children poor at Rapid automatized naming (RAN) tasks? *Scientific Studies of Reading, 18*(3), 192–207. https://doi.org/10.1080/10888438.2013.862249

Protopapas, A., Parrila, R., & Simos, P. G. (2016). In search of Matthew effects in reading. *Journal of Learning Disabilities, 49*(5), 499–514. https://doi.org/10.1177/0022219414559974

Ramus, F., Marshall, C. R., Rosen, S., & van der Lely, H. K. J. (2013). Phonological deficits in specific language impairment and developmental dyslexia: Towards a multidimensional model. *Brain, 136*(2), 630–645. https://doi.org/10.1093/brain/aws356

Saralegui, I., Ontañón, J. M., Fernandez-Ruanova, B., Garcia-Zapirain, B., Basterra, A., & Sanz-Arigita, E. J. (2014). Reading networks in children with dyslexia compared to children with ocular motility disturbances revealed by fMRI. *Frontiers in Human Neuroscience, 8*. https://doi.org/10.3389/fnhum.2014.00936

Shamseer, L., Moher, D., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P., & Stewart, L. (2015). Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: Elaboration and explanation. *British Medical Journal, 349*, g7647. https://doi.org/10.1136/bmj.g7647

Slomowitz, R. F., Narayan, A. J., & McGrath, L. M. (2024). *Resilience research in learning disabilities: Guiding principles from developmental psychopathology*. CO: Department of Neuropsychology, University of Denver [Manuscript submitted for publication].

Slomowitz, R. F., Narayan, A. J., Pennington, B. F., Olson, R. K., DeFries, J. C., Willcutt, E. G., & McGrath, L. M. (2021). In search of cognitive promotive and protective factors for word reading. *Scientific Studies of Reading, 25*(5), 397–416. https://doi.org/10.1080/10888438.2020.1821035

Snowling, M. J., Hulme, C., & Nation, K. (2020). Defining and understanding dyslexia: Past, present and future. *Oxford Review of Education, 46*(4), 501–513. https://doi.org/10.1080/03054985.2020.1765756

Snowling, M. J., & Melby-Lervag, M. (2016). Oral language deficits in familial dyslexia: A meta-analysis and review. *Psychological Bulletin, 142*(5), 498–545. https://doi.org/10.1037/bul0000037

Snowling, M. J., Moll, K., & Hulme, C. (2021). Language difficulties are a shared risk factor for both reading disorder and mathematics disorder. *Journal of Experimental Child Psychology, 202*, Article 105009. https://doi.org/10.1016/j.jecp.2020.105009

Snowling, M. J., Nash, H. M., Gooch, D. C., Hayiou-Thomas, M. E., Hulme, C., & Wellcome Language and Reading Project Team. (2019). Developmental outcomes for children at high risk of dyslexia and children with developmental language disorder. *Child Development, 90*(5). https://doi.org/10.1111/cdev.13216

Stanovich, K. E. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly, 21*(4), 360–407.

Tilanus, E. A. T., Segers, E., & Verhoeven, L. (2016). Responsiveness to intervention in children with dyslexia. *Dyslexia, 22*(3), 214–232. https://doi.org/10.1002/dys.1533

Torppa, M., Eklund, K., van Bergen, E., & Lyytinen, H. (2015). Late-emerging and resolving dyslexia: A follow-up study from age 3 to 14. *Journal of Abnormal Child Psychology, 43*(7), 1389–1401. https://doi.org/10.1007/s10802-015-0003-1

van de Schoot, R., Broere, J. J., Perryck, K. H., Zondervan-Zwijnenburg, M., & van Loey, N. E. (2015). Analyzing small data sets using Bayesian estimation: The case of posttraumatic stress symptoms following mechanical ventilation in burn survivors. *European Journal of Psychotraumatology, 6*(1), Article 25216. https://doi.org/10.3402/ejpt.v6.25216

van de Schoot, R., Kaplan, D., Denissen, J., Asendorpf, J. B., Neyer, F. J., & van Aken, M. A. G. (2014). A gentle introduction to bayesian analysis: Applications to developmental research. *Child Development, 85*(3), 842–860. https://doi.org/10.1111/cdev.12169

van Rijthoven, R., Kleemans, T., Segers, E., & Verhoeven, L. (2018). Beyond the phonological deficit: Semantics contributes indirectly to decoding efficiency in children with dyslexia. *Dyslexia, 24*(4), 309–321. https://doi.org/10.1002/dys.1597

van Rijthoven, R., Kleemans, T., Segers, E., & Verhoeven, L. (2021). Response to phonics through spelling intervention in children with dyslexia. *Reading & Writing Quarterly, 37*(1), 17–31. https://doi.org/10.1080/10573569.2019.1707732

van Viersen, S., de Bree, E. H., & de Jong, P. F. (2019). Protective factors and compensation in resolving dyslexia. *Scientific Studies of Reading, 23*(6), 461–477. https://doi.org/10.1080/10888438.2019.1603543

van Viersen, S., de Bree, E. H., Kroesbergen, E. H., Slot, E. M., & de Jong, P. F. (2015). Risk and protective factors in gifted children with dyslexia. *Annals of Dyslexia, 65*(3), 178–198. https://doi.org/10.1007/s11881-015-0106-y

van Viersen, S., de Bree, E. H., Verdam, M., Krikhaar, E., Maassen, B., van der Leij, A., & de Jong, P. F. (2017). Delayed early vocabulary development in children at family risk of dyslexia. *Journal of Speech, Language, and Hearing Research, 60*(4), 937–949. https://doi.org/10.1044/2016_JSLHR-L-16-0031

van Viersen, S., de Bree, E. H., Zee, M., Maassen, B., van der Leij, A., & de Jong, P. F. (2018). Pathways into literacy: The role of early oral language abilities and family risk for dyslexia. *Psychological Science, 29*(3), 418–428. https://doi.org/10.1177/0956797617736886

van Viersen, S., Kroesbergen, E. H., Slot, E. M., & de Bree, E. H. (2016). High reading skills mask dyslexia in gifted children. *Journal of Learning Disabilities, 49*(2), 189–199. https://doi.org/10.1177/0022219414538517

Vellutino, F. R., Fletcher, J. M., Snowling, M. J., & Scanlon, D. M. (2004). Specific reading disability (dyslexia): What have we learned in the past four decades? *Journal of Child Psychology and Psychiatry, 45*(1), 2–40. https://doi.org/10.1046/j.0021-9630.2003.00305.x

Verhoeven, L., Perfetti, C., & Pugh, K. (Eds.). (2019). *Developmental dyslexia across languages and writing systems*. Cambridge University Press. https://doi.org/10.1017/9781108553377.

Wright, M. O., Masten, A. S., & Narayan, A. J. (2013). Resilience processes in development: Four waves of research on positive adaptation in the context of adversity. In L. Goldstein, & R. B. Brooks (Eds.), *Handbook of resilience in children* (pp. 15–37). https://doi.org/10.1007/978-1-4614-3661-4

Zuk, J., Dunstan, J., Norton, E., Yu, X., Ozernov-Palchik, O., Wang, Y., Hogan, T. P., Gabrieli, J. D. E., & Gaab, F. (2021). Multifactorial pathways facilitate resilience among kindergarteners at risk for dyslexia: A longitudinal behavioral and neuroimaging study. *Developmental Science, 24*(1).

Sanne Appels is PhD-Candidate at Utrecht University working on protective factors in literacy development.

Sietske van Viersen is Assistant Professor at Utrecht University working on literacy development, reading fluency, and dyslexia.

Sara van Erp is Assistant Professor at Utrecht University working on Bayesian regularized structural equation modeling.

Lisette Hornstra is Associate Professor at Utrecht University working on classroom factors facilitating students' cognitive and non-cognitive development

Elise de Bree is endowed professor developmental language disorders in inclusive education at Utrecht University and full professor of developmental disorders and education at the University of Amsterdam